



FCCC/WEB/IRI(3)/2003/DNK

12 February 2004

## DENMARK

### REPORT OF THE INDIVIDUAL REVIEW OF THE GREENHOUSE GAS INVENTORY SUBMITTED IN THE YEAR 2003<sup>1</sup>

#### (Centralized review)

#### I. OVERVIEW

##### A. Introduction

1. In accordance with decision 19/CP.8 of the Conference of the Parties, the United Nations Framework Convention on Climate Change (UNFCCC) secretariat coordinated a centralized review of the 2003 greenhouse gases (GHG) inventory submission of Denmark. The review took place from 8 to 12 September 2003 in Bonn, Germany, and was conducted by the following team of nominated experts from the roster of experts: Generalists – Mr. Paul Filliger (Switzerland) and Ms. Helen Plume (New Zealand); Energy – Mr. Riad Chedid (Lebanon), Mr. Dario Gomez (Argentina) and Ms. Chia Ha (Canada); Industrial Processes – Ms. Kristina Saarinen (Finland) and Ms. Kristine Zommere (Latvia); Agriculture – Mr. Sergio Gonzalez (Chile) and Mr. Vlad Trusca (Romania); Land-use Change and Forestry – Mr. Wojciech Galinski (Poland) and Mr. Goran Stahl (Sweden); Waste – Mr. Philip Acquah (Ghana) and Mr. Takashi Morimoto (Japan). Mr. Sergio Gonzalez and Ms. Helen Plume were the lead reviewers of this review. The review was coordinated by Mr. Javier Hanna (UNFCCC secretariat).

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

##### B. Inventory submission and other sources of information

3. In its 2003 submission, Denmark submitted a complete set of common reporting format (CRF) tables for the years 1990–2001 and a national inventory report (NIR). Some sectoral background tables are not filled in. Where needed the expert review team (ERT) also used previous years’ submissions, additional information provided during the review and other information. The full list of materials used during the review is provided in annex 1 to this report.

##### C. Emission profiles and trends

4. In the year 2001, the most important GHG in Denmark was carbon dioxide (CO<sub>2</sub>), contributing 78.3 per cent to total<sup>2</sup> national GHG emissions expressed in CO<sub>2</sub> equivalent, followed by nitrous oxide (N<sub>2</sub>O) – 12.6 per cent, and methane (CH<sub>4</sub>) – 8.1 per cent. Perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF<sub>6</sub>) taken together contributed 1.0 per cent of the overall GHG

<sup>1</sup> 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 (3) indicates that this is a centralized review report.

<sup>2</sup> In this report, the term total emissions refers to the aggregated national GHG emissions expressed in terms of CO<sub>2</sub> equivalent excluding Land-use Change and Forestry, unless otherwise specified.

emissions in the country. The Energy sector accounted for 78.4 per cent of total GHG emissions, followed by Agriculture (16.6 per cent), Industrial Processes (3.1 per cent) and Waste (1.7 per cent). Total GHG emissions (excluding Land-use Change and Forestry (LUCF)) amounted to 69,410.2 Gg CO<sub>2</sub> equivalent and increased by 0.3 per cent from 1990 to 2001. The CO<sub>2</sub> emission trends of Denmark are not regular, and there are considerable changes from year to year. This is explained by the strong influence of electricity trade. Denmark presents a CO<sub>2</sub> emission trend adjusted for electricity trade and climatic variations. This adjusted trend shows a steady decrease of CO<sub>2</sub> emissions. HFC emissions decreased for the first time from 2000 to 2001, which is explained as an effect of a new Danish regulation. Both trend explanations seem to be reasonable to the ERT.

#### **D. Key sources**

5. Denmark has reported a key source tier 1 analysis, both level and trend assessment, as part of its 2003 submission. The key sources analysis performed by the Party and the secretariat<sup>3</sup> produced slightly different results as they used different subdivisions of the Energy sector. Denmark uses a more detailed subdivision of some categories. Especially in the Energy sector, additional subdivisions are made as compared to table 7.1 in the *Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance). As a result, Denmark defines more key sources compared to the secretariat's assessment. Denmark, in its response to the draft version of this report, noted that it would look carefully at the need for this detailed analysis before its next submission, given the ERT's suggestion that, in order to facilitate comparison with other countries' data, the presentation of a key source analysis following the suggested IPCC source categories would be helpful.

