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REPORT OF THE INDIVIDUAL REVIEW OF THE GREENHOUSE GAS INVENTORY OF THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND SUBMITTED IN THE YEAR 2000[1]

(In-country review)

A. OVERVIEW

1. Introduction

1. The Conference of the Parties (COP), at its fifth session, by its decision 6/CP.5, requested the secretariat to conduct, during the trial period, individual reviews of greenhouse gas (GHG) inventories for a limited number of Annex I Parties on a voluntary basis, according to the UNFCCC guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention, hereinafter referred to as the review guidelines.[2] In doing so, the secretariat was requested to use different approaches to individual reviews, by coordinating desk reviews, centralized reviews and in-country reviews.

2. The United Kingdom of Great Britain and Northern Ireland (United Kingdom) volunteered for an individual in-country review. The review for the United Kingdom, which was the first individual review carried out according to the above-mentioned decision, took place from 30 April to 4 May 2001 in London. In accordance with the review guidelines, the individual review was carried out by a team of nominated experts from the roster of experts, and coordinated by the secretariat. The experts participating were Mr. William Kojo Agyemang-Bonsu (Ghana), Mr. Pavel Fott (Czech Republic), Mr. Sergio Gonzalez (Chile), Mr. Kenneth Olsen (Canada) and Mr. André Van Amstel (Netherlands). Mr. Agyemang-Bonsu and Mr. Van Amstel were selected as lead-authors of this report. The review was coordinated by Mr. Vitaly Matsarski (UNFCCC secretariat) and Ms Rocio Lichte (UNFCCC secretariat).

2. How the review was carried out

3. Experts were allocated to work according to inventory sectors in accordance with their expertise. At least one half-day session was devoted to each sector. During these sessions the national inventory experts responsible for the respective sector of the inventory made presentations and gave the experts of the review team the opportunity to ask questions. Where

[1] In the symbol of this document, 2000 refers to the year the inventory was submitted, and not to the year of publication.

[2] Document FCCC/CP/1999/7, in particular the UNFCCC review guidelines (pages 109 to 114), and decision 6/CP.5 (page 121 to 122).

answers could not be provided immediately, written answers were provided within the course of the visit.

4. The preliminary findings identified in the synthesis and assessment report of greenhouse gas inventories submitted in 2000 contained in document FCCC/WEB/SAI/2000 (hereinafter referred to as the synthesis and assessment report), were addressed during the respective sessions. For all sectors, answers to those issues are given below in the corresponding sections of each sector. In the synthesis and assessment report the secretariat had considered, for each individual Party, those source categories that are *key sources* in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the IPCC Good Practice Guidance.[3] With regard to categories this has been performed at the level of detail recommended in that guidance.

5. The findings and conclusions obtained at the end of the in-country review are a result of an inventory review process, which included the above-mentioned synthesis and assessment report (preliminary findings), the national inventory report "United Kingdom Greenhouse Gas Inventory, 1990 to1998" including the common reporting format (CRF), and the in-country review process itself.

6. In accordance with the 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. Review of the national inventory report and conformity with the UNFCCC reporting guidelines[4]

7. The United Kingdom submitted the CRF tables from its national inventory on GHG emissions by sources and removals by sinks due in April 2000[5] on 15 May 2000 for the years 1990 to 1998. It was submitted both electronically and in hard copy.

8. A national inventory report (NIR) was submitted at a later stage, in April 2001, just before the individual in-country review took place.

Common reporting format

9. The inventory provided in the CRF covered all source and sink categories from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as IPCC Guidelines) and covered the direct GHGs CO_2, CH_4, N_2O, HFCs, PFCs and SF_6, which were presented both on a gas-by-gas basis and aggregated, in terms of CO_2 equivalent. For HFCs, PFCs and SF_6 both actual and potential emissions were reported in the source category Consumption of halocarbons and SF_6. However, HFCs and PFCs were not provided in a disaggregated manner by chemical due to reasons of confidentiality. Estimates on the indirect

[3] Chapter 7 Methodological Choice and Recalculation of the IPCC report "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories", hereinafter referred to as IPCC Good Practice Guidance.

[4] 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 (see document FCCC/CP/1999/7, pages 3-79).

[5] See document FCCC/CP/1999/6/Add.1 for decision 3/CP.5.

GHGs CO, NO_x, NMVOC and SO_x were also provided. Any additional GHGs whose global warming potential (GWP) values were not yet adopted by the COP were not reported.

10. The CRFs for 1990 to 1998 included all requested tables.[6] In accordance with the UNFCCC reporting guidelines, the United Kingdom included in its CRF information on recalculations, covering the entire time series 1990 to 1997 (tables 8 (a) and 8 (b)). Requested information on uncertainties (table 7) and summary information on methods and emission factors used (Summary 3) was also provided adequately. The use of indicators (e.g. NO, IE, NE etc.)[7] throughout the entire set of CRF tables contributed significantly to the transparency of the inventory in that in general no major data gaps due to lack of reporting could be identified. Regarding national coverage, estimates were also considered to be complete.

Completeness of the NIR

11. The extent to which the requirements of the UNFCCC reporting guidelines in relation to the NIR[8] were fulfilled was very similar across sectors. Detailed description of methodologies and related underlying assumption used in easily understood terms and disaggregated emission factors for all sectors were provided in the annex to the report. References to country-specific emission factors and to sources of activity data were provided sufficiently. However, the description of the methodology used was assessed to be very detailed in the energy, industrial processes (for CO_2, CH_4 and N_2O) and agriculture sector, while the waste sector, although a good general description was provided, was not sufficiently detailed to fulfil the reporting guidelines. In the case of land-use change and forestry (LUCF), the description provided in the NIR did not allow for a full understanding of the model used to account for carbon uptake and emissions from this sector. For HFCs, PFCs and SF_6 information on methods was very limited; instead, reference to a published report on those gases was made. In addition to the reporting requirements, the NIR also included a discussion of the estimates for each sector, graphs on trends and the relative contribution of the various subsources to total estimates of each gas.

12. The team noted a lack of reporting with regard to information requested under paragraph 33 (b) of the UNFCCC reporting guidelines, given that no calculation sheets and disaggregated activity data were provided in any of the sectors. They were referenced in separate sources. The same was the case for the explanation of the rationale for the selection of methods (paragraph 33 (d) of the UNFCCC reporting guidelines), emission factors, activity data and other assumptions underlying the emission estimates. However, in the industrial processes sector the rationale for the choice of methods and emission factors was well explained.

13. All changes that had taken place in the methodology since the last submission were explained in a coherent manner for each sector. With the exception of industry sources, time-series were also considered to be consistent as methodologies and assumptions were consistently applied for the entire time series. Any specific findings are discussed below under the respective sector.

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[6] Tables 5.A to 5.D (sectoral background data tables on land-use change and forestry) were not provided. According to the UNFCCC reporting guidelines, these tables should be filled in only by Parties that use the IPCC default methodology.

[7] See paragraph 21 of the UNFCCC reporting guidelines (document FCCC/CP/1999/7, pages 3 to 9).

[8] See paragraphs 32 to 34 of the UNFCCC reporting guidelines (document FCCC/CP/1999/7, pages 11 to 12).

Uncertainty

14. Evaluation of uncertainties is undoubtedly a strong part of the United Kingdom GHG inventory. In the NIR, the complete calculation spreadsheet for evaluation of uncertainties using tier 1 is presented. A tier 2 uncertainty analysis is carried out as well. Both types of uncertainties are considered (uncertainty in level and in trend respectively). This approach was adopted in the IPCC Good Practice Guidance.

Quality assurance and quality control

15. Information on quality assurance and quality control (QA/QC) procedures were lacking in the NIR. The team had the impression that, apparently, there was a misunderstanding in the country in that the reporting of QA/QC was only an element of the IPCC Good Practice Guidance, not a reporting requirement under the UNFCCC reporting guidelines.

Feedstocks and bunkers

16. In relation to the energy sector, specific information on feedstocks and bunkers was given. As the main feedstock in the United Kingdom, natural gas for hydrogen production and subsequent ammonia synthesis is considered. The emission factor for CO_2 is derived from stoichiometry. In the United Kingdom GHG inventory, both aviation and marine bunkers were included and the separation from domestic transport is clearly explained in the NIR.

Conformity with the Revised 1996 IPCC Guidelines

17. The United Kingdom, in preparing its national GHG inventory, followed the requirements of the Revised 1996 IPCC Guidelines. Both IPCC and country-specific methodologies were used, which is encouraged by the IPCC Guidelines if national methodologies that better reflect national circumstances are available. The methodologies used are described for each source category individually under the respective sector. The IPCC Good Practice Guidance was not applied,[9] but for the 2001 submission the team learned that elements from the IPCC Good Practice Guidance have already been implemented. However, in the inventory under review a conscious attempt was made to quantitatively estimate uncertainties for each gas individually and for the entire inventory on an aggregate CO_2 equivalent basis.

