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IRELAND

REPORT OF THE INDIVIDUAL REVIEW OF THE GREENHOUSE GAS INVENTORY SUBMITTED IN 2003[1]

(In-country review)

EXECUTIVE SUMMARY

1. This report describes the findings of the technical review of the 2003 inventory submission of Ireland, coordinated by the United Nations Framework Convention on Climate Change (UNFCCC) secretariat in accordance with decision 19/CP.8 of the Conference of the Parties. Ireland submitted its annual inventory on 15 April 2003, consisting of common reporting format tables for the years 1990–2001 and the national inventory report.

2. The review took place from 22 to 27 September 2003 in Dublin, Ireland, and was conducted by the following team of nominated experts from the roster of experts: Generalist – Mr. Art Jaques (Canada), Energy – Mr. Mohammed Soltanieh (Iran), Industrial Processes – Mr. Teemu Oinonen (Finland), Agriculture – Mr. Luis Ruiz Suarez (Mexico), Land-use Change and Forestry – Mr. Rizaldi Boer (Indonesia), Waste – Mr. Anthony Adegbulugbe (Nigeria). Mr. Jaques and Mr. Soltanieh were the lead reviewers of this review. The review was coordinated by Ms. Sevdalina Todorova-Brankova (UNFCCC secretariat).

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

4. In the year 2001, the most important greenhouse gas in Ireland was carbon dioxide (CO_2), contributing 66 per cent of the total[2] national greenhouse gas emissions expressed in CO_2 equivalent, followed by methane (CH_4) with 18 per cent and nitrous oxide (N_2O) with 15 per cent. Together, perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6) contributed about 1 per cent of the overall greenhouse gas emissions in the country. The Energy sector accounted for 65 per cent of the total GHG emissions followed by Agriculture with 27 per cent, Industrial Processes with 6 per cent and Waste with 2 per cent.

5. Total greenhouse gas emissions (excluding Land-use Change and Forestry) amounted to 69,389 Gg CO_2 equivalent and increased by 31.5 per cent from 1990 to 2001. Tables 1 and 2 provide data on emissions by gas and by sector from 1990 to 2001. Over that period CO_2 emissions increased by 46 per cent, mainly because of increased emissions from the Transportation sector and energy industries fuelled by economic growth. Road transportation CO_2 emissions grew 120 per cent while emissions of CO_2 associated with electricity generation increased by 55 per cent. While emissions of CO_2, driven mainly by the demand for energy, showed

[1] In the symbol for this document, 2003 refers to the year in which the inventory was submitted, and not to the year of publication. The number (2) indicates that this is an in-country review report.

[2] In this report, the term total emissions refers to the aggregated national GHG emissions expressed in terms of CO_2 equivalent excluding Land-use Change and Forestry, unless otherwise specified.

tremendous growth over the period 1990–2001 Gross Domestic Product more than doubled over the decade, averaging over 7 per cent/annum growth. This trend, however, clearly illustrates the extent to which total energy consumption, and concomitant emissions of CO_2, have decoupled from economic growth as a result of both changes in the energy intensity of the economy and improvements in energy efficiency. Part of the huge increase in the emissions from road transportation is also an artifact of the accounting methodologies, since it does not account for the fuel transport due to price differences across Parties (see paragraph 30). CH_4 emissions increased during the same period by 6 per cent, mainly because of increasing emissions from agriculture, which accounted for over 95 per cent of the increase; N_2O emissions increased by 9 per cent over the same period owing to increasing emissions from road transportation, primarily as a result of an increase in the number of vehicles with aged three-way catalytic converters, an increase in energy use from energy industries and increased emissions from agriculture. Emissions of HFCs, PFCs and SF_6 were estimated for the period 1995–2001. Emissions from HFCs have increased by 1100 per cent, as would be expected as they are replacing ozone-depleting substances controlled under the Montreal Protocol, while emissions of PFCs increased by almost 400 per cent, primarily from increased use in semiconductor manufacturing. Emissions of SF_6 declined by 20 per cent primarily because of a decline in its use in semiconductor manufacturing.

6. The national inventory submitted by Ireland is generally in conformity with the UNFCCC reporting guidelines and the Intergovernmental Panel on Climate Change (IPCC) methodological guidelines. Ireland's submission for 2003 consisted of a national inventory report and a complete set of common reporting format tables for all years from 1990 to 2001. The production of a national inventory report for the 1990–2000 and 1990–2001 inventory years, coupled with actions aimed at improving data, demonstrates Ireland's commitment to producing an inventory that adheres to the reporting principles of consistency, completeness, transparency, comparability and accuracy. Specifically, with a few exceptions, the national inventory report and common reporting format tables submitted by Ireland covered all major sources and sinks as well as indirect and direct gases identified in the IPCC and UNFCCC guidelines. The exceptions include estimates in the areas of Land-use Change and Forestry and emissions from waste-water handling, which were omitted.

7. As a result of the introduction of a National Climate Change Strategy, an inter-departmental Inventory Data Users Group (IDUG) has been established to assist in the development of improved inventories and projections. This group helped to develop more formal data-gathering procedures and has raised awareness within Ireland of the need for good-quality data upon which to base emissions estimates. In addition, a number of research projects have been undertaken and are planned, including the development of an automated data management system by the Irish Environmental Protection Agency's Centre of Excellence.

8. Ireland underwent a desk review in 2001. A number of significant improvements have resulted since that time. The production of a consistent common reporting format time series for 1990–2001, more extensive use of the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC Guidelines) and the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and a national inventory report structured around the UNFCCC reporting guidelines have all helped to produce a more complete, consistent, transparent and reliable inventory. In addition, as a result of comments provided in previous reviews, the Environmental Protection Agency (EPA), the Inventory Agency[3] for Ireland, has initiated a number of programmes to obtain better data and emissions estimates. The expert review team notes that Ireland has made great strides in the production of the national inventory report, which is relatively transparent in the explanations it gives of methods used, sources of data, institutional arrangements, uncertainties and the identification of key sources. However, there is still room for improvement, particularly in the areas of transparency and documentation of calculation procedures and all elements of the methodologies used. Information sources, assumptions made and reference sources are not always clearly explained, either in the national inventory report or in the explanatory notes within the common reporting format, and the expert review team therefore recommends that additional details be provided within the national inventory report and the annexes describing the methodologies used to develop the inventory. In addition, further efforts should be

[3] The Inventory Agency is responsible for coordinating quality assurance/quality control activities for the national inventory (2000 IPCC good practice guidance).

directed at ensuring the complete and consistent use of the notation keys across tables and between the common reporting format and the national inventory report.

9. Ireland undertook substantial recalculations in preparation for the 1990–2000 common reporting format time series, which are summarized in the 2002 national inventory report. In addition to the recalculations carried out for the 2001 inventory, Ireland anticipates that further recalculations will be required once the results of a number of research projects are completed. These projects include the application of higher-tier methods and more country-specific emission factors.

10. Along with the improvements in the inventories made by Ireland, the expert review team indicated the need for further work in the following areas:

(a) Energy – A more consistent set of energy balance data is now available to support the development of a consistent time series of energy-related emissions estimates; tier 2 methods are used for some large emitters of CO_2, but should be implemented for other gases for key sources, e.g. for transportation sources[4], and in particular N_2O emissions; additional information should be provided on the source and applicability of emission factors derived from the CORINAIR/COPERT models.

(b) Industrial Processes – Ireland reports clinker production data that are inconsistent with international statistics and, since cement production is a key source, the expert review team recommends that Ireland collect better activity data in a consistent way for all years. For lime production, the review revealed extrapolations in activity data not noted in the national inventory report and the expert review team recommends that additional documentation be provided in the national inventory report. For the fluorinated gases (F-gases), the expert review team notes that their inclusion has improved the completeness of the inventory dramatically, commends Ireland for undertaking special studies to inventory and verify the emissions of these gases, and recommends that these activities continue.

(c) Agriculture – Findings indicate that all sources and gases have been included. National statistics and IPCC tier 1 methods with country-specific emission factors have been used wherever possible. The expert review team notes that Ireland uses an appropriate averaging methodology for livestock populations and this explains the apparent inconsistencies between the data in the national inventory report and Food and Agriculture Organization (FAO) data. The expert review team notes that current and planned research projects will help to improve the estimates for this sector and that the inventory would improve with the provision of additional documentation in the national inventory report and the development of a formal archiving procedure.

(d) Land-use Change and Forestry – Findings indicate that emissions of CO_2 have been estimated only for category 5.A and partially for category 5.D (Liming of Agriculture Soils). No estimates have been made for categories 5.B and 5.C. Additional research and a country-specific model and results were presented to the expert review team and will be used to produce updated estimates in the next national inventory report.

(e) Waste – Notation keys are not well used in the common reporting format, e.g. misuse of “not estimated” (“NE”) and “not occurring” (“NO”). The use of recommended rather than actual protein intake indicates that emissions from human solid waste are underestimated. In addition, no estimates of emissions from waste-water handling were made.

11. The expert review team notes the limited resources and capacity available to produce the national inventory, commends Ireland’s initiatives and recommends that the groups concerned continue their efforts to improve the national inventory.

[4] This is already done for road transportation where tier 3 method was used for N_2O emission estimates.

Table 1. Greenhouse gas emissions by gas, 1990–2001

GREENHOUSE GAS EMISSIONS	Gg CO_2 equivalent												Change 1990–2001
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	%
Net CO_2 emissions/removals	31 732	32 473	33 104	32 609	34 001	34 704	35 950	38 282	40 089	42 012	44 112	45 832	44.4
CO_2 emissions (without LUCF)[a]	31 797	32 535	33 113	32 680	34 114	34 759	35 954	38 312	40 250	42 133	44 160	46 460	46.1
CH_4	11 900	12 183	12 344	12 441	12 506	12 595	12 769	12 955	12 970	12 885	12 785	12 563	5.6
N_2O	9 542	9 564	9 647	9 681	9 908	10 050	10 264	10 422	10 652	10 828	10 760	10 401	9.0
HFCs	0	0	0	0	0	21	58	79	104	152	190	231	N/A
PFCs	0	0	0	0	0	75	103	131	62	196	305	297	N/A
SF_6	0	0	0	0	0	83	101	132	91	63	52	67	N/A
Total (with net CO_2 emissions/removals)	**53 173**	**54 220**	**55 095**	**54 731**	**56 414**	**57 528**	**59 245**	**62 000**	**63 967**	**66 136**	**68 204**	**69 389**	**30.5**
Total (without CO_2 from LUCF)	**53 239**	**54 282**	**55 105**	**54 803**	**56 527**	**57 583**	**59 249**	**62 031**	**64 128**	**66 257**	**68 252**	**70 018**	**31.5**

[a] LUCF = Land-use Change and Forestry

Table 2. Greenhouse emissions by sector, 1990–2001

SOURCE/SINK CATEGORY	Gg CO_2 equivalent												Change 1990–2001
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	%
Energy	31 027	31 781	32 361	32 004	33 240	33 974	35 255	37 473	39 527	41 538	43 124	45 348	46.2
Industrial Processes	2 966	2 766	2 777	2 690	2 953	3 032	3 077	3 418	3 319	3 446	4 004	4 050	36.6
Solvent Use	92	92	93	95	96	98	100	103	105	107	109	109	18.6
Agriculture	17 937	18 393	18 587	18 682	18 861	19 053	19 335	19 598	19 956	20 020	19 730	19 170	6.9
LUCF[a]	–66	–62	–9	–72	–113	–55	–4	–31	–161	–122	–47	–629	857.5
Waste	1 217	1 249	1 286	1 332	1 376	1 427	1 481	1 440	1 220	1 147	1 285	1 341	10.2
Other	0	0	0	0	0	0	0	0	0	0	0	0	N/A

[a] LUCF = Land-use Change and Forestry

I. OVERVIEW

A. Inventory submission and other sources of information

12. Ireland submitted a national inventory report (NIR) on 15 April 2003, together with a complete set of common reporting format (CRF) tables for the years 1990–2001. During the review Ireland provided the expert review team (ERT) with various additional information sources, including full access to all the electronic spreadsheets which proved extremely useful and helpful in verifying the methods and data used to develop the emissions estimates. These documents are not part of the inventory submission and are, to some extent, referenced in the NIR. The full list of materials used during the review is provided in annex 1 to this report.