#### **E. Main findings**

6. Both the CRF and the NIR are at a high level of development, but further improvements are possible. The ERT recommends a better use of notation keys and a more detailed description of country-specific methods in all sectors to make the inventory more transparent. The inclusion of a formal quality assurance/quality control (QA/QC) plan and refinements of the uncertainty estimation would further improve the already good submission of Denmark.

#### **F. Cross-cutting topics**

##### Completeness

7. All years 1990–2001, all gases, all sectors and all source/sink categories are covered in the 2003 inventory submission. Where particular source categories are not relevant to Denmark, this has been indicated in the documentation boxes of the appropriate tables (although notation keys should also have been used in these circumstances). Denmark has included initial GHG inventory data for Greenland and the Faroe Islands in its NIR, but these data are not yet included in the CRFs. There are no significant gaps identified in the CRF and the time series.

##### Transparency

8. The documentation in the NIR is not detailed enough to allow the ERT to fully assess the underlying assumptions and rationale for choices of activity data (AD), methods of estimation of emission factors (EFs) and other inventory parameters required to be reported in the CRF (see paragraphs 38 and 42 in Industrial Processes and Solvent Use, paragraph 46 and 48 in Agriculture, paragraph 59 and

<sup>3</sup> 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.

62 in LUCF, paragraph 66 and 69 in Waste). The Party's comments on the draft report clarified many of the aspects raised in the above-mentioned paragraphs, and the ERT recommends that these explanations be included in the next NIR. A more detailed description of country-specific methods as well as the systematic use of notation keys would enhance the transparency of the inventory submission greatly.

#### Recalculations and time series consistency

9. The ERT noted that recalculations reported by the Party of the time series 1990–2000 had been undertaken to take into account: updated EFs for CH<sub>4</sub> related to stationary fuel combustion activities; the updating of information on CH<sub>4</sub> and non-methane volatile organic compound (NMVOC) emissions from natural gas distribution networks and pipelines to take into account Danish conditions; new EFs for gasoline (military and railways); updated emission estimates for domestic aviation (including flights to and from Greenland and the Faroe Islands); the introduction of a revised methodology for estimating the consumption of halocarbons and SF<sub>6</sub>; and the updating of CH<sub>4</sub> emissions from enteric fermentation to include horses on small farms and riding schools. The major changes include CH<sub>4</sub> in the Energy sector and CO<sub>2</sub> from LUCF. The rationale for these recalculations is only partly provided in the NIR. The reason for the substantial change in LUCF data for the whole time series is not completely clear. This change influences the trend (total emissions including LUCF) considerably and should therefore be explained in more detail. In general, the recalculations have resulted in an improvement of the inventory.

#### Uncertainties

10. For the first time Denmark has undertaken an IPCC tier 1 uncertainty analysis, which covers 93 per cent of total emissions (mainly from the Energy and Agriculture sectors). The uncertainty for N<sub>2</sub>O from agricultural soils dominates the total uncertainty of the inventory. The ERT notes, however, that sector-level uncertainty has not been estimated for all sectors (e.g., the Industrial Processes and Waste sectors are missing). The aim of the Party is to include more of the emission sources during the coming years. A more detailed explanation of EF uncertainties should be given and country-specific EF uncertainties should be included where available. Denmark is encouraged to continue its promising work in this area.

#### Verification and quality assurance/quality control approaches

11. Denmark's NIR reports on several internal checks on the inventory as QA/QC procedures. No formal QA/QC plan in line with the IPCC good practice guidance and no QA with independent national reviewers have as yet been developed. The ERT recommends that Denmark give high priority to further improvements in this field.

#### Follow-up to previous reviews

12. Compared to the last available review (submission 2002), progress has been realized in key source analysis, uncertainty estimates and recalculations. Questions about transparency and the use of notation keys, which were raised in the centralized review of the 2002 submission,<sup>4</sup> are still being discussed.