Additional information provided during the review

18. During the visit the team learned that the NIR provided as part of the 2001 inventory submission contained to a large extent the information lacking in the inventory report provided as part of the 2000 submission subject to this review. This report had already been submitted to the secretariat and was also made available to the review team. Improvements were: information on QA/QC, provision of calculation sheets and more complete references to sources of activity data and emission factors, in particular in the use of country-specific factors and parameters. The review team was also provided with supporting documents during the visit, which are referenced at the end of this report.

[9] It should be noted that Parties are encouraged to apply the IPCC Good Practice Guidance for inventories due in 2001 and 2002.

4. Cross-cutting issues

Institutional arrangements

19. The organization responsible for the National Inventory including planning, co-ordination and its submission to UNFCCC is the Department of Environment, Transport and the Regions (DETR). The organization compiling the inventory is a consultant, the National Environmental Technology Centre of AEA Technology (NETCEN) that prepares the United Kingdom National Atmospheric Emissions Inventory (NAEI). The inventory is developed primarily based on national statistics with some point source input from industry provided on a voluntary basis. The United Kingdom GHG inventory is a subset of the NAEI that covers the entire energy sector as well as GHGs from industries. Source or sink categories not covered by the NAEI were provided by other government departments such as the Ministry for Agriculture, Fisheries and Food (MAFF) that prepare the agriculture component of the inventory. The Centre of Ecology and Hydrology provide land-use change and forestry estimates, under the overall responsibility of DETR. HFC, PFC and SF_6 emission estimates were prepared by the consulting firm EnvirosMarch. Data used for estimating the indirect GHGs were provided by the Environment Agency. The team learned that data from the national statistics office are not used in the preparation of the GHG inventory. DETR commissions periodic research to fill in gaps where national data are lacking.

Record-keeping and documentation procedures

20. The national GHG inventory is compiled in an electronic relational database with a separate inventory manual providing details of calculations and references to the sources of information. For energy, records on activity data and disaggregated emission factors are kept separately in the database (NAEI) allowing processing for submission to UNFCCC and other purposes, as well as reproduction of emission estimates at any time. Data sets submitted annually are locked and archived. The complete database and archive is located at the offices of NETCEN; as a result, review of the archiving was not possible.

Verification, quality assurance and quality control

21. The team learned that the quality of the data was ensured by different internal checks at DETR and NETCEN. In response to the question whether there is a process to validate emission factors and other assumptions used, the team was informed that discussions among national experts take place once that new information is available to validate the applicability to the circumstances of the United Kingdom. No quality assurance by an independent body was in place so far. This will not be the case for the 2001 submission either, although independent review of the inventory is planned to start in 2001.

22. Since the United Kingdom regularly updates and recalculates its estimates, minor improvements in the activity data and emission factors are also incorporated each year.

5. Conclusions and recommendations

Reporting

23. The NIR was provided to the review team on the first day of the visit. Therefore, the review team did not have the opportunity to study the NIR in great detail before the visit. The fact that reviewers came to the country without previous knowledge and critical analysis of the information provided in the NIR hampered the review.

24. In their 2000 submission of the National Inventory for 1990-1998 the United Kingdom adhered to the Revised 1996 IPCC Guidelines. The IPCC Good Practice Guidance will be used in the 2001 submission. The United Kingdom did not adhere to the UNFCCC reporting guidelines completely, in that it did not provide the national inventory report on time, however, the CRF was submitted reasonably timely. Consequently, other Parties did not have the time to share the information in the NIR.

Completeness

25. The United Kingdom inventory is practically complete and well documented.

Sources of information

26. The activity data by the national inventory experts are taken mainly from published sources. As a rule, underlying reports are not published in open peer reviewed literature. The DETR does encourage the institutes to publish, but it depends on the authors and whether they devote time to that kind of reporting.

Uncertainty

27. The uncertainty in the activity data, the emission factors and emissions were reported. The United Kingdom used tier 1 and tier 2 methodology to assess the uncertainty in the emissions. The tier 1 and tier 2 methods will be updated for the upcoming 1990-1999 inventory because then the IPCC Good Practice Guidance will be followed more closely. The reported level of uncertainty for the whole inventory in the United Kingdom is 14 per cent according to tier 2 and 17 per cent according to tier 1 methodology. In the tier 1 approach the level of uncertainty is very much affected by the large uncertainty range and log-normal distribution assumed for nitrous oxide from agricultural soils. The United Kingdom made an extra preliminary assessment at the request of the review team: When the United Kingdom assumed much smaller uncertainty ranges for nitrous oxide the overall level of uncertainty was reduced to about 4 per cent.

Institutional arrangements

28. The institutional arrangements were explained to the team and are reflected in the corresponding sections of this report on sectors. Industry reporting is often based on voluntary cooperation from industry. For HFCs, PFCs and SF_6 confidentiality issues hamper detailed reporting. The United Kingdom experts, however, have been given all the detailed information on a voluntary basis by the industry.

Availability of material

29. The background sectoral publications underlying the national inventory report were not directly available to the review team for energy, fugitive fuels, industrial processes and agriculture. For land-use change and forestry, the team received many relevant publications from the experts during the review. For methane from landfills, a report was made available that was published in 1998. In the case of HFCs, PFCs and SF_6 the underlying publication was also made available.

Future improvements

30. The effort of the United Kingdom to review and improve estimates over the years through research activities and contracted research is impressive. This process is continuing. The review team, however, identified the following possible additional improvements for the future: Underlying reports that are behind the NIR should be archived at one focal point for the review, or be made available on the web. As a rule, publication of findings in the open peer-reviewed literature should be stimulated. Emission and activity data collected through voluntary agreements with industry should have additional QA/QC procedures to ensure the quality of the information. The review team recognized that future reporting of land-use change and forestry will be much improved in the next submission. For this sector, it is recommended to report both emissions and uptakes separately in the various categories defined in the current CRF tables.

B. ENERGY

1. Fuel combustion

1.1. General overview

31. The majority (more than 75 per cent) of the total GHG emissions is from fossil fuel combustion, which accounted for 557,666 and 522,888 Gg of CO_2 emissions in 1990 and 1998, respectively. This sector includes six key source categories - four sources for CO_2: coal, oil, natural gas stationary combustion and road transport, and two sources for N_2O: other combustion and road transport. This sector also includes two important bunkers – aviation and marine. During the period 1990–1998 total GHG emissions from the energy sector decreased by more than 8 per cent. The energy sector of the inventory is treated by the National Environment Technology Centre - NETCEN (under the leadership of DETR), that cooperates with the Department of Trade and Industry (DTI) and the Environment Agency.

1.2. Methodologies, activity data and emission factors for fuel combustion

32. The United Kingdom inventory of GHG emissions from the fuel combustion sector is based on the detailed bottom-up approach, which is usually considered as the IPCC tier 2 approach that utilizes country-specific emission factors. The reason is the long experience in the compilation of the GHG emission inventories as an integral part of the national inventory system that includes also the emission of other (non-GHG) pollutants. The fuel combustion processes are the main part of national emission systems in almost all countries. Such systems were originally developed for the monitoring of traditional pollutants – which are now, from the viewpoint of GHG terminology, classified as indirect GHGs. This concept seems to be

advantageous especially for the ability to treat CO_2 in a detailed way in the same format as non-CO_2 gases. For CO_2 itself, the IPCC tier 1 approach might be sufficient from the viewpoint of uncertainty (emission factors for carbon are dependent mainly on fuel type). But for non-CO_2 gases the tier 1 approach as described in the IPCC Guidelines would not be suitable because of the strong dependence of non-CO_2 emission factors on the type of combustion conditions.

33. The United Kingdom national system of GHG exhibits the typical features of a Common Integrated System - with the same activity data for CO_2 and non-CO_2 gases, consistent methodologies, and the application of some QA /QC procedures.

Activity data for stationary combustion

34. Mass units for solid and liquid fuels (kt) and a United Kingdom specific energy unit for gaseous fuels (Mtherm) are used as original (primary) units for activity data (fuel consumption) for the above-mentioned NAEI system. Activity data are provided by the Department of Trade and Industry (DTI). DTI is responsible for the gathering and treatment of data on energy statistics. All activity data used in the inventory are annually published in a transparent manner in the "Digest of United Kingdom Energy Statistics" and they are also available on the Internet.

35. The activity data provided by DTI are available in a structure that is suitable for application of the country-specific nomenclature (format of source subsectors). Fortunately, conversion of this country-specific source nomenclature to the standard IPCC/UNFCCC format seems to be feasible and is described in the NIR in detail.

