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Report of the individual review of the greenhouse gas inventory of the United States of America submitted in 2007*

* In the symbol for this document, 2007 refers to the year in which the inventory was submitted, and not to the year of publication.

CONTENTS

I. Executive summary

1. This report covers the in-country review of the 2007 greenhouse gas (GHG) inventory submission of the United States of America, coordinated by the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, in accordance with decision 19/CP.8. The review took place from 4 to 9 February 2008 in Washington D.C., United States, and was conducted by the following team of nominated experts from the roster of experts: generalist – Ms. Riitta Pipatti (Finland); energy – Mr. Ralph Harthan (Germany); industrial processes – Ms. Sonia Petrie (New Zealand); agriculture – Mr. Marcelo Rocha (Brazil); land use, land-use change and forestry (LULUCF) – Mr. Mikhail Gytarsky (Russian Federation); waste – Mr. Philip Acquah (Ghana). Mr. Gytarsky and Mr. Acquah were the lead reviewers. The review was coordinated by Ms. Astrid Olsson and Ms. Katia Simeonova (UNFCCC secretariat).

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

3. In 2005, the most important GHG in the United States was carbon dioxide (CO_2), contributing 84.1 per cent of the total[1] national GHG emissions expressed in CO_2 equivalent (CO_2 eq), followed by methane (CH_4), 7.3 per cent, and nitrous oxide (N_2O), 6.4 per cent. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) taken together contributed 2.3 per cent of the overall GHG emissions in the country. The energy sector accounted for 85.6 per cent of the total GHG emissions followed by agriculture, 7.4 per cent, industrial processes, 4.6 per cent, waste, 2.3 per cent, and solvent and other product, use 0.1 per cent. Total GHG emissions (excluding LULUCF) amounted to 7,241,482.12 Gg CO_2 eq and increased by 16.3 per cent from 1990 to 2005.

4. Since 1990, HFCs have displayed the largest increase, rising by 294.7 per cent, followed by CO_2, 20.3 per cent. Emissions of the other gases showed a decreasing trend: PFCs by 70.6 per cent, SF_6 by 49.1 per cent, CH_4 by 12.3 per cent and N_2O by 3.1 per cent. The largest increase in emissions was in the energy sector, 19.2 per cent, followed by industrial processes, 11.2 per cent, and agriculture, 1.1 per cent. Emissions from the waste sector decreased by 13.9 per cent between 1990 and 2005. Removals in the LULUCF sector increased by 15.7 per cent. The drivers for the above trends were generally documented in the national inventory report (NIR) and discussed with the expert review team (ERT) during the review. The ERT finds the observed trends reasonable.

5. The United States Environmental Protection Agency (EPA) has overall responsibility for the preparation of the national inventory, whereas the State Department, as the focal point for the UNFCCC, oversees the annual inventory submission to the UNFCCC secretariat. Other United States agencies (Energy Information Administration (EIA), Department of Agriculture (USDA), Geological Survey (USGS) and many others) and their affiliated agencies or institutions collaborate with EPA in the preparation process, mainly by providing activity data (AD) or making estimations for particular categories. Contractors in different parts of the country (universities, consultant companies and individuals) calculate many of the emission and removal estimates.

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

Table 1. Greenhouse gas emissions by gas, 1990–2005

GHG emissions	Gg CO_2 equivalent									Change BY–2005 (%)
	Base year Convention	1990	1995	2000	2001	2002	2003	2004	2005	
CO_2	5 061 634.36	5 061 634.36	5 384 614.62	5 939 968.48	5 843 025.23	5 892 744.46	5 952 537.51	6 064 328.64	6 089 490.31	20.3
CH_4	601 978.58	601 978.58	594 712.44	549 681.36	541 699.00	539 309.44	541 185.11	533 333.55	527 716.60	–12.3
N_2O	476 113.20	476 113.20	478 148.49	492 441.86	496 073.78	472 164.19	452 828.27	438 200.39	461 267.13	–3.1
HFCs	35 486.79	35 486.79	59 571.54	110 976.38	108 553.84	116 830.12	118 001.46	130 308.91	140 066.16	294.7
PFCs	20 759.93	20 759.93	15 585.61	13 506.60	6 992.05	8 747.73	7 086.73	6 403.79	6 107.35	–70.6
SF_6	33 067.96	33 067.96	28 303.49	19 305.97	18 235.15	17 381.79	17 564.52	17 139.26	16 834.56	–49.1

BY = Base year, GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

Table 2. Greenhouse gas emissions by sector, 1990–2005

Sectors	Gg CO_2 equivalent									Change BY–2005 (%)
	Base year Convention	1990	1995	2000	2001	2002	2003	2004	2005	
Energy	5 202 190.67	5 202 190.67	5 525 797.25	6 069 217.43	5 978 861.46	6 021 376.64	6 079 064.41	6 181 715.66	6 201 949.91	19.2
Industrial processes	300 078.01	300 078.01	314 822.40	338 671.42	309 565.66	320 222.61	316 428.26	330 642.56	333 550.16	11.2
Solvent and other product use	4 300.25	4 300.25	4 479.42	4 766.04	4 766.04	4 284.89	4 284.89	4 284.89	4 284.89	–0.4
Agriculture	530 297.52	530 297.52	526 783.12	547 358.67	560 271.90	537 424.00	521 068.23	507 374.16	536 271.00	1.1
LULUCF	–699 799.41	–699 799.41	–818 740.10	–735 366.26	–755 078.49	–794 495.31	–796 932.89	–810 843.89	–809 547.39	15.7
Waste	192 174.38	192 174.38	189 053.99	165 867.08	161 113.98	163 869.59	168 357.81	165 697.28	165 426.16	–13.9
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	**5 529 241.41**	**5 529 241.41**	**5 742 196.08**	**6 390 514.38**	**6 259 500.56**	**6 252 682.43**	**6 292 270.71**	**6 378 870.66**	**6 431 934.74**	**16.3**
Total (without LULUCF)	**6 229 040.82**	**6 229 040.82**	**6 560 936.18**	**7 125 880.64**	**7 014 579.05**	**7 047 177.74**	**7 089 203.60**	**7 189 714.55**	**7 241 482.12**	**16.3**

BY = Base year, LULUCF = land use, land-use change and forestry, NA = not applicable.

6. The United States provided the NIR and common reporting format (CRF) tables for the years 1990–2005. The inventory submission is generally complete in terms of years and GHGs, geographical coverage and categories. The United States included five new categories in the industrial processes and LULUCF sectors, which contributed approximately 0.1 per cent of the 2005 emissions. Some categories were reported as not estimated ("NE"). In response to the previous review, the United States provided a comprehensive discussion in the NIR on categories that were not estimated, on other potential sources or sinks not addressed in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines), and on the possibility of including them in future submissions.

7. To a large extent, the United States inventory used higher tier methods. The methodologies and models are in general presented transparently. Additional information was provided by the Party during the review, which further clarified these methodological and reporting issues. Recalculations were made to take into account the availability of new methodologies, mainly the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines), more accurate AD and improved emission factors (EFs) and other parameters. Taken as a whole, the recalculations resulted in an improvement of the inventory. The United States used tier 2 methods for quantitative uncertainty assessment for all but two categories. The uncertainty analysis is documented in an annex to the NIR and the category-specific uncertainties are discussed under the sectoral chapters. The United States has a national quality assurance/quality control (QA/QC) plan in place, which is consistent with the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and is being implemented in a comprehensive and commendable way.

II. Overview

A. Inventory submission and other sources of information

8. The United States submitted NIR and CRF tables on 11 April 2007. In its 2007 submission, the United States provided a complete set of CRF tables for the years 1990–2005. Where needed the ERT also used the previous (2006) submission, including the CRF tables for the years 1990–2004.

9. During the review the United States provided the ERT with documents containing additional information. These documents are not part of the inventory submission but are in many cases referenced in the NIR. The full list of materials used during the review is provided in the annex to this report.

B. Key categories

10. As a part of its 2007 submission, the United States reported a tier 1 key category analysis, both level and trend assessments, with and without the LULUCF sector. It also used qualitative criteria to identify key categories. The key category analyses performed by the Party and the secretariat[2] produced similar results. The categorization and aggregation level used by the Party in its analysis differ from those used by the secretariat. This resulted in differences in the names of the key categories identified by the Party and the secretariat, but the coverage of the key categories is the same.

[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*. Key categories according to the tier 1 trend assessment were also identified for those Parties that provided a full set of CRF tables for the year 1990. 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.

11. The United States does not use a tier 2 key category analysis, but indicates that this will be incorporated into future inventory submissions, when tier 2 uncertainty assessments will be made for all categories. At present, there are two missing sources: HFC emissions from hydrochlorofluorocarbon-22 (HCFC-22) production and a small part of N_2O emissions from agricultural soils. The United States uses the results of the key category analysis and uncertainty assessment as drivers for planning and prioritizing improvements to the inventory. The ERT noted that the use of a tier 2 key category analysis is a systematic way of combining the results of these two analyses for use in prioritizing inventory improvements. Therefore, the ERT reiterates the recommendation of the review of the 2006 GHG inventory submission for the United States to carry out a tier 2 key category analysis for its next submission.

C. Cross-cutting topics

1. Completeness

12. CRF tables are provided for all the years 1990–2005. The inventory is complete in terms of years and GHG gases, and close to complete in terms of geographical coverage and categories. For Hawaii, Alaska and the United States Territories (small autonomous islands in the Pacific and the Caribbean), data are not available for all categories (e.g. carbon stock changes in forest land in Alaska are not included) and do not always allow for the same level of disaggregation (e.g. information on energy use) as for the rest of the country. This is addressed transparently in the NIR. The ERT also notes that the NIR does not define the United States Territories, and encourages the Party to do so in its next submission.

13. The United States included five new categories in the industrial processes and LULUCF sectors in its 2007 submission. These categories contribute little to total emissions (approximately 0.1 per cent of the 2005 emissions). Some categories are reported as "NE". In response to the previous (2006) review, the United States provides in the NIR a comprehensive discussion of these categories and of other potential sources or sinks not addressed in the Revised 1996 IPCC Guidelines, and the possibilities of including them in future submissions. The main reasons for not including these categories are: (1) IPCC or national methodologies are not available (insufficient scientific knowledge); and (2) inadequate data are available to apply the methodologies that have been developed (e.g. data on CO_2 injection, enhanced oil recovery (EOR) sites and small-scale composting). According to the United States, the excluded categories introduce a minor bias to its overall GHG estimates. The ERT concurs with the Party and welcomes the comprehensive analysis undertaken so far, as well as the continuous efforts to improve the completeness of the inventory. The ERT commends the United States for including in the inventory categories (e.g. CH_4 from abandoned coal mines) for which methodologies are not included in the Revised 1996 IPCC guidelines or in the IPCC good practice guidance, as well as for exploring new methodologies for such categories (e.g. CO_2 from enhanced oil recovery).

2. Transparency

14. The NIR and its annexes include comprehensive descriptions of the trends in GHG emissions and removals in the United States and of the methodological choices and cross-cutting issues (especially uncertainty estimates and key category analysis) to be reported in accordance with 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" (hereinafter referred to as the UNFCCC reporting guidelines). The ERT commends the United States for the well-written and informative report.

