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Report of the individual review of the greenhouse gas inventory of United Kingdom of Great Britain and Northern Ireland submitted in 2006*

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

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CONTENTS

I. Overview

A. Introduction

1. This report covers the in-country review of the 2006 greenhouse gas (GHG) inventory submission of the United Kingdom of Great Britain and Northern Ireland, coordinated by the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, in accordance with decision 19/CP.8. The review took place from 12 to 17 March 2007 in London, the United Kingdom of Great Britain and Northern Ireland, and was conducted by the following team of nominated experts from the roster of experts: generalist – Mr. Marius Țăranu (Moldova); energy – Mr. Tinus Pulles (Netherlands); industrial processes – Mr. Mauro Meirelles O. Santos (Brazil); agriculture – Mr. Rob Sturgiss (Australia); land use, land-use change and forestry (LULUCF) – Mr. Richard Volz (Switzerland); waste – Mr. Seungdo Kim (Korea). Mr. Tinus Pulles and Mr. Seungdo Kim were the lead reviewers. The review was coordinated by Ms. Astrid Olsson and Ms. Keryn Oude-Egberink (UNFCCC secretariat).

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

3. Comments indicating that the Party will address the remarks made by the expert review team (ERT) in future submissions are not specifically recorded in this report. In many comments, the Party provides explanations of issues, raised by the ERT in the draft review report. In such cases, the ERT has left the relevant paragraphs unchanged since the ERT's recommendation to include such explanations in the national inventory report remains valid, and in many cases the Party has indicated the intention to do so in the next submission.

B. Inventory submission and other sources of information

4. In its 2006 submission, the United Kingdom submitted a complete set of common reporting format (CRF) tables for the years 1990–2004 and a national inventory report (NIR). The CRF tables and the NIR were originally submitted on 13 April 2006. For the review the review team used the resubmitted CRF tables (28 September 2006) and the NIR (9 October 2006). Where needed the expert review team (ERT) also used the previous year's submission, additional information provided during the review and other information. The full list of materials used during the review is provided in the annex to this report.

C. Emission profiles and trends

5. In 2004, the most important GHG in the United Kingdom was carbon dioxide (CO_2), contributing 84.5 per cent to total[1] national GHG emissions expressed in CO_2 equivalent, followed by methane (CH_4), 7.8 per cent, and nitrous oxide (N_2O), 6.1 per cent. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) taken together contributed 1.6 per cent of overall GHG emissions in the country. The energy sector accounted for 85.6 per cent of the total GHG emissions in 2004, followed by agriculture (6.8 per cent), industrial processes (4.2 per cent), and waste (3.4 per cent). Total GHG emissions (excluding LULUCF) amounted to 665,330.19 Gg CO_2 equivalent and had decreased by 14.3 per cent between 1990 and 2004.

[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.

6. Tables 1 and 2 show the greenhouse gas emissions by gas and by sector, respectively.

D. Key categories

7. The United Kingdom has reported a key category analysis, both level and trend assessment, for 2004, both excluding and including the LULUCF sector. The Party uses the results of the key category analysis to prioritize the available resources for inventory preparation. Its key category analysis produced different results from the UNFCCC secretariat's tier 1 analysis.[2] The United Kingdom identified 16 key categories, while the secretariat identified 25 key categories. The differences are primarily due to the incorporation of uncertainty estimates in the analysis by the United Kingdom. Although the NIR describes the key category analysis as tier 1, it is in fact a tier 2 approach (i.e. one which takes into account uncertainties). According to the Intergovernmental Panel on Climate Change (IPCC) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance), a tier 2 key category analysis generally results in fewer key categories. The ERT also noted that the United Kingdom's key category analysis includes only categories that add up to a cumulative total of more than 94 per cent. This is not in line with the IPCC good practice guidance, which defines key categories under the tier 1 approach as follows: "Key categories are those that, when summed together in descending order of magnitude, add up to over 95 per cent of total emissions". The ERT encourages the United Kingdom for its future submissions to continue to use a tier 2 approach for identifying its key categories, as set out in the IPCC good practice guidance, and to describe it correctly as tier 2 in the NIR. The changes that have occurred in the key categories compared with those presented in the previous (2005) submission, and the reasons for the changes (mainly revisions of uncertainty parameters) are well documented in the current inventory submission.

8. The United Kingdom has only provided a key category analysis for the year 2004. 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), Parties shall report a key category analysis for the base year and the latest reported inventory year. The ERT recommends the United Kingdom to follow the recommendations of the IPCC good practice guidance for the key category analysis and to include a key category analysis for the base year.

[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 LULUCF. 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 base year. 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.