### **G. Areas for further improvement**

#### Identified by the Party

13. The NIR identifies several areas for improvement. These include investigating the possibilities for improving the GHG inventories for Greenland and the Faroe Islands, improving the uncertainty analysis when more country-specific uncertainties for fuel consumption and EFs have been incorporated, and further elaboration of how formal QA/QC procedures could be implemented. Denmark also indicates that it is working to improve its use of notation keys.

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<sup>4</sup> FCCC/WEB/IRI(3)/2002/DNK.

Identified by the ERT

14. The ERT identifies the following major areas for improvement related to cross-cutting issues in Denmark's inventory. The Party should: provide information in the NIR on the institutional arrangements for inventory preparation; develop a QA/QC management system in line with the IPCC good practice guidance; develop and document an overall inventory improvement plan using the key source analysis as a basis; extend its uncertainty analysis to cover all other sectors not estimated; complete all tables using notation keys; and provide more comprehensive information on the methodological approaches used and on the sources of AD to improve transparency.

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

## **II. ENERGY**

### **A. Sector overview**

16. GHG emissions from the Energy sector (54,416.20 Gg of CO<sub>2</sub> equivalent) constituted 78.4 per cent of the total emissions of Denmark for 2001, excluding Greenland and the Faroe Islands. This sector includes eight key source categories, namely: six sources for CO<sub>2</sub> (coal, oil, gas and other fuels from stationary combustion together with road transport and fugitive emissions from oil and gas operations), one source for N<sub>2</sub>O (road transport) and one stationary combustion source for CH<sub>4</sub> (gas fuels).

17. The emissions of relevant GHGs for the period 1990–2001 are dominated by fuel combustion activities. Denmark indicates in the NIR that fuel switching from coal to natural gas and renewable energy has occurred since 1990. Both liquid and solid fuels show a peak in consumption in 1996 and solid fuel consumption has decreased drastically from that year.

18. CO<sub>2</sub> emissions show an increasing trend in the period 1990–1996 which reverts to a decreasing trend for the period 1996–2001. Peak emissions in 1996 were 41.7 per cent higher than in 1990 and 39.3 per cent higher than in 2001. Emissions in 2001 were 1.7 per cent higher than in 1990. This behaviour is consistent with fuel switching. Fugitive emissions show an increasing trend with a noticeable peak in 1999.

19. The Energy sector contributed on average less than 10 per cent of total N<sub>2</sub>O emissions for the period 1990–2001. The emission trend also shows a peak in 1996; however, the relative values differ from those for CO<sub>2</sub>. Peak emissions in 1996 were 57 per cent higher than in 1990 and 10.4 per cent higher than in 2001. Emissions in 2001 were 42.2 per cent higher than in 1990. These trends are also compatible with fuel switching in stationary sources and the increment of N<sub>2</sub>O emissions from the road transport because of increasing use of cars with catalytic converters. The trend in fugitive emissions is practically the same as that for CO<sub>2</sub> emissions.

20. The Energy sector contributed less than 5 per cent of total CH<sub>4</sub> emissions in 1990 and more than 14 per cent in 2001. The trend in the total CH<sub>4</sub> emissions from the Energy sector differs significantly from that for the other two gases. For combustion activities, it is a rising trend every year, with a sharp increment in the period 1993–1997. Denmark comments in the NIR that this is related to the increasing use of gas engines in the decentralized cogeneration plants where about 3 per cent of the natural gas is not combusted. Fugitive emissions show a slightly increasing pattern with fluctuation about the average trend.

21. The NIR and the CRF contain emission estimates for all direct and indirect GHGs and sources from the Energy sector. Although Denmark has made an effort to comply with geographic coverage in accordance with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC Guidelines) and the IPCC good practice guidance, the emissions reported from Greenland and the Faroe Islands are not disaggregated for the Energy sector. Also,

emissions from fuel combustion in category 1.A.2 Manufacturing Industries and Construction are not disaggregated because fuel consumption rates provided by the Danish energy statistics are only available at an aggregated level.