15. In general, the structure of the NIR follows the UNFCCC reporting guidelines. However, time-series consistency, and to a certain degree QA/QC and verification, are not addressed in specific sections of sectoral chapters, as recommended in the UNFCCC reporting guidelines. The ERT recommends that the Party include these sections in its next submission.

16. The ERT further noted that reporting on the emissions in the energy sector in the NIR is disaggregated by economic sector, while the reporting in the CRF follows the IPCC categories. Thus, the NIR does not meet the criteria for comparability among other reporting Parties and the information in the NIR and the estimates provided in the CRF tables are not comparable. During the review, the United States explained that the rationale for the inconsistency was linked to the multi-purpose objectives of the NIR. The report is used for domestic purposes, where reporting by economic sector is more informative for the decision makers and the general public. Furthermore, the AD for inventory estimates are also provided by economic sector. The ERT understands this rationale but encourages the United States to follow the UNFCCC reporting guidelines in its future inventory submissions in order to meet the criteria of comparability between the emission and removal categories in the NIR and those in the CRF tables and to ensure their comparability with other reporting Parties.

17. The order of presentation of categories in the NIR was not consistent with that in the CRF tables. In response to the draft review report the Party stated that the order of presentation of categories in the industrial processes section was consistent with that in the CRF tables in the April 2008 inventory submission.

18. The NIR presents national total emissions with and without the LULUCF sector slightly differently from the way these sums are given in the CRF tables (in the NIR non-CO_2 emissions from LULUCF are included in total emissions). The ERT recommends that the United States present these sums in the NIR as they are presented in the CRF tables, as this would enhance the consistency of reporting.

19. The United States inventory uses higher tier methods to a large extent (models, country-specific methods etc.) but stationary combustion, which is the largest category in the inventory, is reported at a fairly aggregated level. The methodologies and models are in general presented transparently. In some cases, largely due to the complexity of the methods and models, the ERT was not able to fully assess the underlying assumptions and rationales for the choices of data, methods and other inventory parameters from the descriptions in NIR. Additional information, such as the spreadsheets used in the estimation of the emissions, was provided by the Party during the review, which clarified these issues. The spreadsheets were transparent and well documented, and the interfaces between sectors (e.g. allocation of emission reporting between the industrial processes and energy sectors) were clearly identified. The ERT encourages the United States to consider the use of higher tier methods for stationary combustion, given the significant contribution it makes to the overall emissions profile. The ERT further encourages the United States to explore ways to increase the "reader-friendliness" of the descriptions of higher tier methods in the NIR. The sectoral sections of this report give more specific information on where such improvements could be made.

20. The notation keys and cell comments are in general used consistently in the CRF, except for the LULUCF and waste sectors, where their use still has to be improved, particularly for categories where no estimates have been provided. The ERT identified some inconsistencies in the use of the notation keys in the CRF tables and the NIR (e.g. for the waste sector, "NE" was used for sludge from domestic and commercial wastewater, when included elsewhere ("IE") would have been the correct notation key). The ERT encourages the United States to correct the use of notation keys in its next submission.

3. Recalculations and time-series consistency

21. The ERT noted that the Party reported significant recalculations for the entire time series 1990–2004. The recalculated emissions increased in 1990 by 2.1 per cent, excluding LULUCF (by 6.4 per cent with LULUCF), and by 1.7 per cent in 2004 (by 1.3 per cent with LULUCF). The most significant recalculations were in the LULUCF sector (CO_2 emissions increased by 21.7 per cent in 1990 and decreased by 5.7 per cent in 2004) and the agriculture sector (N_2O emissions increased by 32.9 per cent

in 1990 and by 24.7 per cent in 2004). The rationale and impact of the recalculations are addressed in the chapter on recalculations and improvements as well as in the sectoral chapters of the NIR.

22. The recalculations were made to take into account the availability of new methodologies, more accurate AD and improved EFs and other parameters. The implementation of the new methodologies in the 2006 IPCC Guidelines was a major factor driving the recalculations.

23. Overall, the recalculations resulted in an improvement of the inventory. For some categories, the new methods and data may, however, require further justification and/or consideration (see e.g. paras. 82, 121 and 142 below).

4. Uncertainties

24. The United States used a tier 2 method (Monte Carlo analysis) for quantitative uncertainty assessment for all but two categories. The remaining two categories, HFC emissions from HCFC-22 production and a small part of N_2O emissions from agricultural soils, were estimated using a tier 1 method. The quantitative uncertainty for the total national emissions[3] varied from –1 to +5 per cent, while the lowest uncertainty (–2 to +5 per cent) was for CO_2 and the highest (–16 to +24 per cent) was for N_2O. The estimated uncertainty range for HFCs, PFCs, and SF_6 varied from –6 to +16 per cent. The uncertainty for fossil fuel combustion (–2 to +5 per cent) had the greatest influence on the uncertainty of the total inventory. The uncertainty of the trend was estimated using a tier 2 method. The uncertainty range for the increase in total emissions from 1990 to 2005 ranged from –12 to +23 per cent. The uncertainties for 2004 and the trend uncertainty for 1990 to 2004 in the 2006 submission were of the same order of magnitude as those reported in the 2007 submission.

25. The uncertainty analysis is documented in an annex to the NIR and the category-specific uncertainties are discussed under the sectoral chapters. The ERT noted that some uncertainty ranges followed asymmetric uncertainty distributions and that AD and EF uncertainties were not provided separately. The ERT reiterates the recommendation of the previous review for the United States to provide more information in its next NIR on the asymmetric shape of the uncertainty bands. In addition, the United States is encouraged to add columns with information on AD and EF uncertainties to tables in annex 7 to the NIR, where the uncertainty analysis is described.

26. The United States used the results of the uncertainty analysis to prioritize further improvements in the inventory (see also para. 10).

5. Verification and quality assurance/quality control approaches

27. The United States has a national QA/QC plan in place, which is consistent with the IPCC good practice guidance and is being implemented in a comprehensive and commendable way. The QC procedures have been standardized, for example through the use of specific forms used as checklists, in order to document the findings including corrective actions taken or planned for the future. The United States also used manual and semi-automated checks during inventory compilation to ensure the correct transfer of data from the sectoral source leads and contractors to the CRF reporter. Tier 1 QC measures are implemented in a comprehensive way in all sectors, with tailored procedures for specific categories. Tier 2 QC measures are undertaken generally for one key category in each sector annually. QA measures include an expert review and a public review undertaken annually before the submission of the inventory to the UNFCCC secretariat. The comments received and the actions taken based on them are documented and archived. Verification of models, AD and EFs or other parameters used in the inventory are done, for example, by comparing top-down and bottom-up data and using measured/field data to verify the parameters used in the models.

[3] The total national emissions also include the non-CO_2 emissions from the LULUCF sector.

28. The ERT noted that sector-specific QA/QC measures were not fully described under all sectoral chapters in the NIR. Furthermore, the sectoral chapters that addressed category-specific QA/QC procedures were very brief and did not do justice to the well developed quality management system. The ERT encourages the United States to include more category-specific information on the QA/QC measures and verification in specific sections in all sectoral chapters of the NIR.

29. The ERT noted that AD and calculation approaches were sometimes inconsistently used for different categories and sectors, in particular for estimation of removals in carbon stocks due to disposal of harvested wood products, yard trimmings and food scraps in the LULUCF sector and estimation of CH_4 emissions from disposal of solid waste in the waste sector. Other examples include the inconsistent use of cattle data in agriculture (para. 113), incomplete AD used to estimate emissions from waste combustion (paras. 67 and 162) and different AD sources used to estimate N_2O from nitrogen fertilization in LULUCF (para. 143). The reasons for this can be found in the calculation methods. Data are estimated sometimes by use of a model (e.g. disposal of harvested wood products in solid waste disposal on land), sometimes based on surveys (e.g. disposal of yard trimmings and food scrap) or sometimes based on a combination of surveys and measurements (e.g. disposal of bulk waste). The ERT recommends the United States to explore the possibility of using consolidated AD when a common source of data is not applicable to describe the activity in question, in order to enhance the consistency of the inventory and the quality of the estimates. The United States is further encouraged to include in its QA/QC plan checks for consistent use of AD across sectors and categories to enhance the accuracy of the inventory and to ensure that potential double-counting or gaps in the emission estimates are avoided.

6. Institutional arrangements

30. During the in-country visit, the United States explained the institutional arrangements for preparation of the inventory. EPA has overall responsibility for the preparation of the national inventory, and the State Department, as the focal point for the UNFCCC, oversees the annual inventory submission to the UNFCCC secretariat. Other agencies (EIA, USDA, USGS etc.) and their affiliated agencies or institutions also collaborate with EPA in the preparation process, mainly by providing AD or making estimations for particular categories. Contractors in different parts of the country (universities, consultant companies and individuals) calculate many of the emission and removal estimates.

31. At EPA, an inventory coordinator is responsible for compiling the inventory and for ensuring consistency and the quality of the inventory. So-called source leads coordinate the preparation and calculation of the estimates, as well as cross-cutting issues such as QA/QC management and estimation of uncertainties. They also make decisions on annual improvements to the inventory, taking the available resources into account. The system reflects the national circumstances of the United States. It is a complex system in the sense that many different organizations take part in the process, and AD are partly decentralized and cover varying circumstances (climate regions, management practices, the economy and policy), and because of the extensive use of higher tier methodologies in the inventory calculations. The ERT finds the institutional arrangements robust, the work well managed and the inventory team committed and experienced.

7. Record keeping and archiving

32. The United States has a centralized archiving system for the inventory submissions (NIR and CRF tables including draft versions produced during the preparation process) and spreadsheets for individual category calculations from the source leads as well as those used to compile the inventory, references, comments and responses to the reviews. The archiving system is an electronic and paper archive at EPA. Data, models and other material used by the agencies and contractors participating in the inventory preparation are archived at the respective institutions. The ERT was provided with access to the data it requested during the review.

8. Follow-up to previous reviews

33. The United States has systematically addressed issues raised in the previous reviews and followed the recommendations where deemed appropriate or possible. An investigation of categories not included in the inventory was performed. Non-CO_2 emissions from forest fires were included based on the recommendation of the review of the 2006 GHG submission. For some other recommendations, such as reporting of carbon stock changes in forest land in Alaska, the development of a tier 2 key category analysis or providing more detailed data in CRF categories in the energy sector, implementation is still in process or under consideration.

D. Areas for further improvement

1. Identified by the Party

34. The NIR identifies several areas for improvement in the sectoral chapters. These include further implementation of the methodological improvements in the 2006 IPCC Guidelines. In its response to the issues raised during the review, the United States indicated that it will include a tier 2 key category analysis in its future submissions, as soon as tier 2 uncertainty estimates are available for the remaining two categories (HFC emissions from HCFC-22 production and a small part of N_2O emissions from agricultural soils), and that it will change the order of presentation in the NIR in the industrial processes sector to follow the order of presentation in the CRF tables.