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

GHG emissions	Gg CO_2 equivalent								Change
	Base year	1990	1995	2000	2001	2002	2003	2004	BY–2004 (%)
CO_2 (with LULUCF)	593 234.75	593 234.75	550 853.88	547 605.11	562 774.37	546 220.72	557 758.75	560 417.53	–5.5
CO_2 (without LULUCF)	590 319.32	590 319.32	549 820.35	548 045.41	563 370.86	547 340.55	558 938.38	562 359.08	–4.7
CH_4	103 653.91	103 653.91	90 253.68	68 524.90	62 694.01	59 710.70	53 621.73	51 839.91	–50.0
N_2O	68 376.96	68 376.96	57 055.68	44 257.77	42 124.71	40 474.53	40 109.71	40 796.73	–40.3
HFCs	11 375.39	11 375.39	15 493.60	9 091.67	9 686.24	9 907.12	10 201.41	8 873.14	–22.0
PFCs	1 401.49	1 401.49	470.71	498.25	425.35	322.72	296.81	352.23	–74.9
SF_6	1 029.95	1 029.95	1 239.30	1 798.19	1 424.76	1 508.92	1 323.69	1 127.56	9.5

Note: BY = Base year; LULUCF = Land use, land-use change and forestry

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

Sectors	Gg CO_2 equivalent								Change
	Base year	1990	1995	2000	2001	2002	2003	2004	BY–2004 (%)
Energy	611 351.03	611 351.03	565 655.35	558 064.25	574 471.50	558 842.31	566 763.73	569 613.44	–6.8
Industrial processes	58 208.32	58 208.32	50 230.73	31 668.96	29 721.16	26 998.00	28 028.90	27 907.48	–52.1
Solvent and other product use	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	IE, NE, NO	NA
Agriculture	53 679.01	53 679.01	51 527.79	49 027.05	46 094.50	46 430.32	45 782.56	45 474.30	–15.3
LULUCF	2 930.67	2 930.67	1 046.24	–418.90	–570.90	–1 098.36	–1 159.36	–1 923.10	–165.6
Waste	52 903.41	52 903.41	46 906.73	33 434.52	29 413.17	26 972.45	23 896.27	22 334.97	–57.8
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	779 072.44	779 072.44	715 366.85	671 775.88	679 129.43	658 144.72	663 312.10	663 407.09	–14.8
Total (without LULUCF)	776 141.77	776 141.77	714 320.61	672 194.78	679 700.33	659 243.08	664 471.46	665 330.19	–14.3

Note: BY = Base year; LULUCF = Land use, land-use change and forestry; NA = Not applicable; NE = Not estimated; NO = Not occurring; IE = Included elsewhere.

E. Main findings

9. The national inventory submitted by the United Kingdom is in conformity with the UNFCCC reporting guidelines. The NIR and the CRF are largely complete and transparent. The methodologies for estimating emissions are consistent with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines) and the IPCC good practice guidance, and are described for each category individually under the respective sector. The United Kingdom inventory is particularly strong in the methodological implementation of cross-cutting activities such as uncertainty assessment and quality assurance/quality control (QA/QC).

10. The ERT noted some minor questions of transparency and consistency, which are described in the sectoral sections on industrial processes, LULUCF and waste below. The Party reports the use of a tier 1 approach in identifying its key categories, although in fact it represents a simplified tier 2 method (due to the incorporation of uncertainty estimates in the analysis, even though no qualitative criteria have been considered). In addition, no qualitative discussion on the sources of uncertainties in individual categories is provided in the sectoral chapters of the NIR, as previous ERTs have requested.

11. The ERT noted that the United Kingdom provided timely and thorough responses to questions raised during the review. It was evident from these responses that the United Kingdom plans to address many of the questions raised by the ERT, either as part of work already under way or specifically as a result of the inventory review.

F. Cross-cutting topics

1. Completeness

12. The national inventory submitted by the United Kingdom is comprehensive and complete. All major categories and direct and indirect GHGs are reported. The CRF tables provided are largely complete in terms of categories and geographical coverage. The ERT noted that in CRF table 8(a), which concerns recalculations, the United Kingdom has only completed the column referring to "latest submission". The United Kingdom explained that this was because of problems with the installation of the CRF Reporter software in 2006. Table 9(b) has not been filled in. This table provides information on estimates of additional GHG for which GWP values have not yet been agreed by the COP. The United Kingdom explained that there is no additional information to report in table 9(b).

13. The NIR states that emissions/removals for the LULUCF sector for overseas territories and Crown dependencies have not been estimated. However, these emissions/removals are reported as 0 in tables 9.4 and 9.6 of the NIR. The United Kingdom experts explained that LULUCF emissions were not estimated for the overseas territories and Crown dependencies as there is not sufficient information available, and that in table 9.4 emissions should be reported as "not estimated" ("NE") instead of 0.

2. Transparency

14. The CRF tables and the NIR provide sufficient transparency for the ERT to be able to assess the data used and methodologies applied. The United Kingdom provides justifications for the assumptions made and the choice of data and methods. The ERT noted that nearly all the data needed to compile the United Kingdom inventory are publicly available. During the review the Party provided the ERT with access to all confidential data.

3. Recalculations and time-series consistency

15. The ERT noted that the recalculations reported by the United Kingdom of the time series from the base year to 2003 resulted from: (a) the updating of activity data; (b) improvement of the methods used to estimate emissions and emission factors; (c) revision of the estimates of CH_4 emissions from landfills as a result of revision of the oxidation factor used in the United Kingdom model; (d) the inclusion of new sources of emissions (petroleum waxes; carbon emitted during energy recovery in the chemical industry; and carbon in products – soaps, shampoos, detergents, pesticides etc.); (e) an improved approach for feedstock emissions; (f) the inclusion of non-combustion emissions from the overseas territories and Crown dependencies; and (g) the reallocation to sectors 1–6 in the CRF tables of some emissions that were originally reported in sector 7.