B. Key sources

13. Ireland has reported a key source tier 1 analysis, both level and trend assessment, as part of its 2003 submission, and indicated that there was insufficient information available on uncertainties to conduct a tier 2 key source analysis. The key source analyses performed by Ireland and the secretariat[5] produced somewhat different results because different levels of disaggregation were used. Ireland has used a more disaggregated level based on the levels used in developing the inventory. The results of its tier 1 key source analysis clearly show the impact of carbon dioxide (CO_2) emissions from energy consumption on total emissions in Ireland. These emissions account for 26 out of 41 key sources identified by level assessment in 2001 and for 64 per cent of total emissions. In the trend assessment, they account for 16 out of 27 key sources and for 54 per cent of total emissions. Ireland correctly notes that, while key source categories determined by CO_2 emissions from energy consumption have a major bearing on total emissions in Ireland, the potential for significant reduction in the uncertainties associated with these source categories is limited. The activity data (AD) and CO_2 emission factors (EFs) for the Energy source categories in general are among the most reliable items of input data in the inventory, and there is consequently little scope for improving the accuracy of the emissions estimates. This is also the case for the larger CO_2 key sources under the Industrial Processes sector, such as cement and ammonia production. As a consequence, Ireland notes that, while the number of key source categories requiring special consideration in terms of reducing uncertainty is small, it finds the key source analysis useful on an ongoing basis for identifying areas for further improvement and fully implementing the IPCC good practice guidance, and for developing a quality assurance/quality control (QA/QC) plan.

C. Cross-cutting topics

Completeness

14. Ireland submitted inventory data for the years 1990–2001 in the form of an NIR and CRF tables. The NIR provides a general assessment of completeness and notes a few sources for which estimates of emissions are not included, for instance, in the Land-use Change and Forestry (LUCF) sector, where estimates of emissions and removals are reported only for category 5.A and the liming of soils in category 5.D. Ireland noted to the ERT and in the NIR that it is undertaking major research to develop the necessary input data and country-specific factors that will allow the available IPCC methods to be applied fully in relation to 5.B Forest and Grassland Conversion, 5.C Abandonment of Managed Lands and 5.D CO_2 Emissions and Removals from Soils. In addition, the ERT noted a few other areas for which information was lacking or estimates had not been made. These included estimates of emissions from waste-water handling, which were not available, and estimates of emissions of sulphur hexafluoride

[5] The secretariat had identified, for each individual Party, those source categories which are key sources in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the IPCC good practice guidance. Key sources according to the tier 1 trend assessment were also identified for those Parties providing a full CRF for the year 1990. Where the Party has performed a key source analysis, the key sources presented in this report follow the Party's analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key source assessment conducted by the secretariat.

(SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) for the period 1990–1994, which were not provided in the NIR or the CRF. However, the ERT was informed that emissions for those years and sources were assumed to be negligible. Table 9 of the CRF, Completeness, had not been filled in, and there were inconsistencies between the notation keys in the completeness tables in the NIR and the sectoral tables in the CRF. With these exceptions, the inventory covered all major sources and sinks, as well as all direct and indirect gases, identified in the IPCC and UNFCCC reporting guidelines.

Transparency

15. Overall, the level of transparency of Ireland's greenhouse gas (GHG) inventory is good and has shown significant improvement with the publication of the 2002 and 2003 NIRs. In line with the reporting guidelines, the NIR contains a general description of institutional arrangements, QA/QC procedures, uncertainty assessments, estimation methods, key source analysis, references to key source estimation methods, a summary of trends in emissions by gas, recalculations, and explanations of the differences between the reference and the sectoral approaches. In addition, the methodology, EFs, AD and measurements used in the Irish inventory are described in the report and calculation sheets for each sector and the energy balance sheets for 2001 are included in appendices to the NIR.

16. The ERT notes that one area of particular importance that could be improved is that of documentation, especially with respect to the information that could be added to the NIR that would provide a more complete explanation, for example, for the choice of an EF, data source or model. This will enhance transparency. During the in-country review, the ERT was provided with additional information that enabled it to resolve most issues related to data and methodologies. Generally, the information provided by the Party was detailed enough and comprehensive data and methodologies were included in accompanying reports and additional documents, including supporting reports, correspondence and other information (including the estimation software) supplied to the ERT during the review. The ERT recommends that a formal QA/QC plan and central archiving system be implemented to ensure full transparency.

Recalculations and time-series consistency

17. The ERT noted that recalculations of the time series 1990–2001 have been undertaken to take into account changes that have occurred subsequent to Ireland's 2002 submission. In its previous submission, Ireland carried out a number of recalculations as part of the preparation of the 1990–2000 CRF time series, and the principal changes are summarized in the 2002 NIR. Recalculations were undertaken primarily to reflect updated national energy balances for the years 1990–1993. Some further changes to methods and data were made in the compilation of the 2001 inventory and, in order to maintain a consistent time series, they have been incorporated in the inventories for all previous years. The changes that result in the most recent round of recalculations include the coverage of some additional minor sources of emissions in the Energy and Agriculture sectors, a revised treatment of AD in general for Agriculture, and more in-depth analysis of the contribution of landfills to CH_4 production in the Waste source category. The combined effect of the latest revisions on total emissions for the years 1990–2000 is very small. The change varies between a reduction of just under 1 per cent in 1990 to an increase of 1.75 per cent in 2000 for total emissions. The increases in CO_2 and nitrous oxide (N_2O) emissions due to the additional sources in the Energy and Agriculture sectors are largely offset by the reductions resulting from recalculation of the estimates of CH_4 emissions from waste. The individual changes are:

(a) The addition of first-time estimates of the emissions of CO_2 and methane (CH_4) from natural gas production under subcategory 1.B.2.b Natural Gas;

(b) The inclusion of first-time estimates of emissions from domestic aviation in subcategory 1.A.3.a Civil Aviation;

(c) Revision of the three-year averaging of AD in the Agriculture sector so that the three-year period ends in the inventory year (previously the period was centered on the inventory year);

(d) Accounting for the nitrogen contributions from nitrogen-fixing crops and crop residues in the estimation of direct N_2O emissions from soils;

(e) Revision of $Frac_{LEACH}$, the proportion of input nitrogen leached from agricultural lands applied as part of the determination of indirect N_2O emissions, from 0.04 to 0.1;

(f) Improved estimates of the historical time series of municipal solid waste placed in landfills and of the associated degradable organic carbon (DOC) that result in CH_4 emissions from this source.

18. The ERT notes that these recalculations, many of them undertaken as a result of previous reviews, have improved the national inventory. Sufficient documentation was provided for the ERT to be able to verify the changes.

19. In its NIR, Ireland has noted that there will probably be a need to carry out further recalculations once a number of research projects are completed. This research is designed to facilitate the application of higher-tier methods and more complete country-specific data for some key source categories already covered, such as CH_4 emissions from enteric fermentation and N_2O from agricultural soils, where there remains heavy reliance on tier 1 methods and default EFs, as well as to ensure complete coverage of all relevant sources included in the IPCC Guidelines.

Uncertainties

20. Ireland has used a tier 1 method as outlined in the IPCC good practice guidance to make an assessment of uncertainty in the emissions inventory. A qualitative assessment of uncertainty was provided in table 7 of the CRF. The input values of uncertainty for AD have been assigned largely on the basis of general information and opinions elicited from the principal data suppliers, such as statistical offices, energy agencies, government departments and individuals, as well as the default values included in the IPCC good practice guidance. In the case of country-specific EFs for combustion sources, which relate largely to CO_2, expert judgment has been used to assign the uncertainties for the source categories. The tier 1 analysis results in an overall uncertainty of 11.4 per cent in the 2001 emissions inventory and a trend uncertainty of 5.5 per cent for the period 1990–2001. Ireland has indicated that the overall level and to some extent the trend results are driven by the high uncertainties of the estimates of N_2O from agricultural soils and notes that this highlights the need for more reliable data for this particular source. CO_2 emissions are responsible for two-thirds of overall emissions in Ireland and their overall uncertainty is estimated to be 2 per cent. When the uncertainties from CH_4 emissions are included, the overall uncertainty rises to about 4.5 per cent, even though there are high uncertainties associated with many of the CH_4 EFs. Ireland does not use uncertainties in its key source analyses, nor does it systematically target areas where the uncertainty estimates require improvement. Given that the quantification and use of uncertainties in the key source analysis and the prioritization of improvement efforts are important as a good practice component of the inventory, the inclusion of the basic assumptions and documentation in the NIR on how individual uncertainties were derived would enhance the transparency of the inventory. The ERT notes that Ireland has indicated that it is planning to solicit additional information and documentation from experts in the various sectors to improve the reliability and usefulness of the uncertainty estimates. In the comments to the draft report Ireland further noted the fact that the values of uncertainty assigned to individual AD and EFs need further studies. The ERT recommends that, when implementing a QA/QC plan, Ireland include uncertainty analysis in identifying its key sources.

Verification and quality assurance/quality control approaches

21. As noted in the NIR, Ireland has not yet implemented a formally written verification or QA/QC procedure plan for the national inventory. However, recognizing that the resources Ireland has available

to develop the national inventory are limited, the ERT noted that Ireland's inventory group has nevertheless undertaken a number of steps that would constitute quality assurance and quality control activities described in the IPCC good practice guidance for QA/QC. The emissions estimates for the most important sectors are produced in three computational systems simultaneously. This duplication provides rigorous internal checking of the calculation process and ensures that there is consistency of application regarding units, aggregation and inputs that are common to several source categories, and that estimates supplied to the inventory group are included. By developing estimates independently, checks for gross errors and completeness can be identified. In addition, the formation of an inter-agency data users' group (the Inventory Data Users Group, IDUG) that could form part of a more formal review process is noteworthy. The Centre of Excellence of the Environmental Protection Agency (EPA) has also initiated a project to assess the potential to apply information technology to the processing of national inventory data in order to minimize the handling of data, maximize automatic data processing and the use of currently held data, and automate much of the data QC procedures. This would permit more time to be spent on the development of a national inventory system, formalizing more of the inventory development process. The NIR notes that the establishment of review procedures as outlined in the UNFCCC guidelines is likely to be deferred for a few years. Currently, given the limitations on the resources and time available for developing, the national inventory does not undergo a formal review process. It should also be noted that special studies have been undertaken as checks on emissions estimates (inverse modelling of fluorinated gases (F-gases)) and these types of activity, which help to verify the estimates, should be fostered. The ERT recommends that consideration be given to increasing resources for the development of the national inventory to bring it fully up to the standards required by the UNFCCC and the IPCC good practice guidance. Typically, an inventory team would have several sector specific experts along with resources to fund special studies to improve data, EFs and models, such that the inventory team would have expertise in all areas (energy, industrial processes, agriculture, forestry, and waste). The ERT would also like to note that the IPCC good practice guidance recommends that a person be dedicated to coordinating overall quality assurance and quality control of the inventory.