2. Identified by the expert review team

35. The ERT identifies the following cross-cutting issues for improvement:

(a) Enhance consistency between the NIR and the CRF in accordance with the UNFCCC reporting guidelines;

(b) Use higher tier methods for key categories where appropriate;

(c) Include a tier 2 key category analysis in the inventory submission;

(d) Explore ways to improve the reader-friendliness of descriptions of complex models (provide key assumptions, key parameter values and calculate average background parameter values to allow comparison with IPCC default values and those of other countries);

(e) Include descriptions of the QA/QC and verification measures in specific sections in the sectoral chapters of the NIR to do justice to the well-developed system and to follow the guidance in the UNFCCC reporting guidelines on the structure of the NIR;

(f) Improve consistency among sectors and categories by using the same sources of information for categories that use similar AD and calculation approaches, or consolidating these data and approaches, where possible;

(g) Provide information on AD and EF uncertainties separately, where applicable;

(h) Provide quantified uncertainty estimates.

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

III. Energy

A. Sector overview

37. In 2005, the energy sector accounted for 85.6 per cent of total GHG emissions in the United States. The energy industries category was the major emitting category in the sector, contributing 38.6 per cent of sectoral emissions and 33.0 per cent of total national emissions. The manufacturing industries and construction, transport, other sectors and other accounted for 13.7 per cent, 30.7 per cent, 9.5 per cent and 3.9 per cent, respectively, of energy emissions in 2005. Fugitive emissions accounted for 3.6 per cent of energy emissions in 2005. Between 1990 and 2005, emissions from the energy sector increased by 19.2 per cent, mainly owing to increased emissions from energy industries and transport.

38. The United States has improved its inventory since the most recent (2006) submission. Major improvements involve the incorporation of a variable CH_4 content in natural gas production, taking into account the different qualities of gas in the country; accounting for CH_4 emissions reductions regulation; and the inclusion of non-energy related CO_2 emissions from the natural gas industry.

39. During the review, the ERT noted that fuel use for energy purposes (combustion) is not strictly separated from non-energy fuel uses (such as feedstocks) in the energy statistics. This causes problems for the estimation of all combustion emissions (see paras. 53 to 56). The Party is encouraged to discuss this issue with the relevant agencies and other entities (e.g. oil associations) to improve the consistent allocation of energy and non-energy fuel use.

40. The CO_2 EFs are based on data on fuel composition taken from studies by the USGS, the Gas Technology Institute, the American Petroleum Institute and other trade associations and academic papers. A comprehensive explanation of the methodology and data for estimating CO_2 emissions from fossil fuel combustion including the derivation of carbon content factors is included in an annex to the report. The ERT noted that the EFs for fuels whose compositions are subject to the most change (e.g. motor gasoline) have been updated, whereas the EFs for other fuels have not been updated because of resource constraints. The ERT further noted that the information provided in the NIR and CRF was not sufficient to understand the assumptions and estimations made regarding the derivation of CO_2 EFs by fuel types used in the United States, in particular: (1) the choices made to obtain the EFs were not fully justified, which may lead to significant variations in accuracy and uncertainty depending on whether the EFs were derived on a mass (volume) or energy basis; (2) the definition of fuel types is not fully transparent. In the NIR, selected fuel specifications are used as representative of a certain fuel type, although more specifications of that fuel type may exist. It remains unclear whether this is a valid assumption for the different fuel types used for the estimation of emissions; (3) the age of data is not fully justified in the NIR. In some cases, quite old data sources were used to derive EFs. It remains unclear whether these sources are still valid for today's fuel specifications; and (4) the choice of the data sources themselves was not fully transparent in the NIR. Several entities may be able to provide data sources on carbon EFs. In the NIR, it remains unclear whether the data sources chosen are the most appropriate.

41. Given the fact that emissions from fossil fuel combustion account for the bulk of United States GHG emissions, changes in CO_2 EFs may affect national totals substantially. After the review visit, the Party provided further information on the above-mentioned issues. However, the assumptions and estimations regarding the derivation of CO_2 EFs for fuel types remained unclear. The ERT acknowledges the Party's intention announced during the review to explore moving towards a standardized rotation of updates of CO_2 EFs. According to these plans, individual, discrete fuel types can be analysed on a continuous multi-year basis. The ERT recommends the United States to further enhance the documentation of the choices and justifications of the carbon content and associated CO_2 EFs in its next submission. The Party is also encouraged to explore improving the carbon content estimates by intensifying existing contacts with data suppliers and obtaining data from other relevant entities such as gas companies, fuel associations and refineries.

1. Transparency

42. The presentation of emission categories in the NIR does not meet the comparability criteria in providing the information as stipulated by the UNFCCC reporting guidelines, making it difficult to reproduce the estimates in the CRF tables with the information provided in the NIR. For instance, the NIR provides a breakdown of combustion emissions into categories (residential, commercial, industrial, transportation, electricity generation and United States territories) and a breakdown into end-use sectors, which includes an allocation of emissions related to electricity generation to these end-use sectors. Information boxes are provided that in some cases relate not to what is reported in the inventory, but to supplementary information. For instance, further emission estimates are provided for CO_2 formation from atmospheric CH_4 oxidation but these are not included in the inventory totals. During the review, the United States explained that structural differences between the NIR and the CRF tables arise from the fact that the NIR is used for domestic information purposes as well as the reporting requirements of the UNFCCC. The ERT understands this rationale but it recommends the Party to improve the comparability between the NIR and CRF and to meet the UNFCCC requirements for maintaining the comparability of the inventories among the reporting Parties.

2. Verification and quality assurance/quality control approaches

43. QA/QC procedures are in place and are to some extent described in the NIR. Important measures include cross-checking the emission inventory prepared by EIA with the official inventory prepared under the UNFCCC by EPA. The United States is encouraged to include more detailed information in the NIR.

B. Reference and sectoral approaches

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

44. In 2005, energy consumption in the reference approach was 0.9 per cent lower and CO_2 emissions were 0.9 per cent higher than in the sectoral approach. The difference in fuel consumption was the largest for natural gas at 1.7 per cent lower in the reference approach than in the sectoral one, followed by petroleum at 0.9 per cent lower. The differences between the two approaches are only moderate. The NIR provides two main reasons for these differences: fuel types are defined at an aggregated level for the reference approach, but for the sectoral approach more disaggregated fuel types are used for the emission estimations; carbon contents are available for different fuel qualities in the sectoral approach, but for the reference approach only default carbon contents are available.

45. During the review, the Party explained that there may also be some inconsistencies in the underlying data for the reference approach, since much of the EIA survey focuses on bottom-up use statistics, which are used in the sectoral approach. The Party is encouraged to undertake a more detailed assessment of the differences between the two approaches, for instance with respect to the consideration of non-energy fuel use and the inter-linkages between the energy, industrial processes and waste sectors.

46. During the review, United States experts explained that the analysis of non-energy fuel use is used only to a limited extent for the derivation of the reference approach (see paras. 53 to 56). The Party is encouraged to explore the possibility of using the full information on non-energy fuel use to derive the reference approach in its next submission.

2. International bunker fuels

47. Emissions of CO_2 from international aviation increased by 36.9 per cent between 1990 and 2005, and those from international navigation decreased by 49.1 per cent over the same period. As a result, the share of aviation bunkers in international bunker emissions increased from 40.2 per cent in 1990 to 64.4 per cent in 2005. CO_2 emissions were estimated by applying specific EFs based on carbon contents and oxidation factors to the individual fuel types used. For the estimation of CH_4 and N_2O emissions,

IPCC default EFs were used. The ERT noted that the United States has reported emissions from international bunker fuel use for military services, which is in line with the IPCC good practice guidance.

48. Fuel consumption data for international aviation were collected from three different sources. Fuel consumption data on United States carriers for international flights were obtained from the Bureau of Transportation Statistics under the Department of Transport. It was assumed that 50 per cent of the fuel consumed was purchased in the United States and can thus be accounted for under international aviation bunkers. Fuel expenditure details were available for foreign carriers departing from United States airports. Average fuel prices were used to calculate international bunker fuel consumption by foreign carriers. Fuel consumption data for international bunker fuel use for military aviation was provided by the Department of Defense (DoD), taking into account fuel use and operations data. The remaining fuel consumption in comparison with the overall fuel consumption data provided by EIA is considered fuel consumption for domestic aviation.

49. Fuel consumption data for international navigation were obtained from the Department of Commerce (DoC). The fuel consumption of naval vessels was provided by DoD. A correction was performed to account for fuel use while vessels were in the harbour. The remainder of overall fuel consumption for navigation provided by EIA was considered domestic fuel use.

50. CO_2 emissions from international navigation have decreased by almost half since 1990 (see para. 47). During the review, it was explained that this decrease could have been an error caused by two parallel reporting systems (hard copy and electronic). Domestic navigation emissions are directly linked to international bunker fuel use for navigation. Domestic emissions may therefore be wrongly estimated. The Party is recommended to investigate further the reasons for this decrease and to revise its estimates, if applicable.

51. Multilateral operations are reported as "NE". The Party is encouraged to explore ways of estimating emissions from the multilateral operations.

52. Military bunker fuel emissions have decreased since 1990 for both aviation and navigation. During the review, it was suggested that this might be owing to the relocation of United States military activities (i.e. fewer operations directly from United States Territory) and to a decrease in corresponding aircraft and vessel movements after the end of the cold war. The Party is encouraged to describe the reasons for this decrease in its next submission.

3. Feedstocks and non-energy use of fuels

53. The United States reported emissions related to non-energy fuel use partly under other – stationary (1.A.5.a) under non-energy use and partly as an aggregate amount of all emissions under United States Territories. In 2005, emissions from the United States mainland in this category contributed 2.2 per cent to overall CO_2 emissions from the energy sector. From 1990 to 2005, the emissions from non-energy fuel use on the United States mainland increased by 19.8 per cent.

54. CO_2 storage due to non-energy fuel use was estimated by multiplying potential emissions of all non-energy fuels with corresponding storage factors. CO_2 emissions are calculated as the difference between potential emissions and stored emissions.

55. Storage factors for several non-energy fuel uses are derived using assumptions about whether carbon is permanently stored (such as in asphalt), partly emitted (such as lubricants) or completely emitted (such as miscellaneous products). For eight petrochemical feedstocks, an aggregate storage factor was estimated in three steps by estimating the amount of carbon stored in the feedstock types as follows: the overall amount of carbon stored is adjusted for import and export of feedstocks; carbon accounted for under industrial processes is subtracted from this amount; a carbon balance is set up in which carbon stored or emitted by industrial releases, due to energy recovery or to the production and use

of products, is estimated using assumptions about the fate of each carbon flow. The overall storage factor for petrochemical feedstocks is then derived as the overall amount of carbon stored divided by the sum of carbon stored and emitted.

56. During the review, the ERT noted that major portions of non-energy fuel emissions actually relate to energy emissions. For instance, the combustion of off-spectrum products from refineries for the production of heat and/or electricity is reported under non-energy fuel use, although it should be reported under energy industries. Hazardous waste incineration is also accounted under non-energy fuel use, although it should be reported under the waste sector (waste incineration without energy recovery) or under energy industries (waste combustion with energy recovery). Currently, combustion emissions related to non-energy fuel use are a key category. The allocation of emissions to other categories may lead to the reconsideration of key categories in the United States inventory. For the purpose of shifting emission estimates, the allocation and reporting of non-energy fuel use in the energy statistics should be discussed. A further breakdown of fuel combustion activities according to categories and technology types (see paras. 59 to 61) could also provide relevant information. Further cooperation with the refining sector could yield further insights into the carbon balance of refineries and related energy and non-energy uses of fuels. Cross-checking with waste statistics (e.g. for hazardous waste) could allow for allocating parts of non-energy fuel use emissions to waste incineration or combustion activities (see para. 66). The Party is encouraged to explore possibilities for reallocating emission estimates from non-energy fuel use to other relevant categories.