16. The major changes and the rationale for these recalculations are thoroughly described in chapter 10 of the NIR. The problem with CRF table 8(a) noted in paragraph 12 above will be solved with improved CRF Reporter software for the 2007 inventory submission. The ERT noted that the recalculations performed are sufficiently justified in the NIR and have improved the inventory. The results of the recalculations are increases in the estimates of total national emissions by 3.8 per cent in 1990 and by 2.1 per cent for 2003. As this increase applies throughout the time series, the trend in emissions is not greatly affected.

4. Uncertainties

17. The information provided by the United Kingdom on uncertainties is appropriate and as required by the UNFCCC reporting guidelines. The Party has provided an uncertainty analysis according to both tier 1 and tier 2 procedures as described by the IPCC good practice guidance. The uncertainties have been reduced compared to the previous year's (2005) submission taking into account the revision of the uncertainty parameters for activity data (AD) and emission factors (EFs). From the NIR it is clear that the Party uses its uncertainty analysis to prioritize further improvements in the inventory.

5. Verification and quality assurance/quality control approaches

18. The United Kingdom has elaborated a QA/QC plan in accordance with the IPCC good practice guidance. This includes general QC procedures (tier 1) with several instances of category-specific procedures (tier 2) being used for key categories. The plan incorporates a series of activities which are carried out each year at various stages of the inventory compilation process. The United Kingdom's inventory is moving towards tier 2 category-specific QC procedures, in addition to complying with the tier 1 procedures. According to the Party, steps to move the QC towards tier 2 procedures include:

(a) Review of the QA/QC provisions and engagement with key data providers to determine their QA/QC procedures and if necessary recommend enhancements (e.g. whether the QA/QC system is developed for a mandatory or a voluntary reporting mechanism; in a few cases the resourcing and effectiveness of these systems within the key data provider organizations could be significantly improved, as they currently do not provide reliable data that are consistent across the whole time series);

(b) Improvements to the data processing systems (e.g. a complete review of the system used to calculate emissions from the road transport, through the development of a new database; a review of the method used to provide the time series of fuel activity data for combustion sources in the gas oil and fuel oil sectors; and a revision of the source data used to derive emissions from the offshore oil and gas industry).

19. The inventory is the subject of periodic internal and external audits. A series of internal reviews within AEA Energy and Environment,[3] which is accredited for the United Kingdom quality management system standards (BS EN ISO 9001:2000), have been carried out to detect any anomalies in the estimates (variations in the time series and inter-annual changes), and these were then rectified. Since 2002, the United Kingdom has been implementing a programme of external peer review for key categories. To date, two peer reviews have been completed – on CO_2 from fossil fuel combustion (Simmons, 2002) and emissions from agriculture (Daemmgen, Doering, Brown et al., 2005). Further reviews are planned for GHG emissions from waste-water treatment and emissions from the offshore oil and gas industry. Recommendations from these reviews are used to improve sectoral emissions estimates.

6. Follow-up to previous reviews

20. The United Kingdom has made improvements to cross-cutting areas, for example:

(a) Following the recommendations of previous reviews, it has improved its uncertainty analysis by bringing the aggregation level into line with the IPCC good practice guidance and by updating specific uncertainty parameters;

(b) A key category analysis has been provided both with and without LULUCF;

(c) The completeness of the inventory has been improved by including some emissions from United Kingdom Crown dependencies and overseas territories;

(d) The methods used to estimate emissions from feedstocks and non-energy use of fuels have been reviewed and revised;

(e) The level of detail provided in the NIR to explain the method used to estimate CH_4 emissions from solid waste disposal has been improved.

21. The ERT noted that the United Kingdom has not fully succeeded in improving consistency between the NIR and the CRF and within the NIR, and that it has not fully provided the quantitative results and qualitative discussions of the sources of uncertainties in individual categories in the sectoral chapters of the NIR, as requested by the 2005 ERT.

G. Areas for further improvement

1. Identified by the Party

22. Several areas for improvement have been identified in the United Kingdom's NIR:

(a) The need to develop more formal agreements between Defra and some data providers in order to specify the framework of data supply; these agreements will formalize the acquisition of data and clarify the main requirements of quality, format, security and timely delivery of data for the national inventory;

(b) The process for official consideration and approval of the GHG inventory, where the work will be focused on a pre-submission review of inventory data by a review group that is independent of the main GHG inventory compilation process;

(c) Review of the QA/QC system. The Party has stated that in a few cases the resources for and the effectiveness of these systems within the key organizations that provide data could be significantly improved, as instances have arisen where the data provided

[3] Formerly the Inventory Agency.

initially were not consistent across the inventory reporting time series, necessitating internal investigation;

(d) Review by the United Kingdom National Inventory Steering Committee in the light of the ERT's feedback and other relevant inputs, from which QA/QC priorities and improvements will be derived;

(e) Full harmonization of reporting between the NIR and the CRF tables.

2. Identified by the ERT

23. The ERT identified the following cross-cutting issues for improvement:

(a) Consistency between the NIR and the CRF and within the NIR should be further improved;

(b) Use of both tier 1 as well as tier 2 approaches for identifying the key categories might usefully provide additional insight into the reasons why particular categories are key and can assist in prioritizing activities to improve the quality of the inventory and reduce overall uncertainty;

(c) Some additional information in the NIR could improve the transparency of the reporting of emissions/removals from United Kingdom's overseas territories and Crown dependencies.