36. For the purpose of the GHG inventory and required presentation using the CRF format it was necessary to convert the activity data into prescribed energy units – TJ defined on a net calorific value basis. As DTI gives only gross calorific values, gross energy data were converted to net energy data using factors recommended in the IPCC Guidelines.

37. The accuracy of the energy statistics seems to be good because statistical differences between supply and demand figures for the main fuels are usually less than 2 per cent. When comparing with IEA statistics (see synthesis and assessment report) for the fuel groups presented in the CRF, the observed differences from IEA are about 1-3 per cent. For bunker fuels the differences are somewhat higher (by 25 per cent for jet kerosene and 20 per cent for diesel oil). The United Kingdom experts explained to the review team that this discrepancy is due to the fact that the IEA does not consider fuels for use by the military and navy.

38. During the reviewed time interval (1990 - 1998) the statistical data were provided consistently: Only some subsectors were slightly re-arranged which had no effect on the total CO_2 estimate. According to the table with the results of the uncertainty analysis, which is presented in the NIR, the uncertainty of consumption data for the main fuels types might be less than 3 per cent.

Activity data for mobile sources

39. For mobile sources different types of activity data are used for CO_2 and non-CO_2 emission estimates respectively. Calculation of CO_2 is based on fuel consumption statistics (amount of gasoline, diesel oil and jet-kerosene). Amounts of individual fuels for mobile sources

were provided by DTI, while adequate transport distance statistics data needed for splitting into transport subsectors and for splitting bunker and domestic fuels were provided by DETR.

40. Uncertainty of CO_2 estimation for overall amount of individual fuels is low (=good accuracy less than 3 per cent, see previous paragraph). However, uncertainty is higher when evaluating relative contributions of fuels (fuel splitting) that are combusted in different types of transport (e.g. case of diesel oil splitting for road and off-road traffic and use in other engines). Similar problems rise when evaluating relative contributions for domestic and for bunker fuels. For instance, when separating domestic and international consumption of jet kerosene used in aviation (international aviation is dominant of course) the uncertainty in the estimation of the contributions from domestic aviation can be even 50 per cent as stated by national experts. On the other hand, practically all gasoline is used for road transport, and thus uncertainty in CO_2 emission from cars on gasoline is low (no splitting is needed).

41. For calculation of non-CO_2 gases from road traffic, another type of activity data was used. For the United Kingdom GHG inventory N_2O is especially important. It is considered a key source. This approach is based on km-distance travelled by individual vehicle types (vehicle population) as used in the widely recommended model COPERT. An important cross-check was made as an example of QC procedure: Fuel consumption calculated from travelled km-distance and from presumed vehicle consumption per km was in accordance with the fuel consumption from energy statistics, the difference was less than 10 per cent. For the N_2O calculation from road traffic it was estimated that the contribution of cars with a three-way catalytic converter in 1998 was about 50 per cent.

Carbon emission factors (CEF)

42. All emission factors used in the United Kingdom inventory are country-specific. The values were estimated in original units as mentioned above (kt C/ kt in case of solid and liquid fuels and kt C/Mtherm in the case of gaseous fuels). CEFs for each country-specific source category and for each fuel are presented in the NIR in the form of transparent tables. To be in harmony with the IPCC methodology, CEFs were converted using energy units and expressed in t C/TJ. However, converted CEFs are not presented in the NIR.

43. Thus it is not possible to compare the United Kingdom country-specific values of CEFs to the IPCC default values. It would be a good test of the reliability of the country-specific CEFs since it is known that for traded fuels the possible deviation of the IPCC default values from the adequately evaluated country-specific or site-specific ones are usually less than 4 per cent.

44. The synthesis and assessment report presents two examples of the aggregated implied emission factors (IEF) that are rather different from the mean values reported by other Annex I Parties:

(a) Higher value (130 kt CO_2/TJ) of CO_2 IEF for coal and coal-derived fuels under the category 1.A.2 Manufacturing industries and construction;

(b) Lower value (88 kt CO_2/TJ) of CO_2 IEF for coal and coal-derived fuels under the category 1.A.4 Other sectors.

45. These cases were explained by the national inventory experts plausibly:

(a) Higher IEF in the case of 1.A.2 Manufacturing industries and construction is due to a high proportion of blast-furnace gas, coke gas and coke - those fuels have the highest CEFs.

(b) Lower IEF in the case of 1.A.4 Other sectors is due to use of bituminous coal only (in other countries usually both hard and brown coals are combusted) – it is known that for bituminous coal the CEF's value is lower than that for brown coal/lignite.

Non-CO_2 emission factors

46. Most emission factors used were country-specific and were presented in a transparent way in the NIR, using the same tables and units as described for carbon. Only some emission factors for non-key sources were taken as default from the IPCC Guidelines or from the EMEP/CORINAIR guidebook. Emission factors for road traffic were taken from the COPERT model. The most important emission among the non-CO_2 pollutants is the emission of N_2O from road traffic (effect of three-way catalytic converter) that is still increasing. Other non-CO_2 sources are not considered key sources.

2. Reference approach

47. According to the UNFCCC reporting guidelines Parties are required to also submit emission estimates calculated from the reference approach and explain any difference greater than 2 per cent compared to the national approach. In case of the United Kingdom inventory for 1998, the estimate by the reference approach is 4.7 per cent higher than the estimate obtained using the national approach. In the CRF, the United Kingdom gave the following reasons for this difference:

(a) Existing statistical difference between apparent consumption and actual consumption;

(b) Different ways of estimating "stored carbon" (Reference approach considers a lesser amount of stored carbon);

(c) Difference in estimation of emissions for liquid fuels: crude oil is not combusted, but its apparent consumption is calculated by reference approach;

(d) 1.4 per cent from the difference of 4.7 per cent can be explained by reporting of CO_2 emission of fossil fuel origin in the industrial processes sector (e.g emissions derived from natural gas for ammonia production).

48. Similar to the case of the "bottom-up" approach, the country-specific CEFs are used and given in the relevant CRF sheet of the reference approach. Most of the CEFs used are close to IPCC default values for coking coal (CEF 28.3 t C/TJ used is rather higher than the IPCC default value 25.8 t C/TJ).

3. Feedstocks

49. To avoid double-counting of carbon in the inventory of the United Kingdom, special attention was given to the following feedstock treatments:

(a) Iron blast furnaces

(b) Coke ovens

(c) Smokeless fuel production

(d) Use of natural gas for ammonia production

50. Emissions arising from combustion of blast furnace gas and other fuels used for heating the blast furnace are reported under 1.A.2.a Iron and steel. Emissions from the process itself (blast furnace treatment) including flaring of blast furnace gas are reported under 2.C.1 Iron and steel production.

51. Emissions from the combustion of fuels to heat coke or from smokeless fuel resorts are reported under 1.A.1.c Manufacture of solid fuels, however process emissions and the residual carbon emission for smokeless fuels are considered to be fugitive and reported under 1.B.1.b Solid fuel transformation.

52. All carbon dioxide formed by steam reforming of natural gas was registered in the industrial processes sector.

53. There is no reason to fear that any important source was omitted in the inventory of the United Kingdom. Only emissions from some minor sources (e.g. non-significant CO_2 emissions from SO_2 removal by limestone) were not estimated.

4. Fugitive fuel emissions

54. Fugitive CH_4 emissions from both the oil and natural gas and the coal mining categories were identified as a key source, accounting together for 1,369 and 738 Gg CH_4 in 1990 and 1998, respectively. For the same years, CO_2 fugitive fuel emissions accounted for 11,908 and 7,984 Gg, respectively.

4.1 Completeness

55. Reporting of this subsector in the CRF is complete. The NIR reporting provides a brief summary of the methods but does not provide detailed calculation sheets or all the detailed emission factors used to make the estimates as required in the UNFCCC reporting guidelines, though aggregate emission factors have been provided for the sources. The detailed methods and emission factors are referenced in separate reports, which were not included in this review due to resource limitations of the review team.

56. CO_2 emission estimates for flaring at refineries are reported as not occurring (NO) in the CRF. The United Kingdom acknowledged that this was most likely a minor source and should be reported as not estimated (NE).

4.2 Methodologies, activity data and emission factors for fugitive fuel emissions

57. The data collection system is based on voluntary cooperation with industry to provide the required site-specific data for estimating emissions or the emission estimates themselves. The institutional arrangements to collect data for this sector are functioning well.

Coal mining

58. A general description of the method is provided in the NIR and it follows the IPCC tier 2 method as reported in the CRF. The assumptions, rationale and details for the emission factors are documented in a separate study referenced in the NIR. Aggregate emission factors are reported in the NIR, and these are reported to take into account mine-gas utilization data. These emission factors are based on site-specific data, which take into account the rapidly changing circumstances of United Kingdom coal mining (mine closures). The activity data are based on national coal production statistics.