4. Country-specific issues

57. The United States has reported its emissions from its territories separately from other categories since no further breakdown according to fuel use categories is available. In 2005, United States territories accounted for 1.0 per cent of CO_2 emissions in the energy sector. Fuel consumption data were collected separately from the national energy statistics. According to the NIR, the Party plans to improve the quality of United States territories data. The ERT acknowledges this endeavour.

C. Key categories

1. Stationary combustion: all fuels – CO_2, CH_4 and N_2O[4]

58. GHG emissions from stationary combustion accounted for 55.9 per cent of total national emissions in 2005. These emissions increased by 18.6 per cent between 1990 and 2005. CO_2 emissions contribute more than 99 per cent of emissions from stationary combustion.

59. The AD used to estimate GHG emissions from stationary combustion are provided by EIA. Fuel consumption data are provided by EIA for each domestic economic sector and converted into IPCC categories as described in the documentation boxes in the CRF tables. Emissions are estimated by multiplying fuel consumption data with corresponding oxidation factors and EFs. The country-specific CO_2 EFs were derived for each category based on country-specific values. The CH_4 and N_2O EFs used were the IPCC default EFs.

60. The CO_2 emissions from stationary combustion of coal, gas and oil and from non-energy use of fuels are key categories. For key categories, it is good practice to report emissions using higher tier methods. In the view of the ERT, the use of higher tiers would improve the overall quality of the United States inventory for these categories in the following respects: (1) a further breakdown of fuel consumption would allow the use of more accurate CO_2 EFs for individual sectors, for example, different categories of manufacturing industries and construction or individual power plants under energy

[4] It should be noted that not all emissions related to all fuels and gases under this category are key categories, particularly CH_4 and N_2O emissions. However, since the calculation procedure for stationary combustion is discussed as a whole, individual categories are not separated here.

industries, and the CH_4 and N_2O emissions from fossil fuel combustion could be calculated using higher tier methods, once a further breakdown with respect to technologies is made; (2) more detailed emission estimates would improve the key category analysis, for instance, key categories could be identified at a more disaggregated level and more accurate data could be used for the analysis; and (3) further information on fuel consumption in the transformation sector (e.g. refineries) or in the manufacturing sector (e.g. iron and steel) could improve the allocation of emissions currently reported under non-energy use of fuels (see paras. 53 to 56).

61. During the review, the ERT noted that facility-specific data of varying quality are to some extent available. Furthermore, a sectoral breakdown of emissions was available for certain years. The ERT therefore reiterates the recommendations of previous reviews that the Party should explore the possibility of reporting emissions from stationary combustion using a higher level of detail about the sectors and technologies used.

2. Road transportation: liquid – CO_2, CH_4 and N_2O[5]

62. CO_2 emission estimates are based on aggregated fuel consumption data and country-specific EFs. For the estimation of CH_4 and N_2O emissions, fuel consumption is further broken down according to vehicle types and ages, and control technologies using information on vehicle miles travelled and the age structure of the vehicle fleet. The CH_4 and N_2O EFs are country-specific and reflect the breakdown of AD.

63. The ERT acknowledges planned improvements by the Party, such as investigating more transport models, which could yield further information for the estimation of CH_4 and N_2O emissions. During the review, the Party explained that its bottom-up and top-down fuel consumption data do not fully match. The ERT encourages the United States to continue to reconcile bottom-up and top-down fuel consumption data in the transport sector.

3. Other – CO_2 and N_2O[6]

64. CO_2 emissions from waste combustion with energy recovery are estimated by multiplying the amount of plastics, rubber, carbon black and fibres combusted with corresponding oxidation factors and EFs. N_2O emissions from waste combustion are estimated by multiplying the amount of waste combusted by an N_2O EF taken from the IPCC good practice guidance.

65. During the review, the ERT noted that different AD were used for the estimation of CO_2 and N_2O emissions. The ERT encourages the Party to harmonize AD for the two emission sources in line with IPCC methodological guidance.

66. The emissions from waste combustion are reported under other (1.A.5). The Party explained that waste combustion takes place in facilities with energy recovery. The ERT therefore reiterates the recommendation of the 2005 inventory to report emissions under energy industries.

67. During the review, the ERT noted that some share of waste was incinerated in plants without energy recovery (see para. 162). The Party is encouraged to report emissions related to waste incineration without energy recovery under waste incineration.

68. The ERT noted that the waste streams considered for waste combustion are not complete. The ERT encourages the Party to improve the completeness of its reporting of emissions from waste

[5] It should be noted that CH_4 emissions from road transportation are not a key category. However, since the calculation procedure for road transportation is discussed as a whole, individual categories are not separated here.

[6] It should be noted that N_2O emissions from other are not a key category. However, since other waste combustion is discussed as a whole, CO_2 and N_2O emissions are not separated into two different categories.

combustion (see para. 161). Cross-checking of emissions from waste fractions reported under waste combustion/incineration and under non-energy fuel use (see para. 56) is also recommended.

4. Fugitive emissions: CO_2 and CH_4

69. Recalculations have been performed since the 2006 inventory submission. Relevant changes include improvements made in the estimation of fugitive emissions from natural gas systems (see para. 38) as well as updating the AD and EFs in different categories. The ERT acknowledges that the recalculations have improved the quality of the inventory. The ERT further acknowledges the high level of detail in estimates of emissions from fugitive emissions from coal mining, natural gas and petroleum systems.

70. The United States provides information on accounting for CO_2 capture, transport, injection and storage in its NIR. The activities considered relate to natural and industrial sources of CO_2 and the use of CO_2 for enhanced oil recovery. The ERT acknowledges the Party's endeavours to provide complete reporting of emission sources.

71. During the review, the United States informed the ERT of planned improvements related to updating the EFs for petroleum systems. The ERT acknowledges these plans.

IV. Industrial processes and solvent and other product use

A. Sector overview

72. In 2005, emissions from the industrial processes sector accounted for 4.6 per cent (333,550.16 Gg CO_2 eq) of the total GHG emissions of the United States (excluding LULUCF). Emissions from the consumption of halocarbons and SF_6 represented the largest category, contributing 42.2 per cent of total industrial processes sector emissions, followed by mineral products, 21.3 per cent, and metal production, 17.4 per cent.

73. Emissions from the sector increased by 11.2 per cent (33,472.15 Gg CO_2 eq) between 1990 and 2005, driven by an increase in cement production and in emissions from the use of substitutes for ozone depleting substances. However, emissions from iron and steel production, aluminum production, ammonia production and urea application, HCFC-22 production and SF_6 use in electrical equipment decreased over the period 1990–2005.

74. There are a number of categories (especially for HFCs, PFCs and SF_6 emissions) for which AD are considered confidential and aggregated data are provided to EPA. Contractors are often used to compile the data and they have agreed protocols to protect the data. Some industry information is provided directly to EPA (e.g. substitutes for ozone depleting substances), which is aggregated before being reported in the CRF tables and the NIR.

75. Total emissions from the solvent and other product use sector amounted to 4,284.89 Gg CO_2 eq, or 0.06 per cent of total national GHG emissions (excluding LULUCF).

76. The ERT commends the United States for including estimates from categories where methodologies are not included in the Revised 1996 IPCC Guidelines or the IPCC good practice guidance (e.g. CO_2 emissions from titanium dioxide production, phosphoric acid production and CO_2 consumption).

1. Transparency

77. The order of presentation of categories in the NIR was not consistent with that in the CRF tables. In response to the draft review report the Party stated that the order of presentation of categories in the

industrial processes section was consistent with that in the CRF tables in the April 2008 inventory submission.

2. Recalculations and time-series consistency

78. The United States compiles emission estimates for a large number of categories and there are consequently many data sources for the industrial processes sector. There were no issues identified with respect to time-series consistency during the review. Sensible methodological choices and assumptions have been made for the years in the 1990–2005 time series where AD was not available . Discussion of data availability and time-series consistency is included under the methodological sections of the NIR. To be consistent with the UNFCCC reporting guidelines, the ERT encourages the United States to include a separate section on time-series consistency in the NIR. A general paragraph under the industrial processes chapter explaining that time-series consistency is discussed in the methodological section of each appropriate category may be an alternative option to explore.

B. Key categories

1. Cement production – CO_2

79. In line with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance, the United States uses a tier 2 approach to calculate CO_2 emissions from cement production. The amount of clinker produced across the country (at over 100 individual kilns) is multiplied by an emission factor of 0.51 t CO_2/t clinker. The emission factor is based on an average of 65 per cent lime content in the clinker and the assumption that 100 per cent of the lime comes from a carbonate source. Data on cement kiln dust recycling in the United States is incomplete so the IPCC default cement kiln dust (CKD) factor of 2 per cent is used in the calculations. The ERT encourages the United States to summarize the information presented during the in-country visit in the NIR on why the IPCC default value for the lime fraction of clinker is appropriate to use for the United States cement production calculations.

80. The clinker data are collected via monthly and annual surveys administered by USGS. The survey usually elicits a 100 per cent response rate because of the high level of commitment by USGS staff and support from the cement industry. The ERT commends the United States for the completeness of the AD for this category.

2. Ammonia production – CO_2

81. The United States estimates CO_2 emissions from ammonia production and urea application. One plant in the United States uses petroleum coke to produce ammonia. Plant-specific production data and EFs (3.57 t CO_2/t NH_3) were used to calculate the emissions. All other ammonia is produced using natural gas. Ammonia production data are taken from the Census Bureau of DoC. An EF of 1.2 t CO_2/NH_3 was applied to the ammonia production data to estimate emissions. The EF is a published value from the European Fertilizer Manufacturers Association and is considered to be applicable to the United States as it reflects the use of the natural gas as a feedstock.

82. Emissions of CO_2 are adjusted to account for the use of some of the CO_2 produced from ammonia production in the production of urea. Total CO_2 emissions do not change as a result of this calculation, but some of the CO_2 emissions are attributed to ammonia production and some to urea application. The calculation of CO_2 emissions from urea application accounts for the application of both imported and domestically produced urea. The amount of imported urea applied is calculated based on the net of urea imports and exports. The increasing implied emission factor (IEF) for ammonia production over the period 1990–2005 is due to increasing amounts of urea being imported into the United States in recent years.

83. The ERT acknowledges the work of the United States in increasing the accuracy of the emission estimates by using the methodology provided in the 2006 IPCC Guidelines. However, the inclusion of

urea application emissions from net imports of urea results in a comparability issue for this category. The ERT encourages the United States to explore ways of reporting emissions from ammonia production according to the Revised 1996 IPCC Guidelines and the UNFCCC reporting guidelines.

3. Adipic acid production – N_2O

84. There are four adipic acid production plants in the United States. Two companies directly report N_2O emissions (tier 3). AD for the other two companies are obtained from the American Chemistry Council and *Chemical Week* publication. The IPCC default EF of 0.3 t N_2O/t product is assessed to be appropriate to use in the calculation of emissions from the two plants that do not directly measure N_2O emissions.