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

II. Energy

A. Sector overview

25. In 2004, the energy sector was the largest contributor to the GHG emissions of the United Kingdom, amounting to 569,613.44 Gg CO_2 equivalent, or 85.6 per cent of total national emissions. Within the sector the largest contributions arose from energy industries (36.8 per cent) and transport (23.6 per cent). Energy sector emissions have declined by 6.8 per cent since 1990 due to fuel switching and the reduced energy-intensity of the economy, according to the NIR. Transport emissions, however, have increased by 12.5 per cent due to increasing activities in transport: fuel use in road transportation increased by 8.7 per cent between 1990 and 2004. At the same, N_2O emissions increased by a factor of 4 due to the introduction of catalytic converters in passenger cars. In civil aviation, fuel consumption and emissions of CO_2 and N_2O all increased by 79.7 per cent. The major categories included are energy industries, road transportation, manufacturing industries and construction, and residential heating in the category other sectors. Fugitive emissions are also accounted for in this sector (they make up 2.9 per cent of the total for the sector), and include emissions arising from the production and extraction of coal, oil and natural gas, and their storage, processing and distribution. These emissions have fallen by 53.9 per cent since 1990 due to significant decreases in mining activities.

26. The reporting of the energy sector is transparent, complete, comparable and consistent, with major categories reported in all years with all respective gases, and appears to be accurate. The United Kingdom has updated its carbon content EFs for fuel combustion in the energy sector and has continued to improve the transparency of the NIR by providing the time series for these EFs. For comparability, the NIR continues to provide detailed information on how categories are accounted for in the data collection system of the United Kingdom and how these are linked in to the correct IPCC categories.

B. Reference and sectoral approaches

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

27. The United Kingdom has calculated CO_2 emissions from fossil fuel combustion using the reference and the sectoral approaches for all years of the time series. For the year 2004, there is a difference of 0.3 per cent in the CO_2 emission estimates. The differences between the two approaches are below 2 per cent across the entire time series, so that explanations are not required in the CRF tables. The differences are described in the NIR; they are caused by the different independent data sources used for the two approaches and are within the range of what might be expected.

2. International bunker fuels

28. The information provided on the consumption of aviation and marine international bunker fuels is different from the values reported to the International Energy Agency (IEA). The emissions from international aviation are based on detailed estimates taking into account individual traffic movements and fuel statistics, and using a method that is consistent with a tier 2 approach. The ERT was informed that the national energy statistics will adopt the same approach to splitting aviation bunkers in domestic and international aviation. This will bring the data on consumption in international aviation and international marine bunkers fully into line with the energy data reported to international agencies.

3. Feedstocks and non-energy use of fuels

29. Emissions from feedstocks are largely reported in the industrial processes sector. Emissions from iron and steel production have been determined using a mass balance approach, based on modelling of integrated steel works. The greater part of CO_2 emissions for energy supply is reported in the energy sector under the category manufacturing industries and construction. Emissions from the use of coke in blast furnaces are split between combustion in iron and steel and iron and steel production in the industrial processes sector according to a mass balance approach. The mass balance approach ensures that all emissions from the integrated steelworks are accounted for.

4. Country-specific issues

30. Earlier stages of the 2006 review identified in a number of cases of relatively large inter-annual changes in implied emission factors (IEFs). These inter-annual changes are caused by the annually agreed/derived carbon content factors for many fuels as published in the Carbon Emisson Factor Review. The purpose of the annual values is to take trends in fuel quality into account. The ERT recommends the United Kingdom to assess the uncertainties in these values. If the uncertainties are in the same range as the inter-annual changes, the United Kingdom may consider applying regression analysis to account for trends in fuel quality and at the same time avoid these inter-annual changes.

C. Key categories

1. Fuel combustion: all fuels – CO_2, N_2O

31. The methods applied and the data used for estimating emissions in all categories included in fuel combustion (1.A) in the United Kingdom are well developed and in line with the IPCC good practice guidance. Fuel combustion data are obtained from the Digest of United Kingdom Energy Statistics (DUKES). CO_2 emission factors are derived annually in a clear and transparent process based on actual carbon contents of fuels used in the country (the Carbon Emission Factor Review). EFs for N_2O are generally derived from international publications and, where this is available, based on plant-specific information.

2. Stationary combustion: all fuels – CO_2, N_2O

32. For stationary combustion in energy industries and manufacturing industries and construction, a correction has been made to the fuel split between power plants and industry in DUKES to ensure proper reporting of electricity generated by the so-called auto-producers.

3. Manufacturing industries and construction: solid fuels – CO_2

33. The 1990–2004 values of the CO_2 IEF (179.06–200.57 t/TJ) for iron and steel are the highest of reporting Parties (4.51–200.57 t/TJ) and higher than the IPCC default range (94.60–106.70 t/TJ). During the review the Party explained that various "solid" fuels are used in the United Kingdom iron and steel industry but the most significant in terms of carbon emissions is blast furnace gas. This classification is consistent with the IPCC fuel classification in the Revised 1996 IPCC Guidelines. This fuel has a high carbon content (as it is mostly carbon monoxide (CO) with a small amount of CO_2), but has a relatively low energy content. The CO_2 IEF for this category is high because of the high usage of this fuel (the CO_2 EF for United Kingdom blast furnace gas is approximately 260 t/TJ).