Institutional arrangements

22. During the in-country visit, Ireland provided information additional to that contained in the NIR on the institutional arrangements for preparation of the inventory. The EPA has overall responsibility for the national inventory, and prepares and submits the NIR and the CRF tables. All inventory data, including background information and support calculations, are stored on servers at the EPA office in Dublin. A number of other agencies and relevant government departments are involved in the development of the inventory, either by providing background data and/or estimates developed through special studies, or by providing models. The estimates of carbon emissions and removals associated with forest biomass are made by COFORD, the National Council for Forest Research and Development. Gas production and distribution companies supply estimates of the gas losses associated with natural gas, and information on waste contained in the EPA's National Waste database is used by the Inventory Agency to estimate emissions from landfills. The Electricity Supply Board (ESB), until recently Ireland's only electricity generator, provides emissions data on a plant-by-plant basis directly to the EPA and these data are used directly in the national inventory. In addition, as a result of the EPA's implementation of a licensing system for Integrated Pollution Control (IPC), GHG data have become available and are used directly in the inventory for combustion and process emission sources in industry. Annual environmental reports are submitted by licensed companies to the Licensing Division within the EPA and, while this has lead to an improvement in the quality and accuracy of the inventory, it has also highlighted the need to implement a QA/QC plan and to formalize the arrangements for archiving of information at a central location maintained by the Inventory Agency as required by the IPCC good practice guidance. The ERT noted that, because some data collected and/or developed on behalf of the Inventory Agency are not always provided to the Inventory Agency, there remains a lack of transparency and quality assurance. The ERT also notes that this also highlights the need to maintain a central archive system documenting all methods, data, assumptions and correspondence.

23. As a result of the National Climate Change Strategy, the IDUG was established to assist in the development of improved inventories and projections. This group has been useful in helping to develop more formal data-gathering procedures and has raised awareness within Ireland of the need for good-quality data upon which to base emissions estimates. In addition, a number of research projects have been undertaken and are planned. The ERT commends Ireland in its efforts to better coordinate the development of data through the formation of the IDUG and notes that the continuation of this group and its activities is crucial to improving the quality of the inventory.

24. In relation to national energy balances, an issue raised by Ireland was the lack of a legal basis within the Department of Communications, Marine and Natural Resources (DCMNR) and its energy analysis group, Sustainable Energy Ireland (SEI), for the collection of energy data other than data on oil. Currently, the Central Statistics Office (CSO) does not require reporting on energy data in physical units and the official energy balances are therefore developed by SEI. As a result, a less than ideal situation exists for developing energy balances because there is, to some extent, a reliance on voluntary reporting. The ERT notes that this has the potential to cause inconsistencies in what is reported and when. It also notes that the implementation of a standardized mandatory energy data collection programme would help to ensure that timely and consistent data are available upon which to base emissions estimates.

Record keeping and archiving

25. While Ireland does not as yet have a formal centralized archiving system, the ERT was provided upon request with information documenting the reasons for choice of methods, AD and EFs. The Inventory Agency at the EPA is responsible for documenting all sources of data and supporting information. Upon request by the ERT, most references and supporting material related to calculations and assumptions were provided by the Inventory Agency. However, the archives of the Inventory Agency did not hold all the information needed for a full assessment of some sources, and this led to a lack of transparency. The ERT notes that additional documentation and explanatory material could be incorporated into the electronic and "paper trail" archives and recommends that a more formal central archiving system be established.

Follow-up to previous reviews

26. Ireland underwent a desk review in 2001. The ERT was hampered at that time by the absence of an NIR and a full time series of CRF tables. In addition, the ERT noted a number of omissions in the CRF tables, specifically recalculation sheets and emissions estimates for HFCs, PFCs and SF_6, and the absence of information on verification procedures. The ERT notes that a number of significant improvements have been undertaken since that time. The production of a consistent CRF time series for 1990–2001, more extensive use of the IPCC good practice guidance and an NIR structured around the UNFCCC reporting guidelines have all helped to produce a more complete, consistent, transparent and reliable inventory. In addition, as a result of comments provided in previous reviews, the EPA has initiated a number of programmes and research efforts to obtain better data and emissions estimates. The ERT notes that Ireland has undertaken many recalculations as a result of previous reviews. Sufficient documentation was provided to enable the ERT to verify the changes.

D. Areas for further improvement

Identified by the Party

27. The NIR identifies several areas for improvement. In its response to the issues raised during the review, Ireland indicates that it is working to improve its estimates in the Energy sector through its IPC licensing system and will be encouraging licensed-plant operators to make available the necessary energy use and production statistics in a consistent manner for inventory purposes. Estimates of HFC, SF_6 and PFC emissions were considered to be quite good for the period 1995–2001, but Ireland notes that additional work by experts will be needed to confirm the most appropriate methods for these gases, in the light of verification studies carried out using an inverse modelling approach to compare top–down

estimates with the current bottom–up method. In addition, Ireland provided the ERT with information on a number of research activities being undertaken within the Agriculture and Forestry sectors to improve the AD, the models, and the emission and removal coefficients. Ireland also plans gradual full implementation of the IPCC good practice guidance.

Identified by the ERT

28. The ERT supports the need for research and improvements to data quality in the areas outlined by the Party. In addition the ERT identifies the following cross-cutting issues for improvement. The Party should:

(a) Provide additional documentation to further improve the transparency of methods used, data and assumptions within the NIR;

(b) Provide more detailed analysis of emission trends, by gas and source/sink category;

(c) Establish a more formal central archiving system;

(d) Create a QA/QC management system;

(e) Implement a formalized data collection system and strengthen the relevant institutional capacity;

(f) Continue to develop higher-tier methods and the collection of national data;

(g) Provide more details of the methods and assumptions used to derive quantified uncertainties;

(h) Implement higher-tier uncertainty quantification methods.

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

II. ENERGY

A. Sector overview

30. The Energy sector is the largest contributor of greenhouse gas emissions in Ireland, accounting for 45,348 Gg CO_2 equivalent emissions in 2001 and thus representing 64.8 per cent of total emissions in the year, up from 58.1 per cent in 1990. The overall increase was driven by the growth in CO_2 emissions from energy use linked to the high rate of economic growth in the country which, measured as the growth in gross domestic product (GDP), more than doubled between 1990 and 2001. During the period 1990–2001, total CO_2 equivalent emissions from Energy increased by 46.2 per cent. By greenhouse gas, CO_2 emissions increased by 46.0 per cent, CH_4 decreased by 28.8 per cent and N_2O increased by 73.6 per cent. The increases were attributable to a 55.1 per cent increase in emissions from Energy industries (1.A.1) and a 124.2 per cent increase in emissions from Transportation (1.A.3). Emissions from transportation are affected by the economic growth as well as by the changes in the fuel prices[6] over the period. Emissions from Manufacturing Industries and Construction (1.A.2) grew more slowly over the 12 years, increasing by 23.3 per cent between 1990 and 2001. Other sectors (1.A.4) grew by only 7.2 per cent. The rate of increase of emissions is lower than the rates of growth of the economy and of energy consumption. The Party explains this with reference to changes in the fuel mix and better generation technologies, leading to a decrease in the energy intensity of the economy in general and in particular in electricity generation. Fugitive emissions from fuels were relatively low and declined by

[6] It is estimated that in 1990, approximately 10 per cent of the road transport fuel consumed in Ireland was purchased abroad, whereas in 2001, of the order of 15 per cent of the fuel sold in Ireland was consumed abroad.

approximately 20 per cent between 1995 and 2001: this is explained by a reduction in natural gas distribution losses.

31. With respect to combustion sources, country-specific EFs were used for CO_2 emissions for all fuels except petroleum coke, and biomass and default EFs (IPCC or CORINAIR) were used for CH_4 and N_2O. For fugitive emissions of CO_2 and CH_4, country-specific EFs were used.

32. Ireland's 2003 inventory report states that national CO_2 EFs for the Energy sector are mostly based on fuel carbon and calorific content, assuming almost complete conversion of carbon to CO_2. This assumption has been used to calculate emissions from both stationary and mobile sources. In keeping with the IPCC good practice guidance, the ERT recommends that Ireland move to higher-tier methods, utilizing country-specific EFs whenever possible, and commends Ireland for the steps already taken in obtaining these data from power plants and applying tier 2 or tier 3 methods for some of the key sources in the sector.

33. The main responsibility for the compilation of energy data in Ireland has recently been given to a newly established national energy agency, SEI, which reports to the DCMNR. Within SEI, the Energy Policy Statistical Support Unit has the role of developing and maintaining comprehensive national and sectoral statistics for energy production, transformation and end use. Additional data were supplied from the Electricity Supply Board and the annual environmental reports from EPA-licensed facilities. With the exception of emissions provided directly from power plants, and a few other discrete sources, emissions estimates are made by the inventory group at the EPA.

34. In relation to national energy balances, one issue raised by Ireland was the lack of a legal basis for the collection of energy data. Implementation of a standardized mandatory energy data collection programme would help to ensure that timely and consistent data are available upon which to base emissions estimates. In addition, the ERT recommends that the energy balance data be provided to the inventory team in both physical and energy units, together with the conversion units used. To help improve transparency, the energy balance should be provided at a more disaggregated level of fuels. A further recommendation regarding the sector in general is the application of cross-verification of the data in the energy balance with the plant-specific data provided in the annual reports for emissions and fuel consumption.

35. Ireland used a tier 1 methodology to analyze key sources according to the IPCC good practice guidance. The results of the analysis for tier 1 level assessment indicate that 26 out of 41 key sources are from the Energy sector. In the trend assessment, the Energy sector accounted for 15 key source categories.

Completeness

36. With a few exceptions, the CRF includes estimates of most gases and sources of emissions from the Energy sector, as recommended by the IPCC Guidelines. Table 1.1 of the NIR indicates full coverage of the gases and sources in the sector. However, table 7 in the CRF shows partial coverage of the CH_4 and N_2O emissions. In one of the tables source category 1.A.5 Other is marked as "not occurring" (NO), while in the other table it is marked as "not estimated" (NE). This source is normally used to report emissions from military fuel use and from the combustion of engine oil and other lubricants. Some (presumably small) emissions should be recorded in this sector instead of being reported as "NO". The "NE" notation key used in table 7 would therefore seem a more correct representation of the situation than "NO".