Solid fuel transformation

59. The fugitive section of the NIR states emissions from solid fuel transformation as negligible, but emissions from this source are reported in the CRF; this caused some confusion during the review. The methodologies for these emissions are described in section 3.3 of the NIR (Manufacture of solid fuels) and are based on the carbon balance of coke production. This is based on an IPCC tier 2 method as reported in the CRF. The methodological issues are discussed in the Fuel combustion section of this review report.

Oil and natural gas

60. The emission estimates for upstream oil and gas are based on a study sponsored by the United Kingdom Offshore Operators Association (UKOOA), an industry association of the United Kingdom offshore oil and gas producers. Very little information is provided in the NIR on how these estimates were derived, except that they are based on data from the operating companies. The estimates are reported as tier 3 in the CRF. According to verbal information provided by the United Kingdom during the in-country review, the estimates are based on site-specific emission data. The sources of the estimates are referenced in the NIR in separate reports, but were not covered in this review. Aggregate emission factors are provided in the NIR for all major sources in this subsector. Tankers loading and offloading emissions are based on industry studies, and aggregate emission factors are shown in the NIR for this source.

61. The estimates for downstream oil and gas (gas transmission, distribution, oil transport, storage and refining) are based on industry-sponsored studies. Brief summaries of the methods have been provided. According to verbal information provided by the United Kingdom during the in-country review, the estimates are based on facility-specific data, which conform to the IPCC tier 3 method as reported in the CRF.

4.3. Recalculations

Solid fuels

62. No recalculations were reported for coal mining and handling. For solid fuel transformation, recalculations were reported upwards of about 10 per cent for all years. The rationale for the revisions was not provided in the CRF or in the section dealing with fugitive emissions of the NIR. During the fuel combustion discussion, the United Kingdom verbally provided the rationale for this recalculation.

Oil and natural gas

63. Methane estimates from upstream oil and gas have been recalculated upwards about 10 per cent for all years, due to new data from industry. This has been reported in the CRF as revised emission factors due to revised emission data. No information has been provided in the NIR as to the rationale for the recalculation nor has the new data been specified.

4.4. Uncertainty

64. Uncertainty estimates are provided in the NIR. The rational behind the uncertainty of this subsector is not discussed in the NIR. The uncertainty estimates seem reasonable and correlate with those in the IPCC Good Practice Guidance.

4.5. Quality assurance/quality control

65. There are no QA/QC procedures specifically for this sector reported in the NIR. The United Kingdom explained that the data from industry are generally taken "as is" with no formal verification. The United Kingdom provided limited validation of the emissions from the gas transmission systems by comparison of the downward emission trend with the upgrading schedule of the infrastructure of the system in recent years. It is acknowledged that this is a very difficult sector to verify due to the site-specific nature of the emissions and the lack of comparative data.

5. Recommendation for the improvement of inventory quality

5.1. Possible improvements for fuel combustion

66. The review team appreciated the high quality of this part of the United Kingdom inventory. All questions posed by the review team to the representatives of the United Kingdom concerning methodological aspects of the combustion part of the United Kingdom GHG inventory, including completeness, transparency, consistency and comparability were satisfactorily explained. The most important items discussed were presented in this chapter of the review report.

67. For further improvement of the inventory quality, namely its transparency, comparability and implementation of QA/QC measures, it is recommended that all country-specific and sector-specific CEFs also be presented in figures expressed per energy unit (e.g. in t C/TJ). This form would facilitate their comparison not only with the IPCC default values, but also with CEFs from other countries. A list of such figures would also be advantageous for the synthesis and assessment review step that, *inter alia*, compares IEF (aggregated for main fuel types) across countries.

5.2. Possible improvements for fugitive fuel emissions

68. The NIR does not discuss planned improvements for the fugitive fuel emissions. There is little need for improving the methods in this subsector since they are site-specific and complete. The United Kingdom is encouraged to include estimates from flaring at refineries though this is expected to be a minor source. The review team recommends that the United Kingdom further

validate the emissions from the oil and gas sector to explain the reason for reducing emissions while production and infrastructure are increasing significantly.

C. INDUSTRIAL PROCESSES

1. General overview

69. In the United Kingdom, aggregate GHGs from the industrial processes sector accounted for 57,501 and 53,412 Gg of CO_2 equivalent in 1990 and 1998, respectively.

1.1. Institutional arrangements

70. Though DETR is the national body for the coordination of the GHG inventory preparation, it is NETCEN that is responsible for the development and management of the GHG inventory in the industrial processes sector. NETCEN works very closely with other contractors engaged by DETR for the purpose of research into sector-specific activities. NETCEN has voluntary arrangements with industry for the provision of necessary data.

1.2. Completeness

71. The United Kingdom inventory covers almost all subcategories of industrial processes, except for a few cases where emissions were not estimated. For example, CH_4 emissions from ammonia, ferro-alloy and aluminium production; CO_2 from road paving with asphalt, asphalt roofing, and NO_x from adipic acid production. The experts from the United Kingdom explained that emissions from some of these sources were in some cases negligible; in others no methodology had been developed for their estimation (e.g. estimation for asphalt roofing). It should be noted, however, that in terms of reporting requirements under the CRF, the 2000 submission of the United Kingdom is complete.

72. The review team was informed that CH_4 emissions from chemical industries had been reported in the 2001 submission.

1.3. Methodology

73. To a great extent, the United Kingdom industrial processes GHG inventory follows the IPCC methodology, except in lime production. A description of the methods employed and assumptions made have been stated in the NIR. As indicated in the preceding paragraphs, the IPCC tier 1 method has been used and where country-specific methods have been used detailed explanations have been given in the NIR. The review team was made to understand that the IPCC Good Practice Guidance has been applied for the 2001 submission.

1.4. Activity data

74. The national system for the preparation of the GHG inventory of the United Kingdom uses data collected by private and public sector organizations both on a mandatory and voluntary basis: whilst the public sector is mandated by law to gather certain data and request certain relevant information, it also relies on voluntary agreement for a large amount of the data. The private sector has to rely on voluntary agreements with industry to receive the data needed, but also has access to certain published information that has been collected on a statutory basis by

public organizations. As for activity data covering production and consumption of HFCs, PFCs and SF_6, data collection relies on voluntary agreements with industry.

75. The activity data for HFCs, PFCs and SF_6 are treated confidentially, reasons being clearly stated in the NIR.

1.5. Emission factors

76. The United Kingdom used a hybrid of IPCC default and country-specific emission factors. The extent of usage of IPCC and country-specific values has been reported under the sources of emissions discussed in this report. The calculated United Kingdom IEFs for iron and steel for the period 1994-1998 are slightly lower than default emission factors.

1.6. Recalculation

77. The United Kingdom did some recalculations, especially for the iron and steel subcategory as a result of changes in available data supplied by British Steel. This recalculation was done for the entire reporting period. However, as identified in the synthesis and assessment report, there was a sudden increase of 153 per cent in the emissions from 1993 to 1994, which was not explained in either the CRF or the NIR. Upon further discussion the review team was informed that as a result of new data available the recalculation was done for only a five-year period retrospectively from 1998 to 1994.

1.7. Uncertainty

78. The annex of the NIR contains a whole section on uncertainty estimations for subcategories under industrial processes. Explanations of these uncertainties are also provided, as well as qualitative discussions of contributors to the uncertainties.

1.8. Quality assurance/quality control

79. There is no national system in place to ensure quality control and quality assurance in activity data gathered for emission estimates for the industrial processes sector. Moreover, there was no clear distinction as to who conducts quality control and quality assurance among the experts from the United Kingdom involved in the preparation of the inventory.

2. Key sources

2.E Production of halocarbons and SF_6

80. HFC emissions from the production of halocarbons were identified as a key source according to the tier 1 level assessment of the IPCC Good Practice Guidance. The United Kingdom used the tier 1 methodology in gathering activity data which were obtained from gas manufacturers and distributors, equipment manufacturers, end-users and trade associations. EnvirosMarch of the United Kingdom gathers activity data on behalf of DETR. Country-specific emission factors were used to calculate emission estimates. DETR has access to the disaggregated data by gas species.

Findings identified in the synthesis and assessment report:

81. *All HFC emissions from 2.E "Production of halocarbons and SF_6" have been reported under "By-product emissions – other" which include both by-product and fugitive emissions. Emissions were not reported by gas species but were all reported under HFC-23 using an average GWP.*
Officials from the United Kingdom explained that, for commercial reasons, fugitive emissions and by-product emissions from halocarbon manufacture are combined in the CRF as there are only two manufacturers in the country, one manufacturer per type of gas produced. The largest proportion of HFCs are the by-product HFC-23 emissions from HCFC-22 production, whilst a small proportion are fugitive emissions from the production of HFC-134a and HFC-32.