4. Road transportation: liquid fuels – N_2O

34. In road transportation, the United Kingdom uses detailed fleet composition, mileage and driving pattern data, matched with the fuel sales statistics, and appropriate emission factors to estimate the N_2O emissions.

5. Fugitive emissions from solid fuels – CH_4

35. The trend in the CH_4 IEF for solid fuel transformation fluctuates. In its answer to queries raised during earlier stages of the 2006 review, the United Kingdom explained that the total activity data for the category solid fuel transformation are incorrectly reported in the CRF. The emissions, however, are correctly reported. The United Kingdom will correct this error in its future submissions.

D. Non-key categories

1. Stationary combustion: all fuels – CH_4

36. Emission factors for CH_4 are generally derived from international publications and, where these are available, based on plant-specific information.

2. Transportation: all fuels – CO_2

37. The estimates of CO_2 emissions from transport are directly based on fuel sales statistics from DUKES. As indicated above, the national inventory system has improved the DUKES methods for determining fuel used for domestic and for international aviation and shipping. CO_2 emission factors are derived annually in a clear and transparent process based on actual carbon contents of fuels used in the country.

3. Road transportation: liquid fuels – CH_4

38. In road transportation, the United Kingdom uses detailed fleet composition, mileage and driving pattern data, matched with the fuel sales statistics, and appropriate emission factors to estimate the CH_4 emissions.

III. Industrial processes and solvent and other product use

A. Sector overview

39. In the United Kingdom, the profile of the industrial processes sector is similar to that found in neighbouring countries in Europe. In 2004, the sector contributed 27,907.48 Gg CO_2 equivalent (4.2 per cent) to total national emissions. The dominant gas is CO_2 (accounting for 48.2 per cent of sectoral emissions), the greater part of it (59.1 per cent) arising from mineral products, followed by HFCs (31.8 per cent) and N_2O (14.5 per cent), and minor contributions of SF_6 (4.0 per cent), PFCs (1.3 per cent) and CH_4 (0.2 per cent). CO_2 emissions are mainly from cement production (40.5 per cent); HFC emissions are mostly from consumption of halocarbons and SF_6 (96.8 per cent), most of it (58.7 per cent) being used in refrigeration and air conditioning equipment; and the two major activities of N_2O emissions are nitric acid production (72.4 per cent) and adipic acid production (27.3 per cent).

40. Emissions of all gases have decreased since 1990, with the largest decreases occurring in N_2O from adipic acid production (by 95.6 per cent) and in production of halocarbons and SF_6 (by 98.0 per cent) due to the introduction of abatement technologies. The decrease in N_2O emissions and emissions from production of halocarbons and SF_6 has, however, been partly offset by an increase of 1,320.2 per cent in HFC emissions from the substitution of ozone depleting substances (ODS) in consumption of halocarbons. Other important reductions are seen in CO_2 emissions from cement production and in N_2O from nitric acid production due to shrinking production. The overall effect is a decrease in the total emissions of the sector by 52.1 per cent and a decrease in the share of emissions from the industrial processes sector in total national emissions compared to that in 1990 (7.5 per cent).

41. The United Kingdom has improved its estimates with the inclusion in this submission of CO_2 emissions from carbon from non-energy use products for the whole time series. This increased the estimated emissions of the industrial processes sector in 2003 by 7.8 per cent. Other recalculations have been carried out for emissions of fluorinated gases in production of halocarbons and SF_6, and aerosols/metered dose inhalers, based on new, updated data, and some other minor recalculations in other categories, leading to an overall increase of 4.6 per cent in estimated emissions from the sector in 2003. Emissions from solvent and other product use have only been estimated for non-methane volatile organic compounds (NMVOCs). The NIR provides the necessary information, although some inconsistencies with the CRF tables were found which were resolved during the review.

42. Emissions of HFCs, PFCs and SF_6 are reported at subcategory level, for both potential and actual emissions, but with no differentiation of species of gas, and this has led to some difficulties with the transparency and comparability of the inventory.

B. Key categories

1. Nitric acid production – N_2O

43. The N_2O EF for nitric acid production varies across time; this is a reflection of nitric acid production patterns across the different sites in the country, as they use different process conditions and only one plant is fitted with N_2O abatement technology. This is a key category, although it only accounts for 0.4 per cent of total national emissions (it is identified as a key category in the level assessment without uncertainties being taken into account). During the review, the United Kingdom provided the ERT with adequate answers in response to questions about the varying profile of these emissions, including the closure of plants and changes in pollution control technologies. The ERT recommends the United Kingdom to include this information in its next NIR.

2. Production of halocarbons and SF_6 – HFCs

44. There has been a steep rise in HFC emissions from ODS substitutes since 1990. The activity data needed to feed the bottom-up model for these categories are confidential, but the ERT was given access to the detailed calculations of the emissions. The mixture of HFCs represented 1.3 per cent of total national emissions in 2004. In order to increase the transparency and comparability of the inventory, the ERT recommends the United Kingdom to report by species of gas rather than by subcategories, thus maintaining confidentiality.

3. Other (production of halocarbons and SF_6) – HFCs and PFCs

45. This is a key category according to the trend analysis. The major component, HFC-23 fugitive emissions from HCFC-22 production, has seen a steep decrease since 1990 due to the abatement technology installed in the two HCFC-22 plants in 1998 and 2003.