37. In the Fugitive Emissions subsector, emissions of CO_2 and CH_4 from natural gas distribution are estimated, but emissions from oil and from natural gas exploration, leakage, venting and flaring are reported as "NO". Emissions of N_2O are also not reported.

Transparency

38. Emissions of greenhouse gases from combustion sources have been generally estimated by the IPCC tier 1 methods, although tier 2 methods were used to estimate CO_2 emissions from power plants and domestic aviation (number of landing/take-off cycles and estimated fuel use), and emissions of CH_4 and N_2O from road transportation were estimated using tier 3 methods (COPERT II). However, although the source of the EFs was cited in the NIR, neither their exact values nor documentation on how and why the EFs were chosen were provided in the NIR or to the ERT. The ERT notes that the transparency of the NIR would be enhanced by additional documentation and more details about the assumptions used to derive the technology-dependent EFs and on the choice of the methodology applied.

Recalculations and time-series consistency

39. Ireland undertook a substantial amount of recalculation as part of the preparation of the 1990–2000 CRF time series that was submitted in 2002. The most recent round of recalculations relating to the Energy sector included the addition of first-time estimates of the emissions of CO_2 and CH_4 from natural gas production under subcategory 1.B.2.b Natural Gas and the inclusion of first-time estimates of emissions from domestic aviation in sub-category 1.A.3.a Civil Aviation. However, the impact of the latest recalculations has been an increase of CO_2 equivalent emissions of less than 1 per cent over the entire time series.

Uncertainties

40. An uncertainty assessment for Ireland's 2003 inventory is provided, as required by the UNFCCC reporting guidelines. In general, uncertainty estimates relating to the Energy sector have been calculated using a tier 1 methodology. A qualitative assessment of uncertainty is provided in table 7 of the CRF tables. The input values of uncertainty for AD have been assigned largely on the basis of general information and opinions elicited from the principal data suppliers such as energy agencies. In the case of country-specific EFs for combustion sources, which related largely to CO_2, expert judgment has been used to assign the uncertainties for the source categories.

41. The AD uncertainties for fuel were estimated to be between 1 and 10 per cent, while the uncertainties of the EFs were considered to be in the range of 2.5–10 per cent. Only the peat EF was assumed to have an uncertainty of 20 per cent. However, neither of the uncertainties assigned was documented. Basic assumptions and documentation in the NIR on how these values have been derived would enhance the transparency of the inventory. The ERT recommends that more systematic methods be used to derive uncertainties and that all data and assumptions be documented.

B. Reference and sectoral approaches

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

42. CO_2 emissions from fuel combustion were calculated using the reference approach and the sectoral approach for the 2003 submission. The difference between the reference and the sectoral approach for the year 2001 was less than 2 per cent (1.84 per cent), indicating that inconsistencies in data and calculations from previous submissions have been resolved to some extent. However, the differences for all previous years are above 2 per cent, indicating that there may be a need to revisit the historical estimates. In any case, the ERT recommends that Ireland provide an explanation for these differences in its next NIR. The comparison for the two approaches indicates a close match for liquid and solid fuels and a discrepancy of 12.4 per cent in emissions from gaseous fuels. The difference was attributed to the exclusion from the national approach of 18.9 PJ of natural gas used as feedstock in the manufacture of ammonia (documentation box of table 1.A(c)), while emissions from ammonia production are included in the reference approach. The carbon stored is assumed as zero.

Comparison with international data

43. As stated in previous review activities, there are discrepancies between the International Energy Agency (IEA) data and national data regarding imports, international bunker fuels and certain fuels. For example, data on lubricants, bitumen and other fuels are not reported by Ireland. This issue was brought up earlier in the 2001 desk review report. In its response to the review, Ireland reported that these products (i.e., bitumen, lubricants and refinery feedstocks) are not included in its national energy balance and are not produced in Ireland. The ERT notes that, even if these products are imported, they should still be accounted for in the national energy balance and in the reference approach.

44. Ireland's inventory team noted that they are aware of the various differences between the national energy balance sheets and those published by IEA and Eurostat. A project investigating these differences is currently under way between SEI and Eurostat in order to resolve this issue.

International bunker fuels

45. The differences between the bunker fuels reported by Ireland and the IEA data set need further investigation. The ERT encourages Ireland to check the definitions of bunker fuels used. In addition, there is an issue of completeness related to the reporting of the emissions from marine bunkers: non-CO_2 emissions are not reported in the CRF.

Feedstocks and non-energy use of fuels

46. No information on some fuels (i.e., bitumen, lubricants, white spirit, refinery feedstocks) has been provided in table 1.A(d). It is unclear in the inventory whether these fuels have been used for non-energy purposes but have not been accounted for in the inventory. The IEA data indicate non-energy use of these fuels in Ireland. In the comments to the draft version of this report, Ireland confirmed that these products are not produced in the country. Nevertheless, Ireland agreed that it may be reasonably assumed that these fuels are used in Ireland and the problem therefore lies in the lack of completeness with respect to the energy balance.

C. Key sources

Energy industries: oil, coal, gas – CO_2

47. The previous stages of the review identified that Ireland's CO_2 implied emission factor (IEF) – 80.06 t/TJ in 2001 – for liquid fuels in the Public Electricity and Heat Production subcategory is one of the highest among the reporting Parties, showing an upward trend from 1990 and an overall increase of 7 per cent in the period 1990–2001. In the same way, the trend of the CO_2 IEF in this subcategory for gaseous fuels fluctuates in the period 1990–2001, showing a significant decrease in 1994 (49.7 t/TJ) in comparison with the 1993 value (8.3 per cent) and an overall increase of 6.3 per cent over the period 1990–2001. The 2001 value of the CO_2 IEF is 56.64 t/TJ. The ERT noticed that these two CO_2 IEFs, which correspond to fuel oil and natural gas, respectively, are not completely consistent with values reported in other subsectors. In its response, Ireland stated that CO_2 emissions from all power plants operated by the ESB are estimated on the basis of the quantities of peat, coal, oil and gas used, which are reported annually on a plant-by-plant basis directly by the company to the Inventory Agency. Ireland reports that the IEFs in the CRF reflect the aggregated emissions for the four fuels and the corresponding energy amounts as they appear in the national energy balance sheet. These energy amounts may not correspond exactly to the natural fuel quantities using standard fuel energy content, resulting in fluctuating IEFs. This discrepancy is one aspect of the investigation mentioned above that is being carried out by SEI and Eurostat. The ERT recommends that Ireland ensure consistency between the fuel consumption reported by the power plants and the corresponding energy amounts reported in the energy balance, implement as soon as possible a rigorous verification of and QA/QC procedure for the data used for the inventory in this subcategory, and implement the recommendations of the investigation carried out by SEI and Eurostat.

48. The ERT noticed that GHG emissions from 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries were reported as "NO". However, it became clear that peat briquettes manufactured in the country are used as fuel in other sources. The ERT encourages the Party to include the emissions resulting from the manufacture of peat briquettes in its future submissions.

Manufacturing industries and construction: oil, coal, gas – CO_2, oil – N_2O

49. A number of issues were identified related to this source category and its sub-sources. These include:

(a) CO_2 IEFs for liquid and solid fuels, which were identified as outliers in 1997 and deviate from the rest of the years in the time series; and

(b) Atypical fuel consumption or lack of estimations for liquid, solid and biomass fuels from various sub-sources for the years 1990–2001.

50. Ireland explained that emissions for the category are estimated at the top level using the national energy balance data and other information obtained directly from a small number of large industrial sources. The top–down allocation to subcategories is based on less reliable disaggregation in the energy balance sheets and some additional work by the Inventory Agency. In certain cases, this results in a mismatch between fuel allocations within subcategories, thereby producing IEFs that are out of line with those for the top level. The ERT recommends that Ireland improve the method of fuel consumption and emissions allocation to sub-sources and implement a rigorous consistency check of the time-series AD. The latter could be supported by reporting in the NIR the main assumptions made in order to improve transparency.

Road transportation – N_2O

51. The N_2O IEF for gasoline increased by 417 per cent in the period 1990–2001 (from 1.93 kg/TJ to 9.95 kg/TJ), showing fluctuations from 1999 onwards. In the same way, the N_2O IEF for diesel oil in 2000 (5.50 kg/TJ) is 33.7 per cent higher than the 1999 value (4.11 kg/TJ). Ireland explained that the large amount of fuel sold to vehicles which are used outside Ireland affects the application of the COPERT II model. In addition to this, recent changes in the model itself appear to distort the trend in N_2O IEFs. Ireland is currently investigating the use of COPERT in relation to this matter and the ERT welcomes these efforts.

Other sectors: oil – N_2O

52. The 2001 N_2O IEF for liquid fuels (28.01 kg/TJ) for the Agriculture/Forestry/Fisheries subcategory is 57 per cent higher than the 2000 value and one of the highest among reporting Parties. Ireland has explained this as a result of revising the proportion of gas oil consumption split between stationary and mobile[7] consumption in agriculture in 2001 (i.e., 90:10 in 2001 versus 50:50 beforehand). The ERT recommends the Party to revise the value of the EF and AD used for estimating N_2O emissions for this subcategory and ensure consistency in the time series.

D. Non-key sources

Energy industries: oil, coal, gas and biomass – CH_4, biomass – CO_2 and N_2O

53. CH_4 emissions in 2001 from the Public Electricity and Heat Production subcategory have not been reported and notation keys are not provided. Also, N_2O emissions from biomass are not reported and no notation keys have been provided. During the in-country review, the Irish officials informed the ERT that Ireland will resolve this issue for future inventories. The ERT encourages Ireland to report the

[7] Ireland noted that the N_2O EF for mobile combustion of gas oil is about three times the EF for stationary combustion.

CH_4 and N_2O emissions from this source and to follow the recommendations of the IPCC good practice guidance regarding the use of a tier 2 method for its estimation.

54. The 2001 value of the CO_2 IEF for biomass (54.94 t/TJ) from the Public Electricity and Heat Production subcategory is the lowest among reporting Parties. For the previous years the notation key "NO" for AD and emissions was reported. At the same time, AD and emissions from other fuels are reported as "NO", while for the period 1998–2000 AD and emissions were reported, and the CO_2 IEFs correspond well with the 2001 value of the CO_2 IEF for biomass. In its response to this issue Ireland stated that a small amount of landfill gas was included as a biomass fuel in 2001. The ERT encourages Ireland to ensure consistency and completeness in the reporting of biomass and other fuels in this subcategory.

Manufacturing industries and construction: oil and gas – CH_4

55. CH_4 emissions in 2001 from liquid fuels and gaseous fuels for Iron and steel and liquid fuels for Non-ferrous metals have not been reported and notation keys are not provided. The ERT encourages Ireland to make the necessary efforts to report the CH_4 emissions from these sub-sources following the recommendations of the UNFCCC reporting guidelines.

Civil aviation: CO_2, CH_4 and N_2O

56. AD and emissions from aviation gasoline in 2001 are reported as "NE" (a small amount of aviation gasoline was reported as international bunker fuel). The ERT encourages Ireland to estimate and report GHG emissions from this source following the recommendations of the IPCC good practice guidance and the UNFCCC reporting guidelines.