85. Emissions from adipic acid production decreased by 60.7 per cent from 1990 to 2005 despite a production increase of 42.1 per cent over the same time period. The decreasing trend in the IEF over the time series is due to the installation of abatement technologies. By 1998 three of the four companies had abatement technology in place. The methodology used to calculate N_2O emissions from adipic acid production adjusts for the percentage of N_2O released as a result of plant-specific emission controls.

4. Iron and steel production – CO_2

86. Process emissions from iron and steel production are included under the industrial processes sector in line with the IPCC good practice guidance. There are several steps in the process where CO_2 is emitted. However, the majority of CO_2 is emitted in the consumption of coke to produce pig iron. To avoid double counting, subtraction of CO_2 is made to account for coal tar used in other processes (e.g. aluminium production), pig iron used for non-steel use and carbon incorporated into the final steel products. Assumptions and EFs are reviewed each year to ensure they are still valid. During the in-country review, the United States provided a diagram showing where CO_2 emissions were emitted in the iron and steel process. The ERT encourages the United States to explore ways of including this diagram in the NIR (it may be able to replace some of the text used to describe the process in the NIR).

87. The spreadsheet used to estimate emissions from iron and steel production is well set out and well documented. The links with the energy sector are clearly shown to ensure that no double counting or omissions are occurring. During the in-country visit, the United States explained that prior to 1998 estimates of coking coal consumed sometimes appeared to exceed the amount of coking coal available. This was because of the way the EIA energy statistics were collected. The apparent inconsistency was overcome by deducting the remainder from the "industrial other coal" category in the EIA energy statistics.

88. Over the period 1990–2005, electric arc furnaces have acquired a greater share in the total steel production of the United States. These furnaces are more energy intensive but produce fewer industrial processes CO_2 emissions, which is reflected in the decreasing IEF for steel over the time series. The IEF for the amount of coke produced fluctuates throughout the time series. During the in-country visit, the United States explained that CO_2 emissions for coke production are estimated by taking the difference between the total carbon in the coking coal and the total carbon in the coke produced. Because these values fluctuate independently throughout the time series, CO_2 emissions also fluctuate throughout the time series. The ERT encourages the United States to include a brief summary of these explanations for the trend for steel and coke emissions in the next NIR.

89. The ERT acknowledges the plan by the United States to move to the methodology in the 2006 IPCC Guidelines to estimate emissions from iron and steel production. To ensure that emissions from this category are comparable with those of other Parties, the ERT encourages the United States to explore ways of reporting the emissions according to the Revised 1996 IPCC Guidelines and the UNFCCC reporting guidelines.

5. Aluminium production – PFCs

90. PFC emission estimates from aluminium production in the United States are based on IPCC tier 2 and tier 3 approaches. Voluntary partnership reporting has become vital for accessing AD. All the aluminium smelters operating in 2005 reported AD. For earlier years in the time series where production data were not reported, AD estimates were based on smelter capacity and total aluminium production (available from USGS).

91. The smelter-specific coefficients used to estimate PFC emissions were available for five of the 15 operating smelters in 2005. For the remaining 10 smelters, technology-specific slope coefficients were applied from the IPCC good practice guidance.

92. The reduction in PFC emissions over the 1990–2005 time series is the result of a combination of the reduction in total domestic aluminium production and aluminium smelting companies reducing the frequency and duration of the anode effects.

93. The IEFs for perfluoromethane (CF_4) and perfluoroethane (C_2F_6) fluctuate during the time period 2000–2002. During the in-country visit, the United States explained that this was caused by fluctuations in production of a large smelter with a high emission rate. The ERT encourages the United States to include this explanation for the trend in the next NIR.

6. HCFC-22 production – HFC-23

94. The small number of HCFC-22 plants in the United States (eight were in operation in 1990 and three were in operation in 2005) means that good AD are available. The plants accounting for most of the production in the early 1990s and all production since 1995 directly measure hydrofluorocarbon-23 (HFC-23) concentrations in their process streams. The AD and resulting HFC-23 emissions are considered confidential so the plants report to a third-party organization, which aggregates the HCFC-22 production data and HFC-23 emissions and sends them to EPA.

95. The ERT commends the United States for the audits of data at the plant level carried out in 1995 and 2007. The ERT encourages the United States to provide a brief summary of the audit process and results in future inventory submissions.

96. The decreasing trend in HFC-23 emissions is due to process optimization and thermal oxidation since the mid 1990s. The majority of HCFC-22 production capacity in the United States now has controls in place to reduce HFC-23 emissions, in contrast to the situation in 1990, when none of the plants had such controls in place. The ERT encourages the United States to include in the next NIR the detailed explanation of the IEF trend for HFC-23 emissions given during the in-country visit.

7. Ozone depleting substances substitutes – HFCs

97. Emissions from the use of HFCs and PFCs as substitutes for ozone depleting substances (ODS) have increased from small amounts in 1990 to 123,325.52 Gg CO_2 eq in 2005. This increase has been due to efforts to phase out chlorofluorocarbons and other ODS in the United States. In 1991 and 1992 relatively small amounts of HFC-152a and HFC-134a were in use in the refrigeration industry. By 1995 HFCs and PFCs entered widespread use as halon production was phased out.

98. A detailed bottom-up Vintaging Model of ODS is used to estimate the actual and potential emissions of various substitutes for ODS including HFCs and PFCs. The model includes six sub-sectors which are broken down into end-uses. The number depends on the sector (e.g. one end-use for the sterilization sector but over 30 for refrigeration and air conditioning). Data and assumptions come from a variety of sources (both published and confidential) including experts, industry and trade associations. Emission methodologies are based on the 2006 IPCC Guidelines using the tier 2a (EF) approach.

99. The Vintaging Model incorporates technology improvements and expected changes in behaviour (e.g. leakage rates decreasing over time, more environmental awareness and improved servicing practices). Assumptions are reviewed regularly and updated whenever new information becomes available. The model was updated for the 2007 inventory submission following an extensive review of the assumptions including market and charge sizes, growth rates and chemical substitution rates. The ERT commends the United States for its continuous improvements to the Vintaging Model.

100. The Vintaging Model is comprehensive, generally transparent, well documented and run by knowledgeable experts. Automated checking and handling of data occurs between the model output and input into the CRF tables to avoid manual handling errors. The ERT encourages the United States to include some additional information on the Vintaging Model in the annex to the NIR to assist with transparency. Including information on the following aspects of the model would be valuable: the time period the model covers (explain that it is both historical and projected); the methodologies used in the model are based on the 2006 IPCC Guidelines; the model is written in Visual Basic and has Microsoft Excel output sheets (explain how the output data is transferred into the CRF Reporter); the submitted version of the model and associated data sheets are frozen and archived; how the model accounts for emissions from equipment manufacture (e.g. refrigerators); and the range of EFs used in the refrigeration and air-conditioning subcategory.

101. A one-off study provided some correlation of top-down data (tracking system for ODS and producer/importer data for HFCs) with the model output. The correlation for ODS tracked reasonably well with the data reported to the United Nations Environment Programme tracking system for the Montreal Protocol on Substances that Deplete the Ozone Layer. The correlation for HFCs varied according to the particular gas. The biggest differences occurred with HFC-134a (the Vintaging Model overestimated results) and HFC-152a (the Vintaging Model underestimated results). During the in-country visit, the United States explained that the difference for HFC-134a was most likely to be owing to a major producer not providing data for producer/importer reporting and the Vintaging Model possibly underestimating HFC-152a emissions from aerosols. The ERT encourages the United States to provide a brief summary of the correlation study with the top-down HFC data in the next NIR.

102. The ERT acknowledges the challenges faced by the United States in obtaining country-specific data for this complex category. The ERT encourages the Party, where possible, to continue to verify the Vintaging Model by checking model outputs against available top-down data.

8. Electrical equipment – SF_6

103. SF_6 emissions in the United States have decreased by 51.3 per cent in the period 1990–2005 in response to price increases in the 1990s and a growing awareness of the environmental impact of these emissions.

104. The majority of SF_6 emissions from this category come from electric power system utilities. AD for the period 1999–2005 come from utilities participating in EPA's SF_6 Emission Reduction Partnership for Electric Power Systems. Partners in this programme use the IPCC tier 3 (facility-level, mass-balance) approach. Emissions of non-reporting utilities have been estimated based on a regression equation relating transmission line length to emissions.

105. Very little AD were available from the utility companies prior to 1999 so SF_6 emissions for the period 1990–1998 were modelled using global emissions from the RAND corporation survey.

106. The ERT acknowledges the work the United States has done in this category to ensure accuracy and time-series consistency despite missing AD.

C. Non-key categories

Lime production – CO_2

107. Lime production data (via sales information) and data on types of lime produced are obtained via an annual survey administered by USGS. Estimates of CO_2 emissions are calculated by multiplying the amount of high-calcium and dolomitic lime by the IPCC default EFs.

108. Emissions from lime production in the 2007 inventory submission took into account CO_2 recovered from the lime production process for use in the sugar refining industry and precipitated calcium carbonate production. The methodology for this recarbonation is not discussed in the NIR. During the in-country visit, the United States explained that CO_2 recovery occurs from flue gas recovery (energy emissions) and not from lime process emissions. A correction to the methodology has been made and revised estimates are to be reported in the 2008 inventory submission.

D. Areas for further improvement

1. Identified by the Party

109. The ERT acknowledges the continuous improvements for most categories in the industrial processes sector identified in the NIR by the United States. Some specific planned improvements include implementing the 2006 IPCC guidelines for iron and steel and ammonia production, obtaining direct N_2O measurement data for all four adipic acid production facilities, research into the availability of limestone and dolomite end-use data and performing research to determine data availability for ferroalloys other than ferrosilicon and silicon metal.

2. Identified by the expert review team

110. The ERT acknowledges the improvements in the industrial processes sector identified by the United States and encourages their implementation as resources allow. Where the improvements include implementation of the 2006 IPCC Guidelines, the ERT encourages the United States to explore ways of reporting the emissions according to the Revised 1996 IPCC Guidelines and the UNFCCC reporting guidelines.

V. Agriculture

A. Sector overview

111. Agriculture emissions in 2005 amounted to 536,271.00 Gg CO_2 eq, representing 7.4 per cent of total national emissions. Emissions increased by 1.1 per cent in relation to 1990. Annual fluctuations occurred in the main categories as a result of variations in the AD or parameters used in the model emission estimations (e.g., manure management as a reflection of annual variation in animal population (swine); and agricultural soils as a reflection of annual variations in weather, synthetic fertilizer consumption and crop production).

112. To estimate emissions from the agriculture sector, the United States used a decentralized approach based on a long-term and well-established system of contracts with different organizations (e.g. USDA, University of Colorado) and companies (e.g. ICF International). The ERT recommends that the United States explain the institutional arrangements for inventory preparation for the agricultural sector, including details of the organizations and companies involved, in its next submission to increase the transparency and credibility of the approach.

113. The United States identified some inconsistencies between the AD used in different categories (e.g. the country-based model Cattle Enteric Fermentation Model (CEFM) used for cattle population figures for enteric fermentation, which differed from those for manure management, although both

sectors used the same USDA cattle population data as the basis for their estimates). The ERT recommends that the United States undertake cross-checks of the AD to ensure their consistent use in the inventory estimates.