22. The methodological approach, the AD and the EFs used to estimate emissions for the Energy sector are presented in the NIR in a transparent manner. Higher-tier methods were used for most combustion sources (e.g., CORINAIR for stationary combustion and the COPERT III model for road transport) while lower-tier methods were used for fugitive emissions. Some of the reference information for stationary combustion is only available in Danish and/or not yet published. The EFs applied are country-specific or based on the COPERT III, CORINAIR and/or the IPCC guidelines.

23. In 2000, recalculations for the overall Energy sector resulted in decreases in the figures for CO<sub>2</sub> and CH<sub>4</sub> emissions of 0.17 per cent and about 26 per cent respectively, while a 0.82 per cent increase in N<sub>2</sub>O emissions was observed. Recalculation of figures for CH<sub>4</sub> from Fugitive Oil and Natural Gas (1.B.2) resulted in a 70 per cent decline in emissions. The CRF indicates that CH<sub>4</sub> emissions from transmission and distribution of natural gas were recalculated in the light of new knowledge for both EFs and AD. For transparency purposes, it is recommended that a detailed discussion of the new set of EFs and AD be provided in the future NIR and CRF (documentation box).

24. Estimation of uncertainty is based on the tier 1 methodology of the IPCC good practice guidance and covers all sources.

25. A formal QA/QC plan has not yet been developed by Denmark. However, a number of QC procedures were performed for fuel combustion activities. As discussed in the NIR, the QC procedures include a time-series review (for comparison with the previous inventory for any major changes) and control of data transfer.

## **B. Reference and sectoral approaches**

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

26. CO<sub>2</sub> emissions from fuel combustion were calculated using the reference and the sectoral approaches. For the year 2001, there is a difference of 0.94 per cent in the CO<sub>2</sub> emission estimates.

### International bunker fuels

27. The distinction between domestic and international emissions from aviation and navigation is made according to the IPCC Guidelines. From 2001 flights to and from Greenland and the Faroe Islands are included under domestic aviation. It is recommended that the AD for jet kerosene, aviation gasoline and lubricants reported in table 1.C of the CRF be reviewed, since these values differ from the values reported in the reference approach, table 1.A(b). Denmark, in its response to the draft version of this report, commented that it will consider these differences in the next submission.

### Feedstocks and non-energy use of fuels

28. The non-energy use of naphtha, lubricants and bitumen is taken into account in the reference approach using IPCC default values for the fraction of carbon stored. Emissions from the non-energy use of fuels are not included in the sectoral approach. Denmark indicates in appendix 4 of the NIR and the documentation box of table 1.A(c) of the CRF that the non-energy use of fossil fuels in the sectoral approach will be considered in future inventories.

## **C. Key sources**

### Stationary combustion: oil and gas – CO<sub>2</sub>

29. Although Denmark reports in Appendix 4.3 of the NIR that 14,234 TJ of refinery gas and 1,670 TJ residual oil were used in category 1.A.1.b Petroleum Refining, only AD for liquid fuel (15,904 TJ) are

reported in Table 1.A(a) of the CRF. It is recommended that Denmark reconcile this information and use the appropriate notation keys in this source category. Denmark's plans to consider further improvements for this category in future inventories will help consistency.

30. The plastic part of municipal waste incineration that is used for heat and power production deserved detailed treatment in the NIR, and the corresponding CO<sub>2</sub> emissions are included in CRF categories 1.A.1, 1.A.2 and 1.A.4. However, neither the corresponding AD nor notation keys are provided. It is recommended that Denmark use the appropriate notation keys in this source category for AD and for the associated non-CO<sub>2</sub> emissions. In its response to the draft version of this report, Denmark stated that the split of emission between plastic waste and biomass waste is only relevant for CO<sub>2</sub>. Consequently, the Party included the total activity data (biomass+plastic) and all non-CO<sub>2</sub> emissions from waste incineration (biomass+plastic) in the fuel category biomass.