C. Non-key categories

1. Cement production – CO_2

46. The estimates of CO_2 emissions resulting from cement production are based on the tier 2 approach of the IPCC good practice guidance. The decrease in CO_2 emissions – by 18.1 per cent since 1990 – is due to changing conditions in the market in the United Kingdom. The ERT recommends the United Kingdom to include this explanation in its next NIR.

2. Adipic acid production – N_2O

47. There is only one production plant in the United Kingdom and so, for confidentiality reasons, the activity data are not presented in the NIR. Emissions fell significantly after 1998 with the introduction of abatement equipment for N_2O.

3. Other (chemical industry) – CO_2

48. A recent United Kingdom report assessed a significant part of carbon contained in petroleum products listed as "non-energy use" that is not stored but emitted. These new results have been used to revise the treatment of non-energy use of fuels in the United Kingdom inventory. The resulting emissions have been estimated and included for the whole times series, with a stable and slightly growing trend since 1990. The ERT considers that this is an improvement in the United Kingdom inventory.

IV. Agriculture

A. Sector overview

49. In 2004, the agriculture sector contributed 6.8 per cent of total United Kingdom emissions. Emissions amounted to 45,474.30 Gg CO_2 equivalent in 2004 and are estimated to have declined by 15.3 per cent between 1990 and 2004. Emissions of CH_4 from the sector fell by 12.6 per cent and emissions of N_2O fell by 17.1 per cent. As in all countries, the uncertainties of the estimates are high for this sector, particularly for N_2O (two standard deviations divided by the mean equal to 424 per cent for agricultural soils). Once these high uncertainties are taken into account, emissions from agricultural soils become the largest key category (and are identified as such in annex 1 to the NIR).

50. The coverage for the sector is complete. Estimates have been prepared for all categories where emissions occur – enteric fermentation, manure management, agricultural soils and, in 1990, emissions from the field burning of agricultural residues. Emissions from the latter category ceased in 1994 as a result of new regulations. Transparency is high: estimation methodologies are well documented in the

NIR while calculation working sheets were provided to the ERT during the course of the review. The emission estimates for the time series are readily replicable and were verified by the ERT, except for one subcategory in enteric fermentation (see para. 51 below). The sector was reviewed by independent international experts in 2005, indicating that the United Kingdom has implemented systematic quality assurance for this sector. Quality control systems are in place, although additional effort could be expended on improving levels of consistency between the NIR and the CRF tables.

51. The activity data are of high quality. Comprehensive data have been collected for long periods of time by the Department of Environment, Food and Rural Affairs (Defra), largely for independent policy purposes, and are available on the Internet. The United Kingdom has used tier 2 methodologies for important subcategories – dairy cattle within enteric fermentation, and for all cattle within manure management. Tier 1 methods have been used for the remaining livestock categories and for the agricultural soils category. Overall, the United Kingdom's choice of methodologies is consistent with the Revised 1996 IPCC Guidelines. Nonetheless, the methodologies applied tend to utilize highly aggregated AD. Given the range of quality data available, the United Kingdom is encouraged to develop methodologies that use more disaggregated data for its future inventories.

B. Key categories

1. Enteric fermentation – CH_4

52. The United Kingdom has implemented a tier 1 IPCC default approach for emissions from beef cattle rather than a tier 2 approach because, it is argued, there is no material difference in the estimates generated by the two approaches. While this is true for the data presented, the use of a tier 1 approach is not strictly consistent with the IPCC good practice guidance, nor with the tier 2 approach adopted for dairy cattle. Implementing a tier 2 approach for beef cattle would make it possible to estimate changes in emissions per animal through time and increase the opportunity to monitor the impacts of changes in farming practices, consumer preferences and policy action on emissions. The ERT recommends that the United Kingdom consider implementing a tier 2 approach for beef cattle in its future submissions.

53. The United Kingdom's methodology is very transparent. However, in one instance, relating to the calculation of the tier 2 emission factors for beef cattle, some additional background information could have been provided in the NIR (it was readily provided to the ERT on request). The ERT recommends that the United Kingdom include this information in its next NIR.

2. Agricultural soils – N_2O

54. The United Kingdom has implemented tier 1, IPCC-consistent methodologies for this subcategory, but at a very high level of aggregation of activity data. Improved emission estimates for this key category could be obtained by disaggregation of the AD for spatial, land-use and possibly temporal variations. Rich activity data sets already exist for some activities (e.g. fertilizer use) and the ERT encourages the United Kingdom to continue to support the development of empirical work to estimate country-specific parameters in this area. Given the number of independent data sources that are available, the United Kingdom should give consideration to the reporting of quality control, cross-checks for direct emissions from fertilizers, and the use of the same data sources for the application of both fertilizers and lime (reported under LULUCF).

V. Land use, land-use change and forestry

A. Sector overview

55. In 2004, total net removals by the LULUCF sector amounted to 1,923.10 Gg CO_2 equivalent, or 0.3 per cent of total national GHG emissions (including LULUCF). In 1990, the LULUCF sector was a net source of 2,930.67 Gg CO_2 equivalent or 0.4 per cent of total national GHG emissions (including LULUCF). Between 1990 and 2004, the LULUCF sector changed from being a net source to being a net sink.