Fugitive emissions: oil and natural gas – CO_2 and CH_4

57. Estimated emissions for CO_2 and CH_4 for source categories under 1.B.2.a Oil are reported as "NO". Ireland indicates that this is correct because there is no oil industry in Ireland and there are no transport/distribution activities for oil that would produce such emissions. The reason for this is not well documented in the NIR and no explanations are given in the documentation box of table 1.B.2. The ERT encourages the Party to provide the necessary documentation on this issue in future submissions.

58. CO_2 emissions from gas flaring are reported only for the years 1999 and 2001. For all other years in the period 1990–2001, emissions from this source are indicated as "NO". Also, emissions of CH_4 and N_2O are reported as "NO". Ireland explained that fugitive emissions from production/ processing and venting/flaring are those obtained from reports by the company concerned. This is a small operation and is likely to have IEFs that are different from the defaults or the IEFs reported by other Parties. The ERT is of the view that the Party should make the necessary efforts to report in a more consistent and transparent way emissions from this source and document them in the NIR.

E. Areas for further improvement

Identified by the Party

59. In general, Ireland has noted that improvement is required in the collection of AD, uncertainty estimation and quality assurance/quality control. Ireland is working to improve its estimates in the Energy sector through its IPC licensing system and will be encouraging licensed-plant operators to make available the necessary energy-use and production statistics in a consistent manner for inventory purposes.

60. Ireland indicated that it is working to resolve the differences between national energy balance sheets and those published by IEA and Eurostat. A project carried out by SEI and Eurostat is currently under way to investigate the discrepancies.

Identified by the ERT

61. The ERT notes that one area of particular importance related to the Energy sector is documentation. It recommends that additional details such as information sources, methodologies, assumptions made and rationale for choices of data and EFs be provided within the NIR and the annexes to ensure full transparency and permit reconstruction of the estimates.

62. Ireland is further encouraged to verify and document the trends in some subcategories that indicate increases higher than the common trends in the other Annex I Parties (e.g., civil aviation).

63. Ireland is also encouraged to try to use lower disaggregation of fuels and improve the subsectoral allocation for estimating and reporting emissions from the Energy sector. This will allow consistent allocation of the fuels and a more consistent and informative IEF over the years.

64. Ireland will also benefit for further consideration of the energy balance so that it is as compatible as possible with the needs of both the sectoral and reference approaches. The consistency with the data submitted to IEA and Eurostat should be ensured, as well as the appropriate treatment of non-energy use of feedstocks.

III. INDUSTRIAL PROCESSES AND SOLVENT USE

A. Sector overview

65. Industrial Processes contributed 5 per cent of Irish GHG emissions (4,050 Gg CO_2 equivalent) in 2001. CO_2 is emitted from cement, lime and ammonia production. All N_2O in the Industrial Processes sector originate from the production of nitric acid. Emissions of HFCs, PFCs and SF_6 (F-gases) are related to the consumption of these gases.

66. The two largest sources, cement and ammonia production, contribute two-thirds of the current emissions in the sector. These sources are also key sources based on the level assessment. The levels of N_2O and F-gas emissions were equal: both contribute nearly 15 per cent of Industrial Processes emissions. These sources were also key sources based on the trend assessment. Emissions of F-gases have risen sharply, whereas N_2O emissions have nearly halved from the 1990 level. Overall, emissions from Industrial Processes have increased by about 36.6 per cent over the period 1990–2001, most of the increase being due to an increase in cement production.

Completeness

67. Ireland has carried out two studies to support the development of estimates for emissions of F-gases. The first of these studies used a bottom–up approach: data on gas usage were gathered directly from the relevant companies and emissions were calculated from these data using EFs. The second study was carried out to verify these estimates. It was based on atmospheric measurements of F-gases and an inverse modelling approach. The preparation of an inventory of emissions of F-gases was one of the recommendations made in the 2001 desk review report. The Party has thus demonstrated considerable improvement with respect to completeness. It should be noted, though, that Ireland reports several sources within the sector as "NE". These include CO_2 emissions from steel production, limestone and dolomite use, soda ash production and use, asphalt roofing and road paving with asphalt. Ireland may wish to assess the relevance of these emission sources in its inventory and to document its results in the NIR and the CRF in line with the UNFCCC guidelines.

Transparency

68. The transparency of reporting has also been improved with the preparation of an NIR. Together with the CRF tables and additional reports on the recent F-gases inventory it facilitated the review of the Industrial Processes sector. However, the methodological descriptions included in the NIR are not sufficiently detailed and do not include a description of all the assumptions made in preparing the

emissions estimates. For example, the lack of detail hides the fact that cement clinker production data for 2001 were estimated on the basis of fuel use data, which is not consistent with good practice. The ERT recommends that Ireland document all the assumptions it has made in calculating emission estimates for the Industrial Processes sector. Moreover, to improve transparency, the ERT recommends that the Party also document the reasons why it has not implemented the IPCC good practice guidance for a particular key source.

Recalculations and time-series consistency

69. None of the source categories of Industrial Processes have been recalculated in the 2003 submission.

70. It was revealed during the discussions with the national inventory experts that the method of producing AD had varied from year to year. For instance, AD for cement production had been estimated on the basis of fuel use, as mentioned above, but the AD for 1990 had been obtained by means of correspondence with the company. Ireland could not explain why the AD calculated from fuel use differed from the international statistics available for the source.

Uncertainties

71. The review indicates that in many places the Party may be underestimating AD uncertainty. For instance, the NIR states that the uncertainty of clinker production AD is 1 per cent. The discussion in paragraph 69 suggests that this is probably an underestimate.

B. Key sources

Cement production – CO_2

72. Ireland reports clinker production data that are inconsistent with the international statistics (reported figures for clinker production are higher than the figures for cement production). Comparison of the cement production data for Ireland (US Geological Survey) with the clinker production data reported by the Party shows that the figures for clinker production were 5–10 per cent lower than those for cement production in seven out of the 11 years for which data were available. Three out of 11 years showed clinker production data 4–20 per cent higher than cement production data, and in one year the two were the same. The NIR describes the difficulties associated with obtaining data on clinker production.

73. With respect to the base year AD, Ireland provided correspondence dating back to 1990. The correspondence did not explain the reported value of 1.5 Mt of clinker produced. Rather, it cited a value of 1.8 Mt, but it was not clear whether this figure was for clinker or for cement production. Ireland explained that at that time data were obtained in an informal way from another department of the body which was the predecessor of the EPA. Further scrutiny of the AD by the ERT indicated that the 2001 clinker AD had been calculated from fuel use data. Difficulties are stated to arise due to confidentiality of business information resulting from small number of cement producing companies in Ireland.

74. The ERT recommends that Ireland obtain reliable clinker production data and calculate emissions according to the IPCC good practice guidance in a consistent way for the entire time series. It also recommends that Ireland document the method of data gathering as well as the calculations transparently in the NIR. Ireland also needs to revise the current uncertainty estimate for the source.

Ammonia production – CO_2

75. Ireland calculates emissions from ammonia production on the basis of natural gas feedstock consumption data. The consumption of natural gas is obtained from the national energy balance. Ireland states that ammonia production has been the only feedstock use of natural gas. It assumes that all carbon in natural gas is emitted during production by using an EF for combustion. This EF for natural gas

combustion is specific to Ireland. The ERT notes that this methodology seems to be broadly consistent with the IPCC Guidelines.

Nitric acid production – N_2O

76. Ireland reported 2.62 Gg of N_2O emissions for the period 1991–2000, whereas in 1990 they were 3.34 Gg and in 2001 they were 1.89 Gg. Ireland explained that these emission reductions were due to changes in plant technology and eventually the closing-down of production, starting in 2000. The plant stopped production in 2001. The estimates were based on data delivered by the industry in 1996 (estimates for 1990 and 1991–2000) and 2002 (estimate for 2001). The Party provided original correspondence between the company and the Inventory Agency, which enabled replication of the calculations for 1990 and 1991–2000 by the ERT. The 2002 correspondence was not detailed enough to enable replication. The result calculated by the ERT for 1990 was 99 per cent of that calculated originally by the company and reported by the Party, and 100 per cent for 1991–2000. The correspondence was not referenced in the NIR, however, nor were the assumptions documented.

77. To increase transparency, the ERT recommends that the Party document these assumptions in its NIR and cite the correspondence with the company.

Refrigeration and air conditioning – HFCs

78. Ireland has prepared its first inventory of HFCs, PFCs and SF_6. It has thus implemented a recommendation made in the 2001 desk review report. The inventories for 1995–2001 are based on a study that produced estimates for 1998 (O'Doherty and McCulloch, 2003 and O'Leary et al, 2003). It has been necessary therefore to extend the 1998 figures to other years using further assumptions. Some additional data was also gathered to enable the extension. The Party also reported difficulties in obtaining enough information to produce a reliable split of the total HFC figures into individual HFC compounds. This is clearly reflected in the time-series data for individual compounds for the source.

79. The ERT notes the progress made and recommends that the Party prepare inventories of HFCs, PFCs and SF_6 in the future as well. The ERT further recommends that the Party may wish to try to improve the estimates by obtaining more reliable data on gas usage and factors leading to emissions.

Semiconductor manufacturing – PFCs

80. Ireland has two semiconductor manufacturing facilities that emit PFCs. Data are obtained from these companies by means of an annual environment report and direct correspondence. Ireland provided a copy of the annual environment report that each company needs to prepare to comply with its annual reporting obligations under Ireland's IPC licensing regulation. Documents containing correspondence with these companies were also available for inspection by the ERT. These documents explained how emissions had been calculated but did not provide sufficient data to permit the emissions estimates to be replicated. In the case of the larger company, this was due to information being confidential. The details are available, however, for the licensing inspectors of the EPA at the company's production site. It should be noted that the licensing inspectors are not the same people as those who prepare the inventory of GHG emissions. The Inventory Agency thus does not have access to the confidential data that would make it possible to check the information reported by the company.

81. The ERT recommends that Ireland, as part of its QA/QC plan, make arrangements with the companies so that all relevant information related to the inventory can be kept in a single location, and that this information be made available for future reviews in accordance with the IPCC good practice guidance.

C. Non-key sources

Lime production – CO_2

82. Inspection of Ireland's calculations of AD for the source showed assumptions that are not documented in the NIR. For two out of three companies data were not available for the years 1991–1998. Instead linear growth of activity matching 1990 and 1999 activity levels was assumed. To increase the transparency of reporting, the ERT recommends that Ireland document these assumptions in its future NIRs.

Iron and steel industry – CO_2

83. Ireland did not estimate emissions of CO_2 from steel production. Ireland indicated that it would investigate what the nature of production is at the plant level and include emissions estimates in future inventories should it be necessary. The ERT recommends that Ireland report the results of this investigation in its NIR.

Electrical equipment – SF_6

84. The SF_6 emissions data showed large annual variations ranging from –30 to +300 per cent. In particular, the estimate for 2000 was considerably lower than estimates for other years. Ireland provided the original calculations prepared by the company that owns all the equipment in Ireland that contains SF_6, for inspection. Analysis of these data showed that emissions had been assumed to equal the quantities of SF_6 used in maintenance. Emissions in 2000 were therefore considerably lower compared to other years because there was much less maintenance during that year. According to the correspondence accompanying the calculations, the company that prepared these estimates was of the view that the annual estimates did not give a good indication of the level of emissions and that the average over a period of years would therefore be a better indicator of annual emissions.