1. Recalculations and time-series consistency

114. Because tier 2 and tier 3 methods were applied for some categories, there were significant recalculations in the 2007 submission (on average the recalculation was 17.5 per cent per year), which were explained in the specific category findings. In general the recalculations are well justified.

115. The ERT recommends that, before making recalculations because of improvements in the models used or changes in AD, the United States correctly apply QA/QC procedures to validate the estimates and avoid calculation errors before the official inventory submission (see para. 122).

2. Uncertainties

116. Because tier 3 methods and country-specific EFs were applied in some categories (e.g. agricultural soils and rice cultivation), the uncertainties of some of the emission estimates are significant (e.g. the uncertainties for indirect emissions in agricultural soils varied from –42 per cent to +135 per cent; and for rice cultivation from –70 per cent to +170 per cent). The ERT noted that the United States has a plan for improvements that should reduce the uncertainties. The ERT recommends the United States to proceed with the improvements planned (e.g. improvements in the DAYCENT process-based model) in order to reduce the uncertainties as much as possible.

B. Key categories

1. Enteric fermentation – CH_4

117. Enteric fermentation emitted 112,130.62 Gg CO_2 eq in 2005, representing 20.9 per cent of sector emissions and 1.5 per cent of total national emissions. Since 1990, emissions from this category have decreased by 3.1 per cent. The main animal category responsible for the emissions was non-dairy cattle (70.7 per cent). Minor recalculations were made following the adoption of the 2006 IPCC Guidelines emission factor for bulls and changes to the USDA cattle population data.

118. The United States uses a tier 2 approach (CEFM) for dairy and beef cattle and a tier 1 approach for other animals (sheep, goats, horses, swine and bulls). This is in line with the IPCC good practice guidance.

119. A transition matrix was elaborated and used to apply the CEFM model. The matrix models the cattle data on a monthly basis to more accurately reflect the weight and population fluctuations that occur throughout the year. The ERT encourages the United States to increase the transparency of the transition matrix in its future submissions by explaining it in a more reader-friendly way.

2. Agricultural soils – N_2O

120. The agricultural soils category emitted 365,096.48 Gg CO_2 eq in 2005, representing 68.1 per cent of sector emissions and 5.0 per cent of total national emissions. Since 1990, emissions have decreased by 0.5 per cent. Major recalculations were made (an average of 29.5 per cent in direct emissions; an average of –57.1 per cent in pasture range and paddock manure and an average of –53.3 per cent in indirect emissions) to account for the changes in nitrogen (N) inputs, local soil and weather variability and the adoption of methods and EFs from the 2006 IPCC Guidelines.

121. The United States used a tier 3 model approach (the DAYCENTmodel, based on the interaction of N inputs and the environmental conditions at a specific location) for the major crops (corn, soybean, wheat, alfalfa hay, other hay, sorghum and cotton), which represent approximately 90 per cent of total cropland. For other (non-major) crops a tier 1 approach was used. The DAYCENT model produces

more accurate estimates but is less transparent (compared with IPCC tier 1 and tier 2 approaches). In order to increase the transparency of the tier 3 approach, the ERT recommends that the United States enhance the description of the model and assumptions used (e.g. rates of fertilizer application) along with the results produced (including validations of the model) and the consistency between the model results and the inputs to the CRF tables.

122. During the in-country visit, the United States indicated that additional QA/QC for the 2008 inventory submission had uncovered a unit conversion error, which led to an overestimation of N_2O emissions by about 25 per cent for major crops. This error has been corrected for the 2008 submission, and will be documented in the recalculations section of the next submission. The ERT encourages the United States to make all necessary recalculations and to explain them in its next submission. The ERT further encourages the United States to correctly apply QA/QC procedures to avoid this kind of error and recalculation in the future.

3. Manure management – CH_4

123. CH_4 emissions from manure management amounted to 41,279.60 Gg CO_2 eq in 2005, representing 7.7 per cent of sector emissions and 0.6 per cent of total national emissions. Since 1990, the emissions from this category have increased by 33.7 per cent, mainly because of the shift to larger (dairy and swine) facilities that use liquid manure management systems.

124. The United States AgSTAR programme is used to estimate CH_4 emissions for each farm that operates an anaerobic digester system. For future years, the United States inventory team is planning improvements to better estimate anaerobic digester emissions by taking into account losses due to leakage and inefficiency and allowing for anaerobic digester emission estimates at the state level. The ERT welcomes the planned improvements and encourages the United States to continue the task.

C. Non-key categories

1. Manure management – N_2O

125. N_2O emissions from manure management amounted to 9,507.22 Gg CO_2 eq in 2005, representing 1.8 per cent of sector emissions and 0.1 per cent of total national emissions. Since 1990, emissions have increased by 10.3 per cent, mainly due to changes in animal waste management systems (AWMS) in the poultry industry.

126. The main AWMS responsible for the N_2O emissions was solid storage and dry lot (83.1 per cent). Major recalculations were made following the adoption of the 2006 IPCC Guidelines EF for N_2O and the use of state temperature and climate-specific methane conversion factors for dry manure management systems.

2. Rice cultivation – CH_4

127. Methane emissions from rice cultivation amounted to 6,891.99 Gg CO_2 eq in 2005, representing 1.3 per cent of sector emissions and 0.1 per cent of total national emissions. Emissions have fluctuated from year to year since 1990 (from –10.8 per cent to +17.0 per cent) with an overall decrease of 3.2 per cent linked to a reduction of the crop area. The emissions were estimated using the tier 1 approach and country-specific EFs. The ERT noted the high uncertainty of country-specific EFs and encourages the United States to improve the accuracy of the EFs used in order to reduce uncertainty as much as possible.

D. Areas for further improvement

1. Identified by the Party

128. Several improvements were identified by the United States:

(a) Future inventories will be updated to ensure compliance with the 2006 IPCC Guidelines, where appropriate;

(b) Enhance the uncertainty analysis by full incorporation of the methods in the 2006 IPCC Guidelines;

(c) Collect additional information and update the cattle diet assumptions by individual States;

(d) Use the information from new cattle diet research (to be published in the *Journal of Animal Science*);

(e) Improve the CEFM model to allow for the separate cattle diet assumptions of all 50 States;

(f) Make direct estimates of the reductions in methane emissions from anaerobic digesters in the inventory estimations;

(g) Incorporate more detailed land survey data from the USDA National Resources Inventory into the DAYCENT simulations;

(h) Conduct additional research to include additional crops, the residues of which may be burned (grass for seed, blueberries and fruit and nut trees), and on recent changes to state crop-burning regulations.

2. Identified by the expert review team

129. The following recommendations were identified by the ERT to improve the quality of the United States inventory:

(a) Enhance the documentation and peer review of emission estimation approaches, particularly where tier 3 methods (e.g. DAYCENT) are used;

(b) Consider validation of the inventory results, particularly those obtained from the use of tier 2 and tier 3 methods (e.g. CEFM and DAYCENT model estimates);

(c) Enhance consistency between the different categories of the AD, methods and inventory estimates (e.g. cattle population used for the estimations of emissions from enteric fermentation and manure management);

(d) Develop an improvement plan for the agriculture sector guided by the principles of transparency, accuracy, consistency, comparability and completeness and the outcomes of QA/QC and recalculations.

VI. Land use, land-use change and forestry

A. Sector overview

130. In 2005, the LULUCF sector was a net sink of 809,547.39 Gg CO_2 eq and accounted for 11.2 per cent of total national emissions (excluding LULUCF). Overall removals, which increased by 21.6 per cent from 1990 to 1997, decreased by 13.6 per cent from 1997 to 2000 and increased by 10.1 per cent from 2000 to 2005. The United States explained these trend fluctuations as recalculation of carbon stocks due to continuous updates of the forest inventory at the state level. The ERT noted that the NIR does not provide information on consistent land representation and the delineation between managed and unmanaged land. The United States indicated that this information will be included in the 2008 inventory submission. The ERT encourages the United States to ensure that the information on land

representation and delineation between managed and unmanaged land is provided in accordance with the requirements of the IPCC *Good Practice Guidance for Land Use, Land-use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF).

131. The United States has in place an inter-agency system for preparation and consistent improvement of AD and GHG calculations in the LULUCF sector. The inventory estimates are prepared by the Northern Research Station in cooperation with the Forest Inventory and Analysis Program, the Forest Products Laboratory under the USDA Forest Service and Colorado State University in collaboration with Natural Resources Conservation Service. The inventory is compiled by EPA. The United States undertook a tier 1 level and trend key category analysis, which identified the categories forest land remaining forest land, cropland remaining cropland, grassland remaining grassland and settlements remaining settlements as key categories. To estimate emissions and removals from the key categories, the United States used a combination of tier 2 and tier 3 methods, as outlined in the IPCC good practice guidance for LULUCF.

132. The NIR and CRF include estimates for all gases and most categories, as recommended by the IPCC good practice guidance for LULUCF. The United States reported CO_2 removals for forest land remaining forest land, cropland remaining cropland, other land converted to cropland, grassland remaining grassland, other land converted to grassland, settlements remaining settlements and other (5.G). Although the United States included the estimates for other land converted to cropland and grassland in its 2007 submission, the reporting on land conversion to other land uses can still be improved. CO_2 emissions from agricultural liming are reported, while the non-CO_2 emissions are reported for biomass burning and fertilization of forest land and settlements. Wetlands, N_2O emissions from drainage of soils and wetlands and N_2O emissions from disturbance associated with land-use conversion to cropland were not reported (notation keys were used instead). The ERT encourages the United States to provide estimates for the land-use categories and activities that are not currently reported.

Transparency

133. The NIR does not provide information on the AD, methods and parameters used to estimate GHG emissions and removals, making it difficult to follow the calculations and understand the estimates. The ERT encourages the United States to enhance its documentation of the methods, AD and parameters used for estimation of emissions and removals and the explanation of inter-annual fluctuations in the GHG trends in its next NIR.

134. The ERT acknowledged the improved use of notation keys since the previous (2006) submission. However, the notation keys and comments were inconsistently used in CRF tables 5.F, 5(I), 5(II) and 5(III). The ERT encourages the United States to further enhance the use of notation keys and cell comments in the next inventory submission.

B. Key categories

1. Forest land remaining forest land – CO_2

135. In 2005, removals by forest land remaining forest land amounted to 595,343.38Gg CO_2 eq, a 27.6 increase on 1990, and eq to 8.2 per cent of total national emissions (excluding LULUCF). The United States used the tier 2 stock change method to estimate CO_2 removals in the tree layer, understory, dead wood, litter and soil. The ERT reiterates the findings of the previous review that the United States does not report on carbon stocks in Alaskan forests. According to the NIR, the Alaskan forests are not included because of insufficient data. The ERT further noted the inconsistency in presenting data on areas and the actual estimates of net changes in organic soil carbon stock under forest land remaining forest land. The United States indicated that the data were incorrectly allocated in the CRF, and that this issue would be addressed in the 2008 inventory submission. If the Alaskan forests are considered

managed, the ERT recommends the United States to collect the data and estimate emissions and removals for them in the next inventory submission. The ERT also recommends the United States to ensure consistent provision of data on soil carbon stocks for forest land remaining forest land in its next inventory submission.