56. Land-use areas are reported in four regional subdivisions in the CRF tables. Annual land-use transitions are reported for the years 1990–1999. These rates have been applied to estimate the carbon stock change in soils caused by land-use change. The NIR does not provide the comprehensive information on land use and land-use change in the country in the form of a land-use matrix as described in the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF) for approach 2 and 3 for the consistent representation of land areas. During the review the national experts presented a land-use matrix for England. The ERT invites the United Kingdom to provide such a land-use matrix for the entire area of the country.

57. CO_2 emissions or removals for the categories forest land, cropland, grassland and settlements are identified as key categories based on level of emissions; and CO_2 emissions from the category cropland are identified as a key category based on the trend assessment. Changes to emissions or removals in these categories result from carbon stock changes in soil caused by land-use change activities.

58. The United Kingdom has provided the complete set of tables for all years from 1990 to 2004. Emissions and removals are estimated in CRF tables 5.A, 5.B, 5.C, 5.E and 5(IV). In table 5(V), emissions from biomass burnt during deforestation are estimated. Emissions of the overseas territories and Crown dependencies are not included in the estimates but seem to be negligible. The LULUCF inventory does not include separate estimates of N_2O from fertilization of forests, from disturbance of soils, or from wildfires. The ERT encourages the United Kingdom to collect data to address these gaps. The United Kingdom's countryside survey does not distinguish wetland from other types of land. Wetland types are mainly included in the grassland, or in the case of open water in the category other land. Table 5.D is reported as "included elsewhere" ("IE"). Grassland converted to other land is reported in table 5 as "not occurring" ("NO"), whereas in tables 5.A, 5.B and 5.E grassland conversion is reported.

B. Key categories

1. Forest land – CO_2

59. Forest land in the United Kingdom was a net sink of 16,302.00 Gg CO_2 in 2004. The removals had increased by 33.6 per cent relative to 1990. Under forest land remaining forest land, only forests in existence before 1920 are reported. According to the information in the documentation box of table 5, these forests are assumed to be carbon neutral and "usually unmanaged". All forests afforested since 1920 are reported under the subcategory land converted to forest land. According to the IPCC good practice guidance for LULUCF, land converted from one land-use category to another should be kept in the conversion state for 20 years. Although after 20 years the equilibrium in soil carbon content may not be reached, the management practice of the new land use may have a significant influence on the carbon stock in the soil. Hence a subdivision under forest land remaining forest land for afforested land based on management practice on this land would be more in line with the IPCC good practice guidance for LULUCF. The ERT invites the United Kingdom to consider the duration of the conversion status.

60. The United Kingdom uses a model approach, described as a tier 3 method as defined in the IPCC good practice guidance for LULUCF, to estimate emissions and removals from forests, afforestation and deforestation. The model provides net changes of all three carbon pools – living biomass, dead organic matter, and carbon stock of soils – as well as of wood products harvested from forests in the United Kingdom. No data are provided in the columns "Increase" and "Decrease" of carbon stock changes in living biomass in table 5.A. The ERT argues that it should be possible to provide increases and decreases separately, because yield classes are used as input to the model and harvested volume and natural loss rates are used as model parameters. The ERT therefore invites the United Kingdom to increase the comparability and transparency of its inventory by providing information on increase and decrease.

61. Two types of forest are specified. Two yield classes are applied for coniferous forests and one for broadleaved forests. The United Kingdom confirmed that it will keep growth rates and management practices under review. The United Kingdom experts further informed the ERT that they are working on the issues of afforested drained peat land, N_2O emission from drainage, and carbon stock change of organic soils, and that they intend to provide this information in the Party's next NIR.

2. Cropland, grassland and settlements – CO_2

62. Cropland and settlements were net sources of 15,329.12 Gg and 6,248.02 Gg CO_2, respectively, in 2004. Emissions from cropland have fallen by 3.2 per cent and emissions from settlements by 9.8 per cent since 1990. The emissions are mainly due to grassland being converted to cropland or settlements.

63. Grassland in the United Kingdom was a net sink of 7,835.52 Gg CO_2 equivalent in 2004 and the size of the sink had increased by 26.5 per cent since 1990. The sink results from increase in carbon stock in the soil on areas where cropland has been converted to grassland. From grassland remaining grassland and from forest land converted to grassland a small amount of net carbon emissions is reported. The area of grassland remaining grassland has high annual variability. United Kingdom experts informed the ERT that the data include land with peat extraction only. They will check the information reported in table 5.C. The emissions include peat extraction for horticultural purposes only. Emissions from peat combustion are included in the energy sector.

64. The effect of land-use change on the carbon stock in the soils from 1950 to the present is taken into account. The area affected by land-use change is reported under the "land converted to" subdivisions. A distinction is made between land converted before 1990 and after 1990. According to the IPCC good practice guidance for LULUCF, land converted from one land-use category to another should be kept in the conversion state for 20 years. Although after 20 years the equilibrium in soil carbon content is not reached, the management practice of the new land use may have a significant influence on the carbon stock in the soil. Hence a subdivision of land remaining in the same category would be more in accordance with the IPCC good practice guidance for LULUCF. The ERT invites the United Kingdom to consider the duration of the conversion status.

C. Non-key categories

65. Previous reviews noted a need for complete reporting of emissions from biomass burning. CRF table 5(V) contains estimates of biomass burning from land converted to grassland and land converted to settlements. The United Kingdom experts informed the ERT that these estimates concern biomass burning from the forest land converted to other land-use categories, especially forest land converted to

grassland and settlements. It is assumed that 40 per cent of the forestry biomass is burnt. No estimates are reported for wildfires. The United Kingdom experts explained that there are almost no wildfires but that they would check whether data are available.