85. The ERT recommends that Ireland document in the NIR the assumptions made in estimating emissions from electrical equipment. Moreover, it is recommended that the trend be explained in the NIR.

D. Areas for further improvement

Identified by the Party

86. Ireland recognized the need to obtain better AD from industry and explained that this might be possible as companies are making preparations for emissions trading within the European Union (EU). In addition to the more active involvement of key industrial players, Ireland identified the need to implement QA/QC activities, as well as the tier 2 method for calculating emissions from cement production.

Identified by the ERT

87. The ERT further emphasizes the need for more reliable AD and a consistent methodology with respect to cement production and consumption of F-gases, as well as more transparent documentation with respect to all industrial emission sources.

IV. AGRICULTURE

A. Sector overview

88. Emissions from the sector were 19,170 Gg CO_2 equivalent in 2001, accounting for 27.4 per cent of total emissions, whereas in 1990 they represented 33.7 per cent of the total. Overall, emissions have increased by 6.9 per cent. However, the contribution of the sector to total emissions decreased, primarily as a result of the growth in emissions from other sectors. In the national key source analysis four out of

11 key sources in the 2001 assessment belong to this sector (CH_4 from enteric fermentation, N_2O from agricultural soils, CH_4 from manure management and N_2O from manure management) whereas in 1990 three out of 11 key sources belonged to the Agriculture sector (N_2O from manure management was not included at that time as a key source).

Completeness

89. The CRF includes estimates of most gases and sources of emissions from the Agriculture sector, as identified by the IPCC Guidelines. Not included are: CH_4 emissions from manure management from non-cattle livestock species, and N_2O emissions from organic soils. These are discussed below in this section.

Transparency

90. Livestock population characterization is consistent within the different emission categories. An outstanding issue from previous reviews was the comparison with international data for several categories. For some sources, livestock population data from the Food and Agriculture Organization (FAO) Web site differed significantly from the data used to develop the national inventory. The detailed investigation of this issue during the review indicated that the differences between the population data in the NIR and the FAO data can be explained as follows:

(a) The Irish CSO releases statistics of livestock populations twice a year, in June and December. This is an official publication and is available to the public through the Web home page of the CSO (http://www.cso.ie). The ERT found that the FAO's figures for a given year are identical to the CSO's figures for December of the previous year.

(b) It is good practice to consider seasonal variations of animal population if they are significant, as is the case in Ireland. The Irish inventory uses an arithmetic mean of the data released in June and December; and

(c) Ireland has developed a three-year average as suggested by the IPCC Guidelines.

91. These three facts explain the issue identified in previous reviews that affects all emission categories that depend on livestock population, namely key sources such as enteric fermentation from dairy and non-dairy cattle, and sheep, animal production, and manure management of non-dairy and dairy cattle. As a result, the ERT finds no inconsistencies between the CSO and FAO data, and notes that the seasonal and three-year averages used by Ireland are consistent with good practice. However, the ERT recommends that the NIR should contain an annex with raw data (June and December) for the time series and an explanation of the way in which AD are compiled to improve transparency and make it possible to reproduce the livestock population data used in the inventory.

92. With these exceptions, the methods and data sources for the Agriculture sector were transparent.

Recalculations and time-series consistency

93. The Irish Inventory Agency also explained that it had recently changed the inventory annual average period for all emission categories. Before, the inventory year was at the centre of the average period. Now the inventory year is the last one of the average period. This change was justified on the grounds of availability of data. This change is reflected in the agency's recalculations since the base year.

Uncertainties

94. Ireland has used a tier 1 method and default values as outlined in the IPCC good practice guidance to make an assessment of uncertainty in the emissions inventory in Agriculture sector. A qualitative assessment of uncertainty was provided in table 7 of the CRF. Ireland has indicated the high uncertainties of the estimates of N_2O from agricultural soils and notes that this highlights the need for

more reliable data for this particular source. The ERT notes that Ireland has indicated that it is planning to solicit additional information and documentation from experts in order to improve the reliability and usefulness of the uncertainty estimates.

B. Key sources

Enteric fermentation – CH_4

95. Emissions of CH_4 from enteric fermentation were 461 Gg CO_2 equivalent in 2001, being the largest contributor in the sector (13.8 per cent of the national total). The largest subcategory is other cattle, which includes beef cattle and calves, with 8.5 per cent of the national totals, followed by dairy cattle with 3.6 per cent and sheep with 1.5 per cent. In 1990 enteric fermentation was ranked as the third-largest key source and in 2001 as the fourth.

96. Statistical data on the cattle population are produced twice a year by the Agriculture Division of the CSO with enough detail to support a tier 2 population characterization as recommended by the IPCC good practice guidance for key sources. However, for this category Ireland uses a tier 1 calculation, applying country-specific EFs for dairy and non-dairy cattle. Irish inventory team and local experts explained how those country-specific EFs were estimated. This was done well before the IPCC good practice guidance was released and no proper record was kept of those proceedings. In addition, a peer review of the country-specific value of 50 kg CH_4/head/year (Lovett and O'Mara, 2002) shows that it leads to an underestimation by about 10 per cent of emissions from this source category.

97. For this reason, the ERT recommends that Ireland move to a tier 2 calculation as soon as possible, as suggested by the IPCC good practice guidance for key sources. The ERT also notes that the Irish inventory team and local experts explained that research currently under way will soon produce country-specific parameters to estimate country-specific EFs and will allow application of a tier 3 method for the calculation of cattle emissions. The ERT was given access to advance reports and abstracts of related scientific meetings. These studies have undergone different peer reviews[8] and could be considered in line with the QC procedures indicated by the IPCC good practice guidance. The progress demonstrated with research in this area leads the ERT to consider that the issues of using a tier 1 approach for such an important key source and a country-specific EF with poor support documentation will be resolved in future inventory submissions.

Direct emissions from soils – N_2O

98. Direct emissions of N_2O from agricultural soils were the second-largest key source subcategory of the Agriculture sector in 2001, with 4.2 per cent of total national emissions.

99. In relation to this source, it has been pointed out in previous reviews that Ireland reports zero emissions from organic soils. The reason given in the 2003 NIR is that little tillage farming occurs on areas where organic soils are dominant within the country. This statement could be supported by including in the NIR a large-scale map of soil categories for the country and supporting tables of cropped areas or crop production by region. In addition, it would be useful if Ireland illustrated the nitrogen balance, as nitrogen flows through different paths, representing losses to the atmosphere as N_2O and ammonia and through leaching. The efforts the Party has made to maintain consistency as between inputs to different media, such as air and water, and under its different commitments to different international bodies, such as EMEP and OSPAR, are to be praised. However, it should be noted that efforts to ensure transparency must be maintained.

[8] At least three Masters theses have been reported to be submitted for graduation based on the studies; results have been submitted to peer-reviewed journals, and copies of peer-reviewed papers at the proof reading stage were provided, two of the research projects have been submitted for mid-term external peer review.

100. With regard to GHG inventories – the object of this review – supporting tables F.9 and F.10 of the NIR are not totally transparent to an outsider who is not familiar with the ammonia emissions inventory procedures and formats used (CORINAIR). The linkages between the ammonia emissions inventory and the assumptions used are important as ammonia lost to the atmosphere reduces the nitrogen available to be emitted as N_2O and will therefore influence the way in which estimates of N_2O are derived. The ERT recommends that the assumptions used in developing both the ammonia and the N_2O emissions estimates be clearly documented and reported in the NIR.

Animal production – N_2O

101. Animal production was responsible for 4.2 per cent of total emissions (excluding LUCF) in 2001. The main issue in regard to this key source is that the nitrogen excretion rates used in the inventory for all animal categories, with the exception of poultry, are lower than the default IPCC values.

102. The use of the country-specific excretion rate factors of 92.5 and 50 kg N/head/year for dairy and non-dairy cattle, respectively, were justified on the basis of a technical report containing information derived from a literature survey and the results of an animal performance model applied to national circumstances (Mulligan and O'Mara, 2002). This work shows that current values for dairy cattle (92.5 kg N/head/year) are in the lower part of the range found in the literature. The Irish value for non-dairy cattle (50 kg N/head/year) is better placed in the range of values found. Experimental work on nitrogen excretion rates from pigs is under way and the ERT was given access to progress reports. This research project also includes a study of nitrogen excretion rates from cattle, to be started later. The upcoming work will provide experimental values to replace current country-specific values for cattle. The research is subject to QC procedures, for example, one MSc thesis was presented to a scientific meeting.

C. Non-key sources

Indirect emissions – N_2O

103. An outstanding issue from previous reviews was that a value of nitrogen lost through leaching (4 per cent) that was based on one national peer-reviewed paper was used for all inventories prior to 2002. In the 2003 submission it has been replaced with a value of 10 per cent loss consistently for the whole time series. However, the IPCC value is 30 per cent.

104. The same comments as are made above for direct emissions from soils apply to the nitrogen lost by leaching: it affects indirect emissions of N_2O. In this case, Ireland's commitment to the OSPAR Convention has triggered work relating to nitrogen inputs to Irish rivers and eventually to the North Atlantic Sea. To be consistent across its commitments to different international agreements and bodies, Ireland has used this last country-specific value. After reviewing the original source of information (NEUT 1999), the ERT identified a possible error in this value: it could be 20 per cent instead of 10 per cent. In response to the draft version of this report, Ireland has re-examined the reference report cited in the NIR and has confirmed that the estimate of nitrogen load to rivers and estuaries from agriculture therein equates to approximately 10 per cent of the total nitrogen applied in animal wastes and synthetic fertilizers. This report also indicates that the nitrogen leached can be determined as 20 per cent of the organic inputs, which is compatible with the above as organic nitrogen and fertilizer nitrogen loads are approximately equal in Ireland. The ERT notes that transparency would be improved if documentation were contained in the annex to this chapter in the NIR.

Manure management from non-cattle livestock – CH_4

105. Emissions from manure management from non-cattle livestock, excluding swine and poultry, are zero. In response to comments from previous reviews, Ireland explained that manure from these livestock species is not managed but remains on the ground, and it is therefore assumed that no CH_4 is generated this way.

106. The default EFs for cool climate and dry systems used for sheep, horses and mules are 0.19, 1.39 and 0.76 kg CH_4/head/year, respectively (table 4-4, Workbook, table B-7 Reference Manual, IPCC Guidelines). Footnotes to these tables state that these values are for dry management systems. Pastures and ranges are considered among these, together with piling up and the use of dry lots (Reference Manual, IPCC Guidelines, p. 4.10). Ireland suggested that in its view virtually no CH_4 will be produced from manure dropped in pastures from these animal species. The IPCC Guidelines (Reference Manual, IPCC Guidelines, p. 4.9) acknowledge this fact and propose a CH_4 conversion factor (MCF) of 1 per cent from which the above EFs are derived.

107. The issue is whether or not the 1 per cent MFC is a realistic value to use. In that sense, although the ERT agrees with Ireland that pastures and ranges should not have the same MCF as piling up and the use of dry lots, current IPCC Guidelines do state a non-zero EF for these subcategories. Therefore, for completeness and comparability between Parties, the ERT recommends that Ireland re-examine the IPCC Guidelines and apply them where appropriate.