82. *On the aggregate IEF and its decline over time only limited information was available in the CRF* (The aggregate IEF of HFCs from production of halocarbons and SF_6 declined from 39.9 to 36.8 kg/t between 1990 and 1998).
Officials from the United Kingdom explained that the production of HFC-134a and HFC-32 increased from around 0.3 per cent of HCFC production in 1990 to around 10 per cent in 1998. Hence the IEF varies. The United Kingdom officials provided the following values for emission factors: HCFC: 0.04 t/t; Other HFCs: 0.005 t/t; aggregate emissions factors: 0.0399 t/t, 0.0381 t/t and 0.0368 t/t for 1990, 1995 and 1998, respectively.

2.B.3 Adipic acid production – N_2O

83. Activity data were gathered by NETCEN based on a voluntary agreement with ICI for 1990 to 1993, and from 1994 onwards with DuPont, after the latter took over the adipic acid plant from ICI. IPCC default emission factors have been used.

Findings identified in the synthesis and assessment report:

84. *IEF for N_2O changes notably from year to year.*
National experts explained that data supplied by ICI included some N_2O emission data from a nitric acid plant operated in conjunction with the adipic acid plant. This N_2O emission contribution has been deducted since DuPont took over. This variation in IEF had been explained in the NIR. The review team was informed that further N_2O emission abatement measures have been put in place since 1998 and emissions have reduced even further as reported in the 2001 submission.

2.A.1 Cement production – CO_2

85. The United Kingdom inventory of GHG emission from cement production is based on the tier 1 approach, which depends on clinker production data compiled by the Construction Directorate of DETR and published in the Monthly Statistics of Building Materials and Components. IPCC default emission factors are used and given in the annex to the NIR.

Findings identified in the synthesis and assessment report:

86. *IPCC tier 1 method and default emission factors are used* (although it is a key source). The review team further asked whether it was possible for the United Kingdom to use country-specific emission factors. It was explained that such attempts have failed as monitoring data from companies and trade associations were not forthcoming.

87. *Ratio of clinker (reported in CRF) to cement data (United Nations' data) is lower than for other Parties. (CRF clinker production data approximately 20 per cent lower than United Nations' production data).*
The national experts informed that clinker data used are published in Monthly Statistics of Building Materials & Components. The United Kingdom also confirmed the data provided in the CRF, namely 12.37 Mt clinker (production of cement was 12.41) and provided the review team with a copy of the latest statistics. The difference in other years is wider but not as high as 20 per cent. However, national officials could not assign any reason to the observation made in relation to the United Nations' statistics and indicated the need to identify the source of the United Nations' data.

2.C.1 Iron and steel production - CO_2

88. Activity data for iron and steel are obtained from iron and steel statistics provided by the Iron and Steel Industry Annual Statistics for the United Kingdom. The United Kingdom used tier 1 for gathering activity data, whilst IPCC and USEPA default emission factors were used in the emission estimates. CORINAIR default emission factors were also used for emission estimates from blast furnace gas flaring. The United Kingdom plans to use higher tiers in the future.

89. With the provision of new data (blast furnace gas) by British Steel, a recalculation was done for the iron and steel sector resulting in an additional 367 Gg emissions from blast furnaces, blast furnace gas flaring, electric arc furnaces and basic oxygen furnaces.

Findings identified in the synthesis and assessment report:

- Change of 153 per cent in emissions from 1993 to 1994;
- Steel production is more than 200 per cent lower than United Nations data;
- Reporting of negative emissions under 'other'.

90. The United Kingdom experts explained that the emission of CO_2 reported in this subcategory is based on a rather more complex calculation to ensure that there is no double-counting of carbon emissions from blast furnaces. The methodology has been explained in the NIR. The national experts further explained that the CO_2 reported is, in effect, the difference between the carbon content of coke fed to the blast furnace and the output carbon contained in the steel and blast furnace gas from year to year.

91. In answer to the large difference between the 1993 and 1994 reported emissions, it was explained that this was due to an error in 2.C.1 Iron and steel CO_2 emissions for the years 1995 to 1998, resulting in a 153 per cent change between 1993 and 1994. This error has been corrected in the meantime. In the corrected version of the inventory, the increase from 1993 to

1994 is around 22 per cent. In addition, national officials explained that new data supplied by British Steel has become available, which led to major recalculation of emission estimates from 1994 to 1998. From this explanation, the review team inferred that the emission estimates for iron and steel production for 1990-1993 might have been underestimated. The United Kingdom, however, confirmed that national total CO_2 emissions are not underestimated because there is compensating overestimation in the energy sector of blast furnace gas emissions from energy use. The United Kingdom uses a mass balance approach to estimate emissions from blast furnaces, coke ovens and patent fuel production. Therefore, the total of CO_2 emissions is based on coal consumption, for which a consistent set of coal data from 1990 to 1998 has been used.

92. On the negative emissions reported in this subcategory, the United Kingdom experts explained that emissions were reported in the energy sector and were given here for information purposes. In order to avoid double-counting, negative emissions were reported here.

93. In response to the difference from United Nations data, United Kingdom officials explained that steel production data is taken from Iron and Steel Industry Annual Statistics for the United Kingdom, and provided a copy of the latest statistics to the review team. The CRF reports the production of iron from blast furnaces and the production of steel from electric arc furnaces. The United Kingdom assumes that the difference is accounted for by the use of scrap and iron ore in electric arc furnaces and blast oxygen furnaces as well as pig iron, but recognized the need to review the methodology in light of the two-stage approach of the Good Practice Guidance.

3. Non-key sources

2.A.2 Lime production

94. There is the possibility of underestimation of CO_2 emissions from lime production, as the United Kingdom currently does not have all data covering sodium carbonate consumption. CO_2 emissions from lime production have been on the increase from 1995-1998. The Revised 1996 IPCC methodology is not applied. An emission factor of 120 t carbon/kt limestone has been used based on the stoichiometry of the chemical reaction, assuming pure limestone. This results in a low emission estimate in comparison to other countries.

2.B.1 Ammonia production

95. There has been a consistently low recording of CO_2 emissions from ammonia production. Emissions values for 1997 were relatively low, about 35.6 per cent decrease from the 1996 value. United Kingdom experts attributed this sudden decrease to the temporary shutdown of one of the three ammonia production plants and that most of the ammonia production plants are integrated into other production processes. This leads to sequestration of CO_2 (20 per cent) in methanol and acetic production and hence CO_2 emission reduction. In addition, CO_2 is sold to food industries and nuclear plants as a coolant for gas-cooled reactors. National experts also explained that the reported ammonia production estimate includes this CO_2 used as coolant as it is eventually released to the atmosphere.

96. The review team questioned why the IEF of the United Kingdom in comparison to that of the United States of America is consistently higher, about 18 times. The United Kingdom experts attributed this to the reporting of natural gas as the feedstock in ammonia production.

2.B.2 Nitric acid production

97. The review team was informed that there were no government estimates of nitric acid production. However, nitric acid plant operators give NETCEN production capacity and NO_x emissions estimates. In 1998 one plant, however, reported N_2O emissions. IPCC default emission factors were used. Between 1990 to 1994 two plants were shut down and another major plant was also shut down in 1995. The latter explains why there was a sharp change in emissions from 1994 to 1995.

4. Possible improvements

98. The NIR does not discuss planned improvements for this sector. DETR informed the expert review team that the voluntary agreements between national inventory preparation organizations for the provision of activity and emission data have so far worked very well. Furthermore, a study that uses a top-down approach to verify HFC estimates is underway. The expert review team recommends the use of QA/QC procedures to ensure the quality of data provided through these arrangements. This may allow for cross-checking such data.

D. AGRICULTURE

1. General overview

99. Total CH_4 and N_2O emissions from agriculture, in 1990 and 1998, accounted for 52,914 and 50,559 Gg expressed in terms of CO_2 equivalent, the major contributor being CH_4 from enteric fermentation.

1.1. Institutional arrangements

100. The GHG inventory for agriculture is the responsibility of the Ministry of Agriculture, Fisheries and Food (MAFF), which contracted a consultant from the Institute for Grassland Ecology (IGER) to collate activity data, define the emission factors, calculate emissions estimates and update a background report for the NIR which was previously compiled by MAFF. This report was not available for review, as it was not yet published at the time of the in-country visit. Results are reported by IGER to MAFF, and MAFF reports to the AEA Technology for incorporation in the National GHG Inventory. AEA Technology does not perform any emissions estimates of this sector by itself.