#### Stationary combustion: gas and other fuels – CH<sub>4</sub>

31. The corresponding values of the CH<sub>4</sub> implied emission factors (IEFs) for source categories 1.A.1, 1.A.2 and 1.A.4, which are the highest among reporting Parties, merited consideration in previous reviews. The link that is explicitly made in the NIR between these relatively high CH<sub>4</sub> IEFs and the large number of cogeneration plants based on natural gas lean burn engines is enough to explain these high values. However, the ERT recommends that Denmark include in future NIRs the explanation given in its response to previous review activities on this issue. It might also be helpful to make the reference for the CH<sub>4</sub> EF for these types of engine (cited in appendix 4 of the NIR) available in English for other Parties in considering these types of emission.

#### Fugitive emissions: oil and gas operations – CO<sub>2</sub>

32. CO<sub>2</sub> emissions from venting in oil and gas operations are not reported. The ERT recommends that Denmark use the appropriate notation keys in this source category.

33. Regarding the unstable trend of CO<sub>2</sub> emissions between 1990 and 2001, Denmark has compared its fuel consumption data (from offshore flaring of natural gas) with the Danish energy statistics. The table and figures provided by Denmark in its response to the previous review activities show that both sets of data follow a similar trend and confirm the fluctuations. To improve transparency, it is recommended that a discussion of factors influencing flaring activities and corresponding fuel consumption for the observed trend of natural gas flaring be included in future NIRs.

### **D. Non-key sources**

#### Mobile combustion: oil – CH<sub>4</sub>

34. The trend of CH<sub>4</sub> emissions from gasoline between 1990 and 2001 shows fluctuations that do not correlate with fuel consumption. They apparently reflect fluctuations in EFs, particularly those for urban driving conditions. It is recommended that Denmark revise the CH<sub>4</sub> EF for gasoline. Denmark, in its response to the draft version of this report, explained that it would consider the ERT's recommendation in its next submission.

#### Fugitive emissions: oil and gas operations – CH<sub>4</sub> and N<sub>2</sub>O

35. CH<sub>4</sub> emissions for subcategories 1.B.2.c and 1.B.2.d have not been reported in the CRF and no notation key is provided. Denmark reports natural gas venting information and associated emissions in appendix 5 of the NIR. It is recommended that Denmark reconcile this information and use the appropriate notation keys in this source category.

### III. INDUSTRIAL PROCESSES AND SOLVENT USE

#### A. Sector overview

36. The share of emissions from the Industrial Processes sector in Denmark's total GHG emissions is 3.1 per cent. Emissions from this sector have doubled since 1990 (from 1,048.52 to 2,164.07 Gg CO<sub>2</sub> equivalent). Combustion processes in the Industrial Processes sector emissions are included in the Energy sector. The key sources in the Industrial Processes sector are cement production (CO<sub>2</sub>), and consumption of halocarbons and SF<sub>6</sub> (HFCs and PFCs). Emissions from solvent and other product use have decreased by approximately 10 per cent since 1990, being currently 111.75 CO<sub>2</sub> equivalent Gg.

37. For the fluorinated gases (F-gases), the trend was for emissions to increase until 2000, since when they have decreased thanks to legislation and greater awareness of environmental issues. HFCs (mainly used as refrigerants) are the dominating gases and will be forbidden in new equipment in 2007. Both potential and actual emissions are included in the CRF.

38. To improve the completeness and transparency of the inventory the ERT recommends that some emission sources that are not as yet covered should be covered (e.g., ammonia production – CO<sub>2</sub> and nitric acid production – N<sub>2</sub>O). The ERT encourages Denmark to indicate clearly whether some emission sources are occurring or not (e.g., iron and steel production, aluminium production) using the appropriate notation keys and to provide the data for those emission sources that do occur in Denmark. For all emissions the documentation should be detailed enough to enable review of the methodology.

39. The non-energy use of feedstocks (white spirit, lubricants, bitumen) is included in the reference approach and the emissions from some of the products produced on the basis of feedstock are taken into account in the national approach, e.g. emissions from the use of solvents and from incineration of plastic in municipal waste. These emissions are allocated in the respective categories.