D. Areas for further improvement

Identified by the Party

108. Research is being carried out into several key sources within the Agriculture sector that will enable obtaining appropriate country-specific factors. In addition, this research will enable Ireland to move to a higher-tier calculation in enteric fermentation from cattle and manure management from cattle and swine.

Identified by the ERT

109. A cross-cutting issue that was identified is the need to improve the documentation of raw data and of calculations or procedures that lead to the use of key parameters in calculations (i.e., 10 per cent nitrogen loss through leaching).

V. LAND-USE CHANGE AND FORESTRY

A. Sector overview

110. In its 2003 NIR, Ireland provides estimates of CO_2 removals and emissions from 5.A Change in forest and other woody biomass stocks, and of CO_2 emissions from Liming of agricultural soils (5.D). CO_2 emissions from commercial harvest have increased steadily, from 1,181 Gg in 1990 to 2,038 Gg in 2001, with an average annual growth rate of about 4.4 per cent. Similarly, CO_2 removals from commercial harvest have also increased, from 1,631 Gg in 1990 to 3,045 Gg in 2001, with an annual growth rate of 4.8 per cent. Net CO_2 removals from managed forest (temperate forest) in the period 1990–2000 were thus between 318 and 574 Gg, while in 2001 they increased sharply to 1,007 Gg. Furthermore, CO_2 emissions from liming of agriculture soils in the same period were between 294 and 467 Gg. Thus net CO_2 removals from LUCF were between 4 and 629 Gg. In the period 1990–2000, net removals from LUCF were between 4 and 161 Gg and in 2001 they amounted to 629 Gg. This was equivalent to about 0.9 per cent of total CO_2 equivalent emissions of other sectors.

Completeness

111. Estimates of emissions and removals have not been made for categories 5.B Forest and grassland conversion or 5.C Abandonment of managed lands, and have only been partially made for 5.D CO_2 emissions and removals from soil. The CRF only includes estimates of emissions and removals of CO_2. The other gases were not estimated. In the CRF, Ireland has used notation keys that indicate that a number of sources and sinks are "NE", while other cells contain values of zero. (The value zero means that the estimation was made but the result was less than 0.5.) Ireland has explained to the ERT that the zero values were used since emission or removals from those sources or sinks were expected to be negligible. Ireland agreed to use "NE" instead and provide the explanation in table 9s1 of the CRF as

necessary. In addition, the use of notation keys in the CRF tables was also not consistent with their use in the 2003 NIR. The Party is aware of this inconsistency, and the correction will be made in later submissions.

Transparency

112. Ireland has provided enough information as well as sources of data used in developing the inventory. The approach used in the estimation of carbon removals from managed forest and emissions from commercial harvest is discussed in detail in appendix G of the NIR.

Recalculations and time-series consistency

113. In 2003, a recalculation has been made for estimating CO_2 emissions from liming of agricultural soils (5.D), and the differences between the emissions estimates of the previous (2002) and the 2003 submissions ranged from –21 per cent to 17 per cent. The difference is mainly due to the different method of averaging the AD. In the previous submission the amount of limestone used in inventory year *i* (L_i) was $L_i = (L_{i-1}+L_i+L_{i+1})/3$, while in the 2003 submission it was $L_i = (L_{i-2}+L_{i-1}+L_i)/3$. This change only shifted the position of the emissions, that is, the emissions in year *i* in the previous submission became the emissions in year *(i+1)* in the 2003 submission.

114. In response to the recommendation in the 2001 desk review report, Ireland made a major revision in the methodology used to estimate the annual increase in forest carbon stocks, from tier 1 to tier 2 (country-specific methodology). Emissions from commercial wood harvest have also been included. The estimates of net CO_2 removals have decreased greatly after the inclusion of the emissions from commercial wood harvesting. This recalculation was reported in the 2002 NIR. In the 2003 NIR, it is mentioned that forestry experts in COFORD have produced substantially revised estimates of the level of carbon uptake in Irish forests using a range of new data and a much-improved tier 2 methodology, but the 2003 NIR did not provide new estimates of carbon removals and emissions using this methodology. However, during the review the ERT was shown the results of the new estimates. The main change was the use of a different biomass expansion factor (BEF) for young and mature trees. In the 2003 NIR, the same BEF was used for all species for both young and mature trees. It was mentioned that in the following submissions there would be major recalculations.

115. On the basis of a trend analysis in both the CRF and the 2003 NIR, it was found that there was a significant increase in net carbon removals from 5.A Changes in Forest and Other Woody Biomass Stock. In the period 1990–2000, the net CO_2 removal ranged from 318 to 574 Gg, while in 2001 it increased significantly, to 1007 Gg. During the review, Ireland stated that the increase was due to the high increase in the number of trees moved from the "young" classification to "mature". However, Ireland may need to check the consistency of its AD and the rationality of the assumptions used in the calculation.

Uncertainties

116. Table 7 of the CRF provides qualitative uncertainty of the estimates. In the 2003 NIR, the quantitative estimates of the certainty were not provided for LUCF. For module 5.A, the quality of the estimates was considered as medium. The report did not provide any explanation as to how the level of certainty was defined as high, medium, or low.

117. On the basis of information given in appendix G of the 2003 NIR and during the review process, it was indicated that at least six factors may affect the certainty of the estimates. They include:

(a) The biomass expansion factor (BEF);

(b) The way the area weighting was performed;

(c) The age definitions of unclassified, young and mature trees;

(d) The inclusion of unclassified trees (age of less than seven years) in the calculation. (In the NIR 2003, the carbon uptake from this forest was ignored even though it accounts for about 30 per cent of total forest plantation area.);

(e) The use of arbitrary values to define the percentage of young trees moved each year to the "mature" category and the area of private forest moved each year from the "mature" to the "cleared" category;

(f) The correction factor for reducing standing volume (15 per cent) to allow for roads and rides.

118. During the review, Ireland illustrated the impact of using the new BEF on the estimates. Using the new BEF, the estimates would change in the magnitude of about 50 per cent. It is strongly recommended that Ireland should also evaluate the sensitivity of the estimates to changes in other factors following the IPCC good practice guidance (e.g., the Monte Carlo Simulation).

Verification and quality assurance/quality control approaches

119. In the 2003 NIR, Ireland notes that it has formed a technical unit called the Forest Climate Change Team which will oversee the development of the national method and the data needed for the inventory. Ireland provided the ERT with the Terms of Reference of the team. In addition, the Irish Forestry Act 1946 obliges the tree felling licence holders to replant forestland. This act ensures that any clear-felling will be followed by tree planting.

B. Sink and source categories

120. Ireland has only provided estimates of CO_2 removals and CO_2 emissions from 5.A and CO_2 Emissions from Soils (5.D). The method used for the estimation of carbon uptake is based on the changes of carbon stock between two inventory years. The Party also used country-specific EFs such as BEF, wood density and carbon content. For 5.D, the Party used the IPCC default method.

121. Ireland indicates that it is waiting for the findings of ongoing research for the estimation of CO_2 emissions and removals from 5.B, and 5.C, as well as for non-CO_2 emissions. During the review, Ireland provided the ERT with documents showing the progress of that research (see annex 1).

Changes in forest and other woody biomass stock

122. Ireland has provided a list of AD sources in the references in the NIR. All public and private forest areas by species from 1990 to 2000 were estimated on the basis of 1995 satellite imagery and orthophotography data and a survey under the FIPS (the Forest Service's Forest Inventory and Planning System; Fogarty et al. 1999), afforestation and reforestation data from the Forest Service (2000) and the Ministry Report (1980–1988), and wood harvest from Coillte Teoranta (a state owned company that owns about 70 per cent of the national forest estate). Wood volume was determined from the Forestry Commission and Irish Yield Models referenced in the NIR. Wood harvest data provided by Coillte (2001) were compiled using the company's timber sales reporting system. However, the data were not complete, and the wood production forecast model developed by Gallagher and O'Carroll (2000) was therefore used to develop wood production data series for 1992–2001. All data used are publicly available[9]. Standing wood volume was converted to standing carbon stock using BEFs, wood dry density (WD), and carbon content of biomass (CC) data. The last two types of data were reasonably well defined and the source of reference was provided in the NIR. For WD, the values used ranged from 0.35 to 0.55 with mean of 0.48, while the CC ranged from 0.40 to 0.45 with mean of 0.43. These data were mostly in the range of the IPCC default values. For the BEF, the Party used a conservative value, (1.3 Stemwood volume to total tree biomass) for all tree species for both growing trees and harvested timber. During the

[9] The *Forestry Statistics of Ireland* can be downloaded from http://marine.gov.ie/files/Forestry.xls, and http://marine.gov.ie/files/standard.xls. See also Gallagher et al., http://marine.gov.ie/files/Iufrop.doc.

review, the Party provided the ERT with new BEF data. The standing biomass (including root) used by the Party for broadleaf temperate forest ranged between 73 and 127 t dm/ha, that for coniferous forest ranged between 48 and 62 t dm/ha, and that for mixed forest was 70 t dm/ha. In the IPCC Guidelines, the default values for the corresponding forests are between 175 and 250 t dm/ha, between 220 and 295 t dm/ha, and between 40 and 87 t dm/ha, respectively. These lower values were estimated based on Coillte average weighted yield class, and these are more relevant to conditions in Ireland than the IPCC default values.

123. Since the 2003 submission, COFORD has updated the 5.A. results for all years by revising BEF. The Party intended to report the updated results in 2004 NIR.

Forest and grassland conversion

124. In the case of forest and grassland conversion (5.B), the Party has indicated to the ERT that deforestation at a rate of about 80–100 ha per year occurred in the country, and these data might be collected by Forest Service, Department of Marine and Natural Resources. The published annual statistics provided by Ireland during the review also showed that the area of grassland has reduced consistently from year to year. In 1990, the total grassland area was 4,240,300 ha, while in 2001 it was only 3,635,000 ha. Thus there was a reduction of about 50,000 ha per year. The reduction may be due to conversion to other uses. As the necessary data are available, it is strongly recommended that for future submissions emissions from forest and grassland conversion be included.

CO_2 emissions and removal from soils

125. In the 2003 NIR, Ireland has not provided a reference to the source of data on the use of lime on agricultural soils. During the review, the Party provided the ERT with the source of the data. The data on the Fertilizer Association Web site were only available up to 1998. Data for 1999–2001 were obtained directly from the TEAGASC (Irish Agriculture and Food Technology Department).

C. Areas for further improvement

Identified by the Party

126. Ireland has provided the ERT with COFORD's *Annual Report 2002* showing that there are many research activities related to the improvement of AD and EFs, in particular for 5.A. In addition, during the in-country review, Ireland also provided a note indicating that research on the estimation of carbon fluxes to and from the atmosphere for a variety of land use categories relevant to Ireland is now under way. A number of documents related to these research activities were provided to the ERT. The Party stated that a major recalculation might be done in the coming years as new data and information become available.

Identified by the ERT

127. Considering the progress made on data availability, Ireland may be able to perform uncertainty analysis in a quantitative manner rather than a qualitative manner (e.g., using the Monte Carlo technique).