2. Cropland remaining cropland – CO_2

136. Net removals by cropland remaining cropland amounted to 39,383.83 Gg CO_2 eq, (a 39.9 per cent rise in relation to the 1990 level) and accounted for almost 0.5 per cent of total national emissions in 2005 (excluding LULUCF). For this category, the United States reports removals due to changes in soil carbon stocks. The changes in soil carbon stocks were estimated using a combination of IPCC tier 2 and tier 3 methods, which implies mathematical modelling. The NIR does not include information on verification of the mathematical models used for the estimations but this information was provided during the review. The ERT encourages the United States to document the verification of the model estimates of soil carbon stocks in its next inventory submission.

3. Grassland remaining grassland – CO_2

137. In 2005, CO_2 emissions from grassland remaining grassland were 0.2 per cent of total national emissions (excluding LULUCF). The emissions increased from 130.43 Gg in 1990 to 16,106.19 Gg in 2005 because of significant losses of soil organic carbon due to droughts. Under this category, the United States reports only the changes in soil carbon stocks, which were estimated using a combination of IPCC tier 2 and tier 3 methods and mathematical modelling. The NIR does not include information on how the model has been verified but this information was provided to the ERT during the review. The ERT encourages the United States to document the verification of the model estimates of soil carbon stocks in its next inventory submission.

4. Settlements remaining settlements – CO_2

138. In 2005, settlements remaining settlements were a net sink of CO_2 equal to 1.3 per cent of total national emissions. Removals were 21.1 per cent higher in 2005 than in 1990. Under this category, the United States reports on removals by urban trees and on yard trimmings and food scraps in landfills. Country-specific data and parameters from the 1990 and 2000 censuses were used to estimate carbon stock changes in urban trees. The annual removals were derived through interpolation or extrapolation of existing data corrected for area changes and dead tree withdrawals. This approach corresponds to the tier 2 method in the IPCC good practice guidance for LULUCF. However, the method, AD and parameters were insufficiently described in the NIR. The ERT also noted that the value for yard trimming and food scraps was erroneously put in the cell for dead organic matter for urban trees in CRF table 5.E. To improve transparency in the reporting, the ERT encourages the United States to describe the calculations step by step, and to document the AD and parameters used for estimating removals in urban trees with the reasons for their inter-annual variations. The inputs for specific carbon pools should also be cross-checked in the CRF tables.

139. The United States reports on removals due to changes in carbon stocks of yard trimmings and food scraps in landfills under the category settlements remaining settlements in CRF table 5.E. However, the same removals are reported under the category other (5.G) in the NIR. The approach follows the 2006 IPCC Guidelines first order decay (FOD) method for the estimation of CH_4 emissions from landfills in the waste sector. Within reporting on yard trimmings and food scraps, country-specific values of half-lives were used that were not justified in the NIR. As in the previous (2006) review, the ERT noted that the reporting on yard trimmings and food scraps in landfills is inconsistent with the UNFCCC reporting guidelines. Furthermore, the ERT noted the lack of a relevant IPCC methodology, resulting in high uncertainty of the estimates. To maintain consistency with the UNFCCC reporting guidelines, the ERT recommends the United States to report on yard trimmings and food scraps under the category other (5.G) in both the NIR and the CRF tables. The reporting should be made in a separate line to improve

transparency. Furthermore, the United States is encouraged to justify the half-lives used for the estimation of carbon stock changes in yard trimmings and food scraps.

C. Non-key categories

1. Land converted to cropland – CO_2

140. The ERT acknowledges that, in response to the recommendations of the previous (2006) review, CO_2 emissions from land converted to cropland were introduced in the 2007 submission for the first time. These emissions decreased by 16.9 per cent between 1990 and 2005, and amount to about 0.1 per cent of the total national emissions (without LULUCF) in 2005. Under this category, the United States reports changes in soil carbon stocks estimated using a combination of IPCC tier 2 and tier 3 methods, which implies mathematical modelling. However, the NIR does not include information on how the model was verified or an explanation of the decreasing emission trend. The ERT encourages the United States to document the verification of the model estimates of soil carbon stocks along with the explanation of the decreasing emission trend in its next inventory submission.

2. Land converted to grassland – CO_2

141. The ERT acknowledges that, in response to the recommendations of the previous (2006) review, land converted to grassland was introduced in the 2007 submission for the first time. In 2005, the category was a net CO_2 sink of 0.2 per cent of the total national emissions (without LULUCF). These removals have increased by 12.2 per cent since 1990. Under this category, the United States reports the changes in soil carbon stocks estimated using IPCC tier 2 and tier 3 methods, which implies mathematical modelling. However, the NIR does not include information on how the model was verified or an explanation of the reasons for the carbon stock increase. The ERT encourages the United States to document the verification of the model estimates along with an explanation of the increase in soil carbon stocks in its next inventory submission.

3. Emissions from agricultural lime application – CO_2

142. Emissions from agricultural lime and dolomite application were estimated using IPCC tier 2 methods and country-specific AD and EFs. As in the previous review, the ERT noted that the country-specific EFs were taken from a unique analytical assessment by West and Mc Bride (2005) and are almost half of the IPCC default EFs. The ERT encourages the United States to either provide further justification for the country-specific EFs for liming or use the IPCC default EFs.

4. Direct N_2O emissions from nitrogen fertilization – N_2O

143. The United States reports N_2O emissions from nitrogen fertilization of forest land and settlements. In 2005 these emissions amounted to 6,151.32 Gg CO_2 eq, 18.6 per cent higher than in 1990. The calculations were made using a tier 1 method and default EFs from the 2006 IPCC Guidelines. Emissions from forest land were estimated by assuming an average rate of nitrogen fertilizer application to pine plantations. Emissions from settlements were calculated by assuming a 10 per cent application of national fertilizer use and using data from fertilizer statistics. The ERT noted that the 2006 IPCC Guidelines were applied in full for the agriculture and LULUCF sectors, making the use of EFs appropriate. The ERT further noted that the use of different assumptions and AD sources may lead to an overestimation or an underestimation of N_2O emissions. The ERT encourages the United States to cross-check the consistency of the data sources used and to justify the assumptions about the rates of nitric fertilizer application to forest plantations and settlements.

5. Biomass burning – CH_4, N_2O

144. The ERT acknowledges that in response to the previous review, the United States reported on emissions from biomass burning in its 2007 inventory submission, which were calculated using the tier 1

method. In 2005, CH_4 and N_2O emissions from this category amounted to 12,753.95 Gg CO_2 eq, accounting for 0.2 per cent of total national emissions and being 63.7 per cent higher than in 1990. The ERT noted that in CRF table 5(V), the United States reported on emissions from controlled burning. During the review, the United States explained that no delineation between prescribed burning and wildfires was made and all fire events were considered to be wildfires, leading to the inappropriate allocation of the estimate in the CRF table 5(V). Furthermore, the ERT learned that the total area of wildfires was corrected to identify only those referring to forest land. Thus, the emissions were underestimated, because emissions from other managed land were not included. The ERT encourages the United States to report fire emissions under the wildfire sub-category. The United States is further encouraged to identify where fires occurred on other managed land during the reporting year, and include the emissions from these fires under the relevant land categories.

6. Other – CO_2

145. The United States reported on removals by harvested wood products in use and in solid waste disposal on land under other (5.G) in the CRF, whereas in the NIR harvested wood products are reported under forest land remaining forest land. Harvested wood products in use were estimated in accordance with the tier 3 method in the 2006 IPCC Guidelines. Harvested wood products in solid waste disposal on land were estimated using the FOD method applied for estimation of CH_4 emissions from landfills in the waste sector. As in previous reviews, the ERT noted that reporting on harvested wood products is inconsistent with the UNFCCC reporting guidelines. Furthermore, the ERT noted that there is no IPCC methodology for estimation of CO_2 removals by harvested wood products in solid waste disposal on land, resulting in high uncertainty of the estimates. To maintain consistency with the UNFCCC reporting guidelines, the ERT recommends the United States to report on harvested wood products under the category other (5.G) in both the NIR and the CRF. Harvested wood products in use and harvested wood products in landfills should be reported separately (in separate lines), for reasons of transparency.

D. Areas for further improvement

1. Identified by the Party

146. The ERT noted that EPA has elaborated a plan for further improvements, which is currently being implemented. The plan takes into account the issues raised by the previous reviews. The United States identified the following areas for further improvements:

(a) Develop consistent land representation within the country;

(b) Include Alaskan forests in the inventory subject to availability of data;

(c) Enhance (tier 3) assessment of soil carbon stocks, particularly for agro-forestry systems and other crops, such as vegetables and rice, and for perennials and horticulture;

(d) Update the data on areas of pine plantations, cropland and grassland management including, the integration of the remote sensing data;

(e) Further enhance the QA/QC system and tier 2 uncertainty analysis for croplands and grasslands;

(f) Enhance consistency between the estimates of carbon stocks in landfills reported under the LULUCF sector and methane emissions from landfills reported under the waste sector;

(g) Delineate between managed and unmanaged land in accordance with the requirements of the IPCC good practice guidance for LULUCF.

2. Identified by the expert review team

147. In addition to the planned improvements identified by the Party, the ERT proposes that the United States:

(a) Reconcile the use of notation keys and cell comments and cross-check the correct allocation of inventory estimates in the CRF;

(b) Enhance the reporting on land remaining in the same categories and those converted to other land uses as well as on land categories and activities that are not yet reported;

(c) Improve documentation of methods, AD and parameters for the GHG inventory estimations along with verification of model estimates and explanation of inter-annual fluctuations in trends, particularly for the categories where tier 3 approaches are used;

(d) Justify the country-specific EFs for liming, and the assumptions on the rates of nitrogen fertilizer use in forest plantations and settlements as well as the half-lives for yard trimmings and food scraps in landfills;

(e) Undertake reporting on yard trimming and food scraps and on harvested wood products in use and harvested wood products in landfills in separate lines under category other (5.G) in both the NIR and the CRF;

(f) Identify where fires occurred on other managed land to include the emissions from fire events on such land in the reporting on biomass burning.

VII. Waste

A. Sector overview

148. Waste sector emissions in 2005 amounted to 165,426.16 CO_2 eq and accounted for 2.3 per cent of total national emissions. The highest contributors to the sectoral emissions were from CH_4 from solid waste disposal on land, 79.8 per cent, CH_4 from wastewater handling, 15.4 per cent, and N_2O from wastewater handling, 4.8 per cent. Waste incineration was included in the energy sector.

149. The ERT noted that despite population and waste generation increases in the period 1990–2005, sectoral emissions decreased by 13.9 per cent during the same time period. The reduction achieved was the result of increased recovery of landfill gas for energy and flaring, which grew from about 11.2 per cent in 1990 to 44.8 per cent in 2005 (of total potential methane emissions from landfills), mainly driven by the 1996 federal regulations, and voluntary reporting and recovery of CH_4 by operators under the landfill methane outreach programme (LMOP) of EPA along with implementation of local (state-level) and federal economic incentive schemes.

150. The United States revised its waste sector emissions estimation methodologies in 2005, using predominantly results from country-specific studies, the 2006 IPCC Guidelines and the IPCC good practice guidance. AD were also improved on landfill gas recovery as well as industrial solid waste generation and disposal. The methodologies and underlying assumptions were well summarized and documented in the NIR and its annexes.