1.2. Activity data

101. MAFF statisticians collect activity data that are used by IGER. Statistics used are annual surveys for livestock numbers and fertilizer use and a census every 2 or 3 years for manure management. Activity data are published by MAFF and are available on the MAFF web site http:/maff.gov.uk.egs/index1.htm. Activity data are collected by MAFF and used by IGER from a centralized published source.

1.3. Completeness

102. Emission reporting in the CRF was complete, although additional information for the tier 2 methodology of CH_4 from enteric fermentation was not provided in the CRF (Table 4.A). This information, however, was provided in the NIR for 1990 to 1998. Information on all

required GHGs for all the source categories is provided in the NIR. In addition, CH_4 emissions from deer on farms have been included in the inventory. The NIR did not include all the information about methodologies and assumptions needed to replicate the calculations.

1.4. Methodology

103. The agriculture inventory was produced following the Revised 1996 IPCC Guidelines. Uncertainties were addressed but with a slightly different methodology (Eggleston et al., 1998). Extra assumptions affected its comparability with other countries. This was the case in the CH_4 estimates from enteric fermentation from cattle and sheep.

1.5. Emission factors

104. Apart from cattle, lambs and deer, CH_4 emission factors are defaults from the Revised 1996 IPCC Guidelines, and do not change from year to year. Some values (emission factors for cattle, lambs, deer, N_2O emissions from soils) were changed according to new knowledge coming out from national research institutions. Supporting research needs to be documented properly in the NIR. The observation from the review team is that country-specific methods comparable to the IPCC tier 2 methodology can give widely varying results if countries use new assumptions. As a result, the methodology used by the United Kingdom for CH_4 from enteric fermentation appears not to be giving robust results at the moment.

2. Key sources

4.A Enteric fermentation – CH_4

105. Data on animal population size used were taken from published Agricultural Census data. Data reported in the CRF corresponded exactly to those published by FAO, given that the same set of data is provided to the FAO as used by the inventory experts. The emission factors used were IPCC defaults, except for cattle, lambs and deer, where they were calculated using IPCC tier 2 methodology. CH_4 emission factors for each livestock type were provided in the NIR. The description of the methodologies used was considered to be sufficiently detailed.

106. The United Kingdom uses the IPCC tier 2 methodology to estimate CH_4 from this source category.

107. The United Kingdom inventory included some nationally derived assumptions for cattle and sheep that affected the emission factors, which reduces the comparability with other countries.

Findings identified in the synthesis and assessment report:

108. *IEF for sheep is among the lowest compared to other countries and is also significantly lower than the IPCC default.*
National experts explained that the emission factor for young animals is assumed to be 40 per cent of the emission factors for adult animals. Upon request, the review team was provided with a publication from the Silsoe Research Institute/IGER which was commissioned by MAFF ("A U.K. inventory of methane emissions from farmed livestock"), which provides information to support that assumption.

109. *IEF for dairy cattle shows a 6 per cent increase from 1990 to 1998.*
The national experts explained that this is the result of a combination of factors. Within the IPCC tier 2 methodology the United Kingdom assumes a 1 per cent live weight increase per year for dairy cattle following the advice of MAFF statisticians, which results in increases in intake and yield and thus in the IEF. The review team noted that this might give problems when comparing it with other countries. Emissions from this source are going down from 1990 to 1998 because of reduced dairy cattle numbers. This results in an improved national efficiency of the system.

110. *IEF for non-dairy cattle decreased 3 per cent between 1997 and 1998.*
After the spreadsheets held by MAFF and IGER were checked by the national experts the team was informed that IEFs should read 42.82 and 42.88 kg CH_4/head/year for 1997 and 1998, respectively, which does not correspond to an annual 3 per cent decrease (instead of 45.81 and 44.29 kg CH_4/head/year as was found in the CRF submitted to the UNFCCC secretariat). A final answer could not be provided, but it was assumed that a transcription error in either the CH_4 emissions estimates entered or the activity data could have occurred during completion of the CRF.

111. *IEF for sheep change from -6 per cent to 8 per cent from 1994 to 1995.*
After the national experts checked the relevant spreadsheets, the team was informed that the IEF in the CRF for the year 1994 should read 4.67 instead of 4.37 kg CH_4/head/year. The IEF of 4.67 also corresponds to the CRF tables for 1990 to 1999 that were submitted to the secretariat for the 2001 submission.

4.D Agricultural soils, 4.D.1 Direct soil emissions – N_2O

112. Direct emissions of nitrous oxide from agricultural soils are estimated using the methodology recommended in the Revised 1996 IPCC Guidelines, but using some recently derived United Kingdom-specific emission factors. The methodology is described in sufficient detail in the annex to the NIR.

Findings identified in the synthesis and assessment report:

113. *N_2O IEF from cultivation of histosols seems too high by a factor of 100 compared to other countries.*
After checking the relevant spreadsheets, the national experts identified an error in the activity data which should read 39,200 ha instead of 392 ha. This changes the corresponding IEF from 500 to 5, which corresponds to the IPCC default. This error has already been rectified in the CRF tables for 1990 to 1999 of the 2001 inventory submission.

3. Non-key sources

4.B Manure management – CH_4

114. Methane from manure management is estimated using the methodology of the Revised 1996 IPCC Guidelines. The emission factors are listed in table A41 of the NIR. Apart from cattle, lambs and deer these are all IPCC defaults and do not change from year to year. The emission factors for dairy cattle were calculated from the IPCC tier 2 approach using data shown in table A42 and A44 in the NIR from MAFF. For dairy cattle, the calculations are based on the

population of the dairy breeding herd rather than dairy cattle in milk used in earlier inventories. This definition includes cows in calf but not in milk. The waste factors used for beef and other cattle are now calculated from the IPCC tier 2 approach but do not vary from year to year. Emission factors and base data for beef and other cattle are given in table A43 in the NIR.

Finding identified in the synthesis and assessment report:

115. *The IEF for CH_4 from manure from sheep is low compared to other countries. The emission factor is also lower than the IPCC default.* The national experts assumed an emission factor for lambs, which is 40 per cent of that for adult sheep. The review team noted that this is an assumption that goes beyond the IPCC methodology. This may be valid but leads to differences with countries that did not apply such an assumption.

4.B Manure management – N_2O

116. The nitrogen excretion factors for animals in the United Kingdom are based on a publication by Smith (1998) and given in table A45 in the NIR. Smith has revised these excretion factors since the 1996 inventory based on a new balance. The United Kingdom methodology assumes that 20 per cent of the total N emitted by livestock volatilizes as NO_x and NH_3 and therefore does not contribute to nitrous oxide emissions from animal waste management systems.

Finding identified in the synthesis and assessment report:

117. *The nitrogen excretion for swine used to estimate nitrous oxide seems low compared to the IPCC default.* This nitrogen excretion is used as input for the calculation of nitrous oxide from manure. The national experts explained that the United Kingdom uses specific experimentally derived emission factors. In this case, this is based on recent research by Ken Smith at ADAS. The national experts agreed to provide a general indication in the next national inventory report on the criteria the United Kingdom uses when selecting emission factors that deviate from the IPCC defaults.

4.F Field burning of agricultural residues

118. The review team noted that emissions from field burning of agricultural residues were reported from 1990 to 1993. Field burning of agricultural residues has indeed been abandoned since 1993, according to the national experts. For field burning of agricultural residues: legislation prohibited this action from 1994 onwards. In 1998, 63 per cent of crop residue was baled and removed from farms, 90 per cent of which was used for livestock bedding, with various other minor uses such as mushroom compost and power generation. The remaining 37 per cent are estimated to be incorporated into the soil with the amount burnt being too small to be considered in the analysis.

4. Possible improvements

119. The NIR does not discuss planned improvements in this sector. The expert review team suggested reporting on research programmes in place in the United Kingdom specifically devoted to improving emission factors through fundamental research in agriculture.

E. LAND-USE CHANGE AND FORESTRY

1. General overview

120. In the United Kingdom, land-use change and forestry (LUCF) constituted a net source of CO_2 emissions, accounting for 21,186 and 14,984 Gg CO_2 in 1990 and 1998, respectively.

1.1. Comments on documents received and the review process

121. Given that the NIR was not available before the visit and the open disposition of the national experts involved in the LUCF inventory process, the meeting held during the in-country review process and the personal contacts with the National Coordinator of this process were essential for the reviewers to get a proper understanding of the LUCF inventory and to make findings and produce sound conclusions.