128. In its next submission, Ireland should be able to include estimates of non-CO_2 emissions, as the data required for the estimation will be available.

129. The ERT encourages Ireland to provide revised estimates and supporting documentation in next submissions.

VI. WASTE

A. Sector overview

130. The Waste sector accounted for 1,217 Gg and 1,341 Gg CO_2 equivalent emissions, representing 2.3 per cent and 1.9 per cent of the net emissions of Ireland, in 1990 and 2001, respectively. Between 1990 and 2001 emissions from this sector increased by only 10.3 per cent. This trend in emissions follows closely the trend in CH_4 emissions for solid waste disposal in landfills. The GHG emissions estimates which were reported in this sector are the CH_4 emissions from solid waste disposal in landfills and N_2O emissions from human waste. Overall the sector is the second-largest source of CH_4 and the fourth-largest source of N_2O. Only CH_4 emissions from landfills are ranked as a key source.

131. The EPA has responsibility for estimating emissions from this sector. For AD it relies primarily on the National Waste Database Reports which are referenced in the NIR. In addition to these reports, various assumptions on many parameters driving AD are derived from expert judgements. These assumptions are well documented and transparent, and are generally within the IPCC default ranges. The EFs used are mainly IPCC default values.

Completeness

132. The CRF includes estimates of most gases and sources of emissions from the Waste sector, as recommended by the IPCC Guidelines. Not included are CH_4 emissions from waste-water handling, which were considered negligible by the Party because the application of anaerobic treatment processes to either waste water or sludge remains limited in Ireland. In addition, CO_2, CH_4 and N_2O from waste incineration are not estimated because Ireland records that it has no major incineration plants and the few that are operating are confined to a small number of chemical and pharmaceutical companies. It is reported in the NIR that data on these sources are sparse and often confidential; hence no estimates of emissions can be reported with any reliability. The NIR states further that the estimates from this source will in any case be negligible.

Transparency

133. The information provided in the NIR coupled with the supplementary data in the National Waste Database Reports is detailed enough and transparent. However, minor inconsistencies were observed related to the use of notation keys.

Recalculations and time-series consistency

134. CH_4 emissions from this sector have been recalculated, primarily because of changes in the input parameters driving the AD, such as the percentage of degradable organic carbon (DOC) dissimilated (representing a decrease from 70 per cent to 60 per cent in accordance with the IPCC good practice guidance), the fraction of municipal solid waste (MSW) that is managed (an increase in the proportion that is managed from 60 per cent to 63 per cent for 2000), and the fraction of different constituents of the MSW. The impact of this recalculation is that the latest estimates for CH_4 emissions are now considerably lower than previous estimates. The change varies from 20 per cent in 2000 to about 34 per cent in 1990. The ERT considers the recalculation justified given the sensitivity of emissions to various parameters.

Uncertainties

135. The significant changes in the recalculations mentioned above illustrate the high sensitivity of the estimates to input parameters, which are themselves uncertain. This means that the estimate of uncertainty in this sector is high. The Party has given the levels of uncertainty for AD and emissions data as 20 per cent and 50 per cent, respectively, for this sector. Given the state of knowledge and data availability, the ERT considers that the 20 per cent uncertainty level for the AD may be low.

B. Key sources

Solid waste disposal on land – CH_4

136. According to the level assessment there is only one key source in this sector, namely, CH_4 emissions from solid waste disposal on land. This source contributes about 1,341 Gg CO_2 equivalent emissions, representing about one-tenth of all CH_4 emissions and less than 2 per cent of total net emissions. Between 1990 and 2001, emissions from this source initially increased until 1997; thereafter they declined rapidly until 2000, increasing again modestly in 2001. The trend can be explained by significant landfill gas recovery since 1997, offsetting increasing emissions due to more waste being generated.

137. A modified tier 2 method was used for the estimation of emissions. The method models the contributions of the previous 20 years' emissions from landfills to the current year. A release profile from landfills incorporating a one-year time lag was adopted, based on results from published sources (Cossu, Andreottola and Muntoni 1996). This profile has not been checked against country-specific experiments. If resources are available, this may be included in the research agenda that the EPA may want to embark upon. A spreadsheet accounting model was then built which took into consideration various parameters driving emissions, such as the ratio of waste in managed and unmanaged sites, the composition of MSW, the percentage of the solid waste accounted for by DOC, and the percentage of DOC dissimilated. These parameters and methodology are in line with the methodology described in the IPCC good practice guidance.

138. The EPA has recently used the landfill gas first-order decay (FOD) emissions model (LANDGEM FOD, US Environmental Protection Agency) to estimate CH_4 emissions. Fifty-two landfills and four CH_4 recovery sites were considered. Overall CH_4 emissions were then estimated to be 67.5 Gg, which is comparable with the present figure of 60.8 Gg. However, the verification results are not included in the NIR because they were not yet available at the time the estimates were being put together.

139. The main source of data for this key source is the National Waste Database, which has been compiled every three years since 1995. The waste production figure for municipal waste generation in the 2001 National Waste Database Report is not consistent with what was used in the NIR. The database report provides a figure of total waste generated that is larger by more than 30 per cent. Ireland indicated that the real data for 2001 was not available when the 2001 inventory was produced but informed the ERT that the data is now available, and along with that for 1998, will be used in submission 2004 to modify the AD previously used for 1999 and 2000. What was used in 2003 submission was extrapolation of the actual data in the 1998 report. It would add to the transparency of the inventory if this was stated in the NIR. IPCC default values for DOC percentage for the organic wastes, paper and textiles constituents of the MSW were used. Expert judgement for DOC values for street-cleaning waste and others were used and are comparable with those of other countries.

140. There are some minor input errors in table 6.A and some changes in notation keys from "NO" to "NE" in table 6.A which should be corrected in the next submission. These, however, do not affect the overall quality of the inventory.

C. Non-key sources

Emissions from human sewage – N_2O

141. Nitrous oxide emissions from human sewage were estimated using the IPCC methodology. Emissions from this source are very small and have increased only slightly, reflecting population growth in Ireland. Apart from population changes, the other variable driving emissions is the protein intake per person per day. The calculation in the NIR and CRF assumes a figure of 60 g/cap/day, which is the protein intake for active adults recommended by the Ireland Food Safety Agency. The FAO statistics

(http://apps.fao.org/lim500) have time series data for Ireland for actual protein intake which, at 114 g/cap/day, are almost twice what was used in the inventory calculation. The ERT brought this to the attention of Ireland. Ireland agreed that the FAO figure should be the more appropriate one to use.

142. Efforts should be made to report available information on waste-water handling data as contained in the Additional Information table to the CRF table 6.B.

D. Areas for further improvement

Identified by the Party

143. Ireland is planning to investigate the possible contributions from sludge and industrial waste to CH_4 emissions in landfills. It also plans to study and assess the waste-water treatment systems so as to establish the extent of the anaerobic systems in operation.

Identified by the ERT

144. The ERT agrees with the EPA's identification of areas for further development. In addition, however, the ERT encourages efforts to gathering information on the waste incineration available in the country.

145. Future research efforts could carry out sensitivity analysis on the various parameters driving AD for CH_4 emissions from landfills with the aim of identifying the key parameters for which efforts and resources could be devoted in order to decrease the overall uncertainty of the emission estimates for the source.

146. Further efforts are needed for more transparent and complete reporting in the CRF.

ANNEX 1: MATERIALS USED DURING THE REVIEW

A. Support materials on the CD-ROM and the web page for the review

2003 Inventory submissions of Ireland, including CRF for years 1990–2001 and an NIR.
2002 Inventory submissions of Ireland, including CRF for years 1990–2000 and an NIR.
UNFCCC secretariat. "Report of the individual review of the greenhouse gas inventory of Ireland submitted in the year 2001 (Desk review)." FCCC/WEB/IRI(1)/2001/ (available at http://unfccc.int/program/mis/ghg/countrep/irldeskrev.pdf).
UNFCCC secretariat. "2003 Status reports for Ireland" (available at http://unfccc.int/program/mis/ghg/statrep03/ire03.pdf).
UNFCCC secretariat. "Synthesis and assessment report of the greenhouse gas inventories submitted in 2003. Part I." FCCC/WEB/SAI/2003 (available at http://unfccc.int/program/mis/ghg/s_a2003.html) and Part II – the section on Ireland) (unpublished).
UNFCCC secretariat. Compilation of review findings for Ireland (unpublished).
Ireland's comments on the draft "Synthesis and assessment report of the greenhouse gas inventories submitted in 2003" (unpublished).
UNFCCC secretariat. "Handbook for review of national GHG inventories." Draft 2003 (unpublished).
UNFCCC secretariat. "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories." FCCC/CP/1999/7 (available at http://www.unfccc.int/resource/docs/cop5/07.pdf).
UNFCCC secretariat. "Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention." FCCC/CP/2002/8 (available at http://unfccc.int/resource/docs/cop8/08.pdf).
UNFCCC secretariat. Database search tool – *Locator* (unpublished).
IPCC. *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000* (available at http://www.ipcc-nggip.iges.or.jp/public/gp/gpgaum.htm).
IPCC/OECD/IEA. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, volumes 1–3, 1997* (available at http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm).

B. Additional materials received during the in-country visit

General and Energy

Howley, Martin, O'Gallachoir, Brian and O'Loughlin, Brendan. 2003 *Energy in Ireland 2002: Trends, Issues and Indicators 1990–2001*. Sustainable Energy Ireland, Department of Communications, Marine and Natural Resources.

Industrial Processes

Clean Technology Centre, Cork Institute of Technology. "Extension of the Project on Emission Inventories for HFCs, PFCs and SF_6 for Ireland 1998 to Obtain Inventories for the years 1990–2000, backup documentation for common reporting format tables, May 2002." Prepared for the Environmental Protection Agency (unpublished).
European Foundation for the Improvement of Living and Working Conditions, "Pacts for employment and competitiveness: case studies, Irish Cement Ltd." (available at http://www.eurofound.eu.int/industrial/pecscstudies/pecs_irish_cement.pdf).
Newman, Harold R., Reports on the mineral industry of Ireland (available at http://minerals.usgs.gov/minerals/pubs/country/), cited 4 September 2003.
O'Doherty, Simon and McCulloch, Archie. 2003. "Climate change emissions of industrial greenhouse gases (HFCs, PFCs and sulphur hexafluoride), Final report." LS-5.1.3a, Environmental Protection Agency, Johnstown Castle, Wexford (available electronically).
O'Leary, Eileen, Finn, Jean and Cunningham, Dermot. 2003). "Climate change emissions of industrial greenhouse gases (HFCs, PFCs and sulphur sexafluoride), Final report." LS-5.1.3b, Environmental

Protection Agency, Johnstown Castle, Wexford (available at http://www.epa.ie/r_d/downloads/publications/phase 1/largescale/ls-5.1.3_for_web.pdf').

Agriculture

Food and Agriculture Organization of the United Nations Web site (available at http://www.fao.org)
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Responses to questions during the review were received from Dr. Eugene Hendrick and Dr. Gerhardt Gallagher from COFORD (National Council for Forest Research and Development), and Dr. Michael McGettingan from Environmental Protection Agencies. The ERT was also provided with additional materials:

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