66. The United Kingdom reports a net emission of 618.82 Gg CO_2 from harvested wood products in table 5 but there is little explanation in the NIR as to how this sink is calculated. The United Kingdom is encouraged to improve the transparency of this calculation by addressing these issues in the NIR of its future submissions.

VI. Waste

A. Sector overview

67. In 2004, GHG emissions from the waste sector amounted to 22,334.97 Gg CO_2 equivalent, representing approximately 3.4 per cent of total national emissions. Solid waste disposal on land accounted for 88.8 per cent of emissions in the waste sector, waste-water handling 9.0 per cent, and waste incineration 2.3 per cent in 2004. GHG emissions from the sector decreased by 57.8 per cent between 1990 and 2004. Solid waste disposal on land was responsible for 98.0 per cent of the total reduction. The high rate of reduction in CH_4 emissions from solid waste disposal on land is attributed to the high recovery rate of CH_4 and a reduction in the quantities of landfilled wastes due to the European Community Landfill Directive and the United Kingdom's landfill tax.

68. The inventory report for the waste sector is transparent, consistent, comparable, complete and accurate in accordance with Revised 1996 IPCC guidelines and the IPCC good practice guidance. However, completeness should be improved by including the N_2O and CH_4 emissions from industrial and domestic and commercial waste water. The ERT noted that little information is provided on waste management policies and measures that can influence emissions in this sector. The ERT encourages the United Kingdom to consider opportunities for including this information in its next NIR.

B. Key categories

1. Solid waste disposal on land – CH_4

69. A modified tier 2 methodology has been used to estimate CH_4 emissions from solid waste disposal on land. Activity data have been determined from different studies. Using different studies to determine AD could lead to high uncertainties if a complete set of parameter values is not available. However, the trend of the AD over the period 1990–2004 demonstrates a reasonable pattern, suggesting that the model studies used for calculating the AD are acceptable. The ERT recommends the United Kingdom to explain more clearly in the NIR how it obtained the AD. It is also not clear from the NIR how national policies and measures influence the reduction of the quantities of landfilled wastes and the CH_4 emissions. The ERT recommends the United Kingdom to provide more information on these issues in its next submission.

70. The recovery rate of CH_4 has increased linearly with time, reaching an unusually high rate, 69.4 per cent, in 2004. The ERT further recommends the United Kingdom to clarify how it has obtained such high recovery rates of CH_4 in recent years (2000–2004) compared with other European countries.

2. Waste-water handling – N_2O

71. The IPCC default methodology has been used to estimate N_2O emissions from human sewage. An inconsistency in the time series was observed for N_2O emissions from human sewage. The reason for the inconsistency was ascribed to the adoption of different data sources for per capita protein consumption. From 1990 to 1996, the average per capita protein consumption was

22.7 – 23.7 kg/person/yr, based on Defra's National Food Survey, whereas it was 25.7–26.3 kg/person/yr from 1997 to 2004, based on the Expenditure and Food Survey.

72. N_2O emissions from industrial waste water are not included due to lack of activity data and of information on processes, which makes it likely that they would be underestimated. The ERT recommends the Party to include these emissions in its future inventories.

C. Non-key categories

1. Waste-water handling – CH_4

73. The United Kingdom has not estimated CH_4 emissions from industrial waste water due to the lack of information on activity data and processes. The ERT recommends it to include these emissions in its future inventories.

2. Waste incineration – CO_2

74. The United Kingdom uses country-specific EFs for estimating CO_2 emissions for waste incineration. The NIR does not provide sufficient clarity on how the biogenic portions of municipal solid waste incinerated were handled for estimating the country-specific EFs. However, during the course of the review the United Kingdom provided the ERT with the relevant information and the ERT recommends it to include this information in its next NIR.

VII. Conclusions and recommendations

75. The expert review team concluded that the United Kingdom's institutional arrangements are well organized and well functioning, leading to a high-quality, transparent, consistent, comparable, complete and accurate inventory report in accordance with the Revised 1996 IPCC guidelines and the IPCC good practice guidance. There is room to improve the quality of the inventory report. The key recommendations[4] are that the United Kingdom:

- In the general part: improve consistency between the NIR and the CRF. Include in its key categories all categories which added together amount to more than 95 per cent of total national emissions; identify the key categories for the base year;
- In the energy sector: estimate the uncertainty in the carbon emission factors used and explain in the NIR any unusual IEFs (e.g. for iron and steel);
- In the industrial processes sector: try to separate HFC and PFC emissions by species and not just by subcategories. Include in its next NIR some of the explanations that were provided to the ERT during the review (e.g. for nitric acid and cement production);
- In the agriculture sector: develop methodologies that use more disaggregated data, which are available;
- In the LULUCF sector: provide a land-use change matrix for the United Kingdom in line with the IPCC good practice guidance for LULUCF. For forest land, change in living biomass should be divided into increase and decrease;
- In the waste sector: provide more supporting information on the high CH_4 recovery rate in solid waste disposal on land.

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

Annex

Documents and information used during the review

A. Reference documents

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

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B. Additional information provided by the Party

Responses to questions during the review were received from Mr. James Davey and Mr. Jim Penman (Defra) including additional material on the methodology and assumptions used.

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