122. An additional complication was that the information provided in the NIR was slightly different to that provided in the CRF tables. At the meeting, it was explained that the differences were a consequence of rearranging data in the NIR for the CRF tables, such as not reporting set-aside removals separately in the tables of the NIR. Differences between the CRF and tables in the NIR were:

(a) Total gross CO_2 emissions for 1998 (26,512 and 26,646 Gg) and total gross CO_2 removals (-11,528 and -11,662 Gg), producing the same net balance;

(b) Under category 5.A: Only removals from temperate forests in the NIR, and disaggregation in temperate forests and harvested wood in CRF tables;

(c) Under category 5.D: Only gross emissions in the NIR and disaggregation in emissions from mineral soils, emissions from liming, removals from forest soils and removals from set-aside, in CRF tables;

(d) Under category 5.E: Only aggregate figures for gross emissions and gross removals were given in the NIR, while in the CRF the disaggregation of the emissions into peat extraction, lowland and upland drainage, and of the removals into crop biomass, was provided.

1.2. Institutional arrangements

123. The LUCF inventory is officially released and integrated into the United Kingdom GHG inventory by DETR. It was fully developed by the Centre of Ecology and Hydrology (CEH), under the guidance of DETR; CEH being responsible for collecting and processing activity data, proposing methodological approaches to DETR, and calculating emissions/removals estimates. Preparation of reports and archiving of final estimates are the responsibility of DETR.

124. DETR contracted the Centre of Ecology and Hydrology (CEH) to produce the final 1990-1998 LUCF inventory, after assessing the CEH's tender as technically the best among a number of other submitted proposals. CEH is an autonomous research centre related to the national Government through the Natural Environment Research Council (NERC).

125. A steering committee was set up to discuss technical matters, analyse progress and submit sensitive proposals to DETR; apart from DETR and CEH, the steering committee is composed of MAFF, the United Kingdom Forestry Commission, the Scottish Executive and the research

institutes working under subcontract to CEH (MLURI, Queen's University Belfast, Rothamstead Experimental Station, among the most important ones), to produce relevant information for the process (mainly emission and conversion factors).

1.3 Transparency

126. Information provided in the NIR and CRF tables is not enough to guarantee the full transparency of the inventory process, as there is not enough information on methodologies and on the underlying assumptions and parameters (specifically, emission factors, conversion factors, activity data, management issues) used to make the calculations.

127. In relation to category 5.A Changes in forest and other woody biomass stocks, the NIR does not provide all necessary information on the model used, activity data (planted forest area, both accumulated and annual increase, per specie), and management parameters (expansion and conversion factors, rotation length per specie, carbon content in biomass).

128. In relation to category 5.D CO_2 emissions and removals from soils, the NIR is more explicit on the model used to generate estimates but does not release information on annual activity data, except some very aggregate tables (A54a to A54c). Some information is provided for average soil carbon contents linked to land use but this seems to be insufficient. Lastly, there was no information whether the estimates took into account the first 30 cm of the soil profile or not.

129. For set-aside removals (reported as "other" under 5.D), there is no explicit reference to the values of emission and conversion factors, nor to underlying parameters used. For changes in crop biomass the way of calculating estimates cannot be understood solely on the basis of the information provided in the NIR. However, the team was provided with the relevant background documentation.

130. Finally, tables included in the NIR provide only very limited information of aggregate or specific emission factors for the LUCF categories (from 5.A to 5.E). Implied emission factors were not calculated given that the United Kingdom uses a country-specific methodology and therefore is not required to provide tables 5.A to 5.D of the CRF.

1.4. Comparability

131. As the LUCF inventory was produced following a particular national approach, specifically concerning the two more important sources of carbon fluxes (forest management and changes in soil carbon due to land-use change), the inventory is not directly comparable to other Parties.

132. Today, there is no direct access to the models used by the United Kingdom team to produce the inventory, which are a key part of the methodology, although they are properly published (references given). What is published is the structure of the models, and any effort to replicate the process would mean either getting the consent of the CEH to use the models or to produce the necessary algorithms, according to the published information.

1.5. Completeness

133. The inventory may be assessed as almost complete, as it has a national coverage of the major sources of carbon fluxes that IPCC recognizes for the LUCF sector. Non-CO_2 trace-gas

emissions were not reported. The United Kingdom assumed that some potential sources of C emissions or removals were not taken into account, mainly due to either expert judgement of negligible effect or lack of accurate activity data. The sources that should be included in the next inventories are biomass burning (mainly carcasses from the occurrence of foot and mouth disease in 2001) as a source of trace gas emissions, accidental fires, non-forest and urban soils as sink sources and deforestation as an emission source.

1.6. Accuracy

134. The inventory seems to be as accurate as possible, although it was recognized that some minor overlapping or double-counting could have happened, but not to the extent of changing results significantly. This could have been the case for set-aside farming and upland/lowland drainage, which could already be accounted for under category 5.A Temperate forests. Quantitative uncertainties were given in the NIR for forest biomass and soil carbon contents. They were estimated following the Monte Carlo simulation.

1.7. Consistency

135. The inventory was consistent in the time-series as calculations for 1990 to 1998 were performed using the same methods, models, assumptions and emission and conversion rates. As for consistency of LUCF with other sections of the inventory, such as biomass use for energy, the national experts recognized that such consistency checks are currently not performed.

1.8. Reporting

136. Some inconsistencies in the United Kingdom NIR, compared with categories identified in the IPCC default methodology for the LUCF inventory, were detected:

(a) 5.A Changes in forest and other woody biomass stocks:

(i) Output was a net balance of CO_2 instead of disaggregate information on captures from biomass growth and commercial harvest;

(ii) Output includes changes in soil carbon from forest management, a component that should be included in category 5.D;

(b) 5.D CO_2 emissions and removals from soil: For changes in soil carbon due to land-use change, the output was a CO_2 gross emission instead of disaggregate information on removals and emissions;

(c) 5.E Other: No disaggregated reporting of the relevant subcategories;

(d) Set-aside farming, currently reported under "other" CO_2 emissions and removals from soils might be better allocated under category 5.C Abandonment of managed lands, and, afterwards, under category 5.B Forest and grassland conversion;

(e) Changes in crop biomass might be better allocated in category 5.B Forest and grassland conversion.

2. Methodologies, activity data and emission factors

2.1. Methodology

137. For categories 5.A and 5.D, the LUCF inventory was built up using a country-specific approach, whilst for other sources (category 5.E), emissions and removals were estimated on the basis of the IPCC default methodology.

138. For 5.A Changes in forest and other woody biomass stocks, the output was a net balance of CO_2, resulting from the use of a model that takes care of carbon fluxes in managed planted forest (C-flows) and soil carbon stock changes due to land-use change (dynamic model).

139. For 5.D CO_2 emissions and removals from soils, particularly for changes in soil carbon due to land-use change, the output was a CO_2 gross emission derived from a methodological approach based on a matrix of land use, within two endpoints (to estimate annual land-use changes), linked to a model of C fluxes. It must be emphasized that the IPCC recognizes the possibility of having removals under this category in addition to emissions, thus the reported net emissions do not provide information on these removals. Estimates for Northern Ireland were produced separately using the IPCC default methodology.

140. For the other sources considered (emissions due to liming, emissions from peat extractions and cultivation of drained peat soils), the estimates were based on United Kingdom country-specific emission factors and activity data, using a methodology consistent with the IPCC Guidelines (following the concept of activity data * emission factor).

2.2. Emission and conversion factors

141. For estimates under 5.A Changes in forest and other woody biomass stocks, emission and conversion factors (biomass annual expansion, carbon content in biomass) were taken from published articles and official reports. For category 5.D (soil carbon content linked to land use), the main information was produced by the Soil Science and Land Research Centre, the MLURI and Queen's University, Belfast.

142. It is important to emphasize that the review team recognizes the efforts invested in producing national-based emission and conversion factors and information in areas with known data scarcity (such as carbon content in different soil types).

2.3. Activity data

143. Activity data were collected from different Government and private agencies, which had been producing and publishing statistics long before the GHG inventory came into being. The main agencies mentioned in the NIR and during the meeting, were:

(a) For category 5.A, activity data came from the United Kingdom Forestry Commission and the Northern Ireland Forest Service, and timber traders, both producing annual figures of forest planting and commercial harvest;

(b) For category 5.D:

(i) Changes in soil carbon due to land-use change: activity data were collected from the Monitoring Landscape Change Project, DETR/CEH Countryside Surveys and the Annual Farm Census (MAFF), producing consolidated statistics of land-use change over a number of years (6 to 8);

(ii) Set-aside farming: activity data came from the Annual Farm Census (MAFF);

(iii) Liming application: activity data were produced by the British Geological Survey (mineral extraction data);

(c) For category 5.E, activity data were reproduced from the Annual Census Report (MAFF) and estimates from Queen's University, Belfast, and others.

144. The review team was informed that access to activity data has become increasingly restricted, mainly due to cost-cutting from the agencies that collect the field information. Also, that there were some minor disagreements in figures among some statistics sources, mainly in the scope of land use, due primarily to differences in term (class) definition.