151. The United States provided recalculations for CH_4 emissions from domestic and industrial wastewater handling, and N_2O emissions from domestic wastewater handling for the complete time series from 1990 to 2004 to reflect the changes in the methodological choices based on the 2006 IPCC Guidelines. The recalculation of CH_4 emissions resulted in a reduction of industrial wastewater emissions of 45 to 50 per cent, resulting in a decrease of up to 16.7 per cent in the overall waste sector emissions for the entire time series. The recalculations of methane emissions were largely due to

improved AD for poultry processors, which gave a 25–33 per cent reduction in the anaerobically treated component. N_2O emissions from domestic wastewater handling also decreased by 50–51 per cent from 1990 to 2005 owing to the use of default EFs from the IPCC 2006 Guidelines (the EF of 0.005 kg N_2O-N/kg sewage replaced 0.01 kg N_2O-N/kg sewage from the 1996 IPCC Guidelines).

Completeness

152. The ERT noted that the waste sector inventory is generally complete in terms of categories and gases. However, the United States did not include any information on hazardous waste incineration without energy recovery and biogenic fractions of waste combustion in boilers and industrial furnaces (BIFs). To improve the completeness of the inventory, the ERT recommends the United States to include these currently missing categories in its next inventory submission.

B. Key categories

Solid waste disposal on land – CH_4

153. In 2005, CH_4 emissions from solid waste disposal on land accounted for 1.8 per cent of total national emissions (without LULUCF) and 25.0 per cent of total national CH_4 emissions (without LULUCF).

154. The emissions from this category reduced by 18.0 per cent from 1990 to 2005. The observed trend is the result of increased landfill gas recovery for energy and flaring, and recycling and increased composting of biodegradable waste streams – particularly for yard trimmings. The United States explained that the disposal rate of yard trimmings and food scraps decreased significantly owing to increased backyard and municipal composting facilities as a result of discouraging disposal.

155. The emission trends, however, showed significant inter-annual increases in some interim years. The United States attributed such changes to the number of landfill gas-to-energy projects that reported their data to EIA. The ERT noted during the review that the AD have been improved as result of the inclusion in the biocycle of annual data reporting, and improved voluntary reporting under LMOP.

156. The ERT noted that the NIR reported the fraction of waste disposed as solid waste disposal on land to be 64 per cent while the CRF indicates 54 per cent. The United States explained the apparent discrepancy by the fact that the 64 per cent figure was based on total solid waste generation, which included construction and demolition waste, while the CRF value was based on municipal solid waste (MSW) only. Additional information obtained during the review showed that on average non-MSW constituted about 24 per cent of total solid waste generation in 2004 (Bio-cycle, 2006). To improve consistency and transparency in the reporting in the NIR and CRF, the ERT encourages the United States to explain the differences in the values of total waste generation in its next inventory submission.

157. The FOD methodology used for the category emissions estimates was enhanced by the application of the 2006 IPCC Guidelines. The United States developed a country-specific methane generation potential (Lo) from which the degradable organic carbon (DOC) value was also derived. The methodology employs regression analysis to obtain the best value of Lo from a wide range of measured methane emissions. The ERT noted that the constant DOC may not reflect the changing composition of waste in the United States due to increased recycling and composting of degradable fractions. The ERT therefore encourages the United States to investigate the sensitivity of the FOD model to changing DOC as a part of an ongoing study to reduce the differences between actual emissions and the FOD model estimate.

158. The ERT acknowledged the changes made by the United States to the methodological choices of AD for industrial solid waste generation in response to the comments made by the ERT in the review of the 2006 inventory submission. The use of production data from industry activities improved transparency and reduced uncertainty for industrial waste disposed at landfills. This change resulted in a

decrease of 2 per cent in the estimate of CH_4 generation at industrial landfills relative to the previous method, which assumed that emissions from industrial solid waste landfill were approximately 7 per cent of total emissions from the municipal solid waste disposal sites for the entire time series.

C. Non-key categories

1. Wastewater handling – CH_4

159. CH_4 emissions from domestic and industrial wastewater handling increased from 1,180.0 Gg in 1990 to 1,209.54 Gg in 2005, representing an increase of 2.5 per cent over the period. The increase is attributed to population growth of approximately 20 per cent and a corresponding rise in wastewater generation during the period.

160. The United States refined its methodological approach to make it consistent with the 2006 IPCC Guidelines and the IPCC good practice guidance. The choice of AD and IPCC default EFs for the various types of handling practices, namely septic tanks, anaerobic systems, aerobic treatment with and without nitrification and denitrification systems, biodigesters, and discharge of effluent to the aquatic environment were adequately explained in the NIR and well documented in its annex.

161. The ERT notes, and encourages the implementation of, the United States' improvement plan to develop a CH_4 emission correction factor to account for biochemical oxygen demand (BOD) that is not removed by the various wastewater treatment systems and therefore does not contribute to methane emissions, and also to study the potential for CH_4 generation of some aerobic operating systems in order to refine the methane correction factor (MCF) for such systems and improve the accuracy of the inventory estimates. During the review, the ERT was informed that the United States plans to provide additional information on the methodology to account for BOD removal and ethanol wastewater treatment emissions in the next inventory submission.

2. Waste incineration – CO_2, CH_4, N_2O

162. Total emissions from waste incineration, including hazardous waste combustion, were reported under waste incineration and non-energy use of fuels in the energy sector. The NIR indicates that over 50 per cent of hazardous waste was combusted in boilers and industrial furnaces with energy recovery, and that some proportions are also incinerated solely for waste management without energy recovery in permitted facilities. The ERT also noted that AD on waste existed in the Biennial Report System of EPA. The ERT recommends that the United States identify and allocate the appropriate component of incineration to the waste sector. In addition, a short summary on waste incineration should be included in the NIR under the waste sector to indicate the rationale for the allocation and improve the transparency and consistency of the reporting in accordance with the Revised 1996 IPCC Guidelines, even though the emissions are included elsewhere under the present method.

163. The ERT observed that the NIR reports only the non-biogenic fractions used as sources of energy in waste-to-energy combustion plants. The ERT encourages the United States to also account for the biogenic fractions in the waste streams and report CO_2 emissions as memo items, consistent with the Revised 1996 IPCC Guidelines.

D. Areas for further improvement

Identified by the Party

164. The ERT acknowledges that the United States identified the following improvements, which the Party is encouraged to introduce in its future inventory submission:

(a) The designation of systems as aerobic or anaerobic could be further refined to differentiate aerobic systems with the potential to generate small amounts of CH_4

(aerobic lagoons) versus other types of aerobic systems, and to differentiate between anaerobic systems to allow for the use of different MCFs for different types of anaerobic treatment system instead of the current value of 0.8 for all practices;

(b) Obtain better data and further research on an appropriate EF to account for BOD, and include its removal through final discharge of treated wastewater in the aquatic environment, which is currently not explicitly considered in the inventory calculations.

(c) Assess the appropriateness of the inclusion of ethanol production in industrial wastewater emissions and undertake further research to obtain new and updated data and develop country-specific EFs for N_2O to account for non-sewage nitrogen in wastewater (bathing, laundry, kitchen and industrial components) to reduce the uncertainty associated with the updated IPCC default values;

(d) Obtain data on the changes to average influent nitrogen concentrations in centralized treatment systems over the time series to improve the estimation of total N entering the system and reduce or eliminate the need for other EFs for non-consumed protein or industrial flow.

VIII. Conclusions and recommendations

165. The United States provided the NIR and CRF tables for the years 1990–2005. The inventory submission is generally complete in terms of years and GHGs, geographical coverage and categories. In 2005, the most important GHG in the United States was CO_2, contributing 84.1 per cent to total national GHG emissions in CO_2 eq, followed by CH_4, 7.3 per cent, and N_2O, 6.4 per cent. HFCs, PFCs and SF_6 taken together contributed 2.3 per cent. The energy sector accounted for 85.6 per cent of total GHG emissions followed by agriculture, 7.4 per cent, industrial processes, 4.6 per cent, waste, 2.3 per cent, and solvent and other product use, 0.1 per cent. Total GHG emissions (excluding LULUCF) increased by 16.3 per cent from 1990 to 2005. The drivers for the trends were generally well documented in the NIR and discussed with the ERT during the review. The ERT finds the observed trends reasonable. The United States included five new categories in the industrial processes and LULUCF sectors, which contributed approximately 0.1 per cent to 2005 emissions. Some categories were reported as "NE". In response to the previous (2006) review, the United States provided a comprehensive discussion of the not estimated categories and on the possibility of including them in the future submissions.

166. To a large extent, the United States inventory used higher tier methods (models, country-specific methods, etc.). The methodologies and models are in general presented transparently. Additional information was provided by the Party during the review that further clarified these methodological and reporting issues. Recalculations were made to take account of the availability of new methodologies, mainly the 2006 IPCC Guidelines; more accurate AD; and improved EFs and other parameters. Taken as a whole, the recalculations resulted in the improvement of the inventory. The United States used tier 2 methods for quantitative uncertainty assessment for all but two categories. The uncertainty analysis is documented in an annex to the NIR and the category-specific uncertainties are discussed in the sectoral chapters. The United States has a national QA/QC plan in place, which is consistent with the IPCC good practice guidance and is being implemented in a comprehensive and commendable way.

167. The key recommendations made by the ERT to the United States are that the Party should:

(a) Enhance consistency between the NIR and the CRF in accordance with the UNFCCC reporting guidelines;

(b) Use higher tier methods for key categories where appropriate;

(c) Perform a tier 2 key category analysis;

(d) Document the methods, AD, assumptions and parameters used in the inventory estimates, particularly for the categories where higher tiers have been used;

(e) Include descriptions of the QA/QC and verification measures in specific sections of the sectoral chapters of the NIR;

(f) Improve consistency among sectors and categories by using the same sources of information for categories and provide quantified uncertainty estimates.

Annex

Documents and information used during the review

A. Reference documents

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B. Additional information provided by the Party

Responses to questions during the review were received from Mr. Leif Hockstadt (EPA), Ms. Lisa Hanle (EPA), Mr. John Davies (EPA), Ms. Kimberly Klunich (EPA), Ms. Linda Heath (NRS, USDA-FS), Ms. Melissa Weitz (EPA), Mr. Tom Wirth (EPA), Ms. Mausami Desai (EPA), Ms. Deborah Ottinger (EPA), Mr. Dave Godwin (EPA), Ms. Marian Martin Van Pelt (ICF International), Mr. Christopher Steuer (ICF International), Mr. Robert Lanza (ICF International), Mr Hendrik van Oss (USGS), Mr. Ken Skog (FPL, USDA FS), Mr. David Nowak (NRS, USDA FS), Mr Stephen Ogle (Colorado State University), Mr. Perry Lindstrom (DOE/EIA) and Mr. Randall Freed (ICF International), including additional material on the methodology and assumptions used.

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Table 3-Portland cement production, capacity and stocks in the U.S, by district;
Table 4-Masonry cement production and stocks in the U.S., by district;
Table 5-Clinker capacity and production in the U.S. in 2005, by district;
Table 6-Raw materials used in producing clinker and cement in the US;
Table 7-Clinker produced and fuel consumed by the cement industry in the U.S., by process;
Table 8-Electric energy used at cement plants in the U.S., by process;
Table 15-Portland Cement Shipped from Plants in the U.S. to domestic customers, by type;
Table 22-Hydraulic Cement: world production, by country.

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