3. Findings identified in the synthesis and assessment report

5.A Changes in forest and other woody biomass stocks

145. The net increase in removals (12 per cent between 1990 to 1998) was explained as a result of the expansion of planted forest area during the nineties and earlier. This expansion was supported by new planting of Sitka spruce and beech.

5.D CO_2 emissions and removals from soils

146. The decrease of 17 per cent in emissions from 5.D.1 Cultivation of mineral soils, which also include organic soils, was explained as the result of annual changes in the matrix of land-use changes and soil types, resulting in a consistent reduction of emissions.

147. Annual fluctuations of emissions from limed soils were explained as the reflection of annual usage of liming materials.

148. Fluctuations in removals from set-aside farming were explained as a result of a first rapid growth of the area submitted to the system up to 1995, and then a rapid extinction of the scheme (supposedly dying out in 1999).

149. The decrease in emissions from peat extraction and land drainage was explained as a reflection of the activity data provided by the responsible agencies, which were mainly based on estimates.

4. Possible improvements

150. The NIR does not discuss planned improvements for this sector.

151. It seemed to the reviewers that there is some weakness in the archiving process. As far as the LUCF inventory is concerned, CEH keeps the working files and provides final results to DETR and NETCEN. This means that DETR is holding only final estimate data, without having direct access to underlying calculation worksheets.

152. The review team also noted that there is a need for improving the accessibility to published supporting references. In order to ensure the permanence of the data produced, the archiving system could be improved, for example by creating a centralized unit to store all these pieces of information, both inventory data and references. As far as references are concerned, the archiving need not mean creating a library with hard copies, but a system of electronic links that allows the search for a particular reference.

F. WASTE

1. General overview

153. Total GHG emissions from waste accounted for 25,086 and 17,147 Gg of CO_2 equivalent in 1990 and 1998, respectively, the major emission source being CH_4 from solid waste disposal sites.

1.1. Completeness

154. Emission reporting in the CRF was complete, even though some sources considered small were reported as NE (not estimated) such as industrial waste-water treatment. A general description of the methodologies was recorded in the NIR with details of the assumptions included in separate reports, referenced in the NIR and provided during the visit. The NIR was complete with the exception of including calculation tables, and a detailed description of the methods.

1.2. Additional information received during the review

155. An additional report reviewed during the visit was “Methane emissions from UK landfills” K. Brown et al., 1999. An additional report received, but not reviewed was: “Control measures to limit methane emissions from sewage sludge treatment and disposal” Hobson et al., 1996.

1.3. Methodology

156. The focus of the review was on landfill emissions, as these contribute to the vast majority of emissions for this sector in the United Kingdom. The institutional arrangements and procedures to develop the estimates are presently evolving, primarily due to recent legislative changes in the United Kingdom. The estimates are made from models developed by consultants using the best available data. The landfilled waste data is primarily collected from the Environment Agency, which regulates the industry. The properties of landfills and the characteristics of waste are based on expert opinion.

1.4. Recalculation

157. The only recalculation was for municipal solid waste (MSW) incineration. These were insignificant for earlier years and 100 per cent for 1997 due to a reallocation of the emissions to

the energy sector. The recalculations were documented in the CRF. It was determined that in 1997 all MSW incineration should be classified as electric power generation. There was no description of the recalculation in the NIR.

1.5. Uncertainty

158. Uncertainty estimates are given in the uncertainty chapter of the NIR. The rationale behind the uncertainty is briefly discussed in the NIR. The specific sources of uncertainty are discussed in the above-mentioned background report "Methane emissions from UK landfills". The uncertainty estimates seem reasonable and correlate with those in the IPCC Good Practice Guidance.

1.6. Quality assurance/quality control

159. There are no QA/QC procedures specifically for this sector reported in the NIR. The above-mentioned background report describing the landfill methodology received limited external review before completion and did not receive peer review. Since finalization it has been used as a background paper for the IPCC Sao Paulo workshop to develop good practice in the waste sector.

2. Key sources

6.A Solid waste disposal on land

160. The United Kingdom used a first order kinetic decay model to estimate emissions. This is recommended as a tier 2 method in IPCC Good Practice Guidance (this method was not elaborated on with very much detail in the Revised 1996 IPCC Guidelines). The details of the method are not in the NIR. Rationale for assumptions and background data can be found in a supporting document, which is referenced in the NIR.

161. A consultant developed the methodology using the best available data from public sources such as the Environment Agency. The consultant also provided projections of emissions. For the years after 1995, the United Kingdom has based its GHG inventory estimates on the projected data.

162. As is typical in many countries, activity data is difficult to obtain for this source. The United Kingdom has derived much of their estimates from assumptions (such as carbon content of waste, and methane capture rates). The quality of the activity data has been improving in recent years. As a result, the best data for waste disposed is from 1995. This data is improving since the United Kingdom introduced a tax on landfilled waste.

163. The primary drivers of the trend in emissions generated by the model are government policies on reducing the amount of MSW generated and the effect of the installation of comprehensive landfill gas capture technologies. There is little factual data to support the assumptions used for this underlying data. This activity data is estimated based on the assumption that government policies, which have been implemented, will be effective.

164. The method deviates from good practice in that volumes of captured gas are not subtracted from the amount of landfill gas generated. This is done to accommodate for a lack of actual captured data. The capture efficiency of the landfill gas collection systems is integrated

into the model as an assumption of the gas collection efficiency of four types of landfills. This was calibrated to measurement data at 28 landfill sites. It is uncertain if the assumptions of gas collection efficiency of comprehensive landfills include emissions resulting from the working face of the landfill. The United Kingdom considers the method to be reasonable since it is calibrated with measurements and is based on realistic assumptions, although it is acknowledged that this is a major source of uncertainty in the trend. The United Kingdom does not collect comprehensive data on landfill gas capture and currently only has data on landfill gas used for electricity generation.

165. The waste generated data in the CRF was described as a low value in the synthesis and assessment report. The United Kingdom identified this as a typing error.

3. Non-key sources

6.B Waste-water treatment

166. The estimates of methane emissions are based on a country-specific method for 1990-1995 and are extrapolated based on population for the years up to 1998. Details of the method are provided in a background document, which is referenced in the NIR. Generally the method appears to follow the Revised 1996 IPCC Guidelines, however complete assessment with compliance to those guidelines was not made because the background document was not reviewed due to lack of time in the review. The extrapolation procedure used for the years after 1995 follows IPCC Good Practice Guidance. Emissions from private waste-water treatment systems are not estimated and this is documented in the NIR and CRF. These are assumed to be insignificant.

167. Nitrous oxide emissions follow the IPCC default methodology and are based on country-specific protein consumption. This method follows the Revised 1996 IPCC Guidelines. The protein content data in the CRF identified as anomalous in the synthesis and assessment report was a typing error and corrected by the United Kingdom.

6.C Waste incineration

168. The methods used for this source follow the IPCC default methodology. The emission factors are provided and referenced as CORINAIR. It is unclear from the NIR that emissions from sewage sludge incineration are included under waste incineration: During the review the United Kingdom confirmed that sewage sludge incineration emissions are included in the estimates. The activity data are based on the same data used for solid waste disposal on land estimates. Clinical and hazardous waste incineration was not estimated; this is not stated in the NIR. The United Kingdom acknowledged a typing error in the NIR for this section: The NIR states that carbon emissions from photosynthesis carbon are estimated whereas actually carbon emissions from fossil carbon are estimated.

4. Possible improvements

169. The NIR does not discuss any specific planned improvements but recognizes the need for improvements of the estimates from landfills due to the high uncertainty. Though the supporting document for the landfill method does recommend areas (such as quantity of waste disposed and amount of gas captured), which require improvement, cost is cited as a significant barrier to improving the estimates. The limited review of the model for estimating emissions from

landfills in the United Kingdom is of concern, since there is significant variability in potential input parameters for the landfill model. The team recommended that the assumptions in the method which underlie the emission trend should be validated in the future.

170. During the in-country review it was learned that the United Kingdom Environment Agency is undertaking a methane measurement programme at operating landfills and it is expected that data from this study will help validate or refine the present estimates.

171. The future inclusion of hazardous waste and clinical waste will be encouraged when data become available from the Environment Agency, though it is recognized as not being a priority item due to the small amount of emissions from this source. The team also recommends that the United Kingdom should investigate the contribution of methane emissions from private waste-water treatment systems to determine if these are significant.

References provided during the country visit:

Industrial processes

United Kingdom Emissions of HFCs, PFCs and SF_6 and Potential Emission Reduction Options, ENVIROS for the Department of Environment Transport and Regions, January 1999.

Agriculture

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Land-use change and forestry

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