40. No uncertainty analysis has been yet carried out for emissions in the Industrial Processes and Solvent Use sector.

#### B. Key sources

##### Cement production – CO<sub>2</sub>

41. The emissions data are based on information from mandatory industry reporting, which is quality checked by means of audits. The EF is calculated by weighting the EFs resulting from the production of low alkali cement, rapid cement and basis cement.

##### Consumption of halocarbons and SF<sub>6</sub> – HFCs and PFCs

42. In general, good work has been done in estimating HFC, PFC and SF<sub>6</sub> emissions, although some problems were detected in reporting emissions and providing background information. There are uncompleted blank cells in the CRF 2(I) and 2(II) tables, summary 3 and tables 7 and 9; and the ratios of potential to actual emissions in CRF table 2(II) are inconsistent with the data in table 2(I) and summary 1.A. The ERT recommends that Denmark include more detailed explanations in the NIR. Denmark has indicated that the methodology used for the 2001 inventory has been revised to better reflect the tier 2 methodologies of the IPCC guidelines. For most of the gases the inventory reported in this NIR reflects the new methods for all years. Information on the gases for which data have not been updated according to the new method will be updated with the next NIR. The changes to come will make only a minor difference to the data. This source is an emerging key source and the ERT therefore encourages Denmark to implement QA/QC procedures and uncertainty analysis in order to meet the IPCC good practice guidance.

### C. Non-key sources

#### Other production – N<sub>2</sub>O, NMVOC

43. The AD associated with the reported emissions should be reported even if they are derived from interpolation. The ERT recommends that Denmark also indicate whether N<sub>2</sub>O emissions occur from this source and, if they do, document its calculation of the emissions.

#### Lime production – CO<sub>2</sub>

44. The IEFs for CO<sub>2</sub> reported for the years 1990–2001 (0.23 t/t in 2001) are the lowest among reporting Parties and lower than the IPCC default range (0.79 to 0.91t/t). Denmark explains that there are two activities in the CORINAIR database which contribute to this type of production – the production of lime and the production of bricks. The activity rate is therefore the sum of burnt lime and bricks produced, and the implied EF is a “mixture” reflecting different trends in these two different productions. The AD and emissions are aggregated in the CRF but consideration is being given to reporting them separately in future.

## IV. AGRICULTURE

### A. Sector overview

45. The Agriculture sector contributes 16.6 per cent of total GHG emissions. From 1990 to 2001, emissions in the sector decreased by 20 per cent, mainly because of a decrease of N<sub>2</sub>O emissions from agricultural soils as a result of a proactive national environmental policy during the past twenty years. Recalculation was applied to CH<sub>4</sub> emissions from enteric fermentation to also account for horses on small farms and riding schools, resulting in a small increase of 1 per cent.

46. The submission is almost complete in terms of gases, sources and years covered. Goats will be included for the next submission. CRF tables 4.C, 4.E and 4.F were not filled in as they are not applicable for the Party. Notation keys are not always used and some values for EFs and IEFs are not fully consistent with those reported in the NIR; these inconsistencies are found in manure management (CH<sub>4</sub> and N<sub>2</sub>O) and N<sub>2</sub>O emissions from soils (direct, indirect and animal production). The AD used are taken from the official national statistics agencies. Denmark’s submission shows consistency across the time series as the same methodologies, EFs and AD sources have been used. The ERT encourages Denmark to include more detailed information in the NIR to make the methodological approaches easier to understand.

47. Denmark has performed a key source analysis which was fully consistent with that performed by the secretariat as the same sources were defined as level/trend key sources. Qualitative estimates for uncertainty came from expert judgement. Internal checks on the AD are performed by specialists and researchers. No QA with independent review was implemented. A list of institutions and persons linked to the collection, generation and reporting of AD is included in the NIR. A list of references is included as part of appendix 9. No information on sectoral archiving or documentation procedures is reported in the NIR.

48. Denmark has responded to all the findings of the previous 2003 review activities. It plans to improve the next submission by recalculating AD and EFs on an annual basis, developing a system to estimate CH<sub>4</sub> emissions similar to the ammonia (NH<sub>3</sub>) model, using tier 2 methods to estimate CH<sub>4</sub> emissions from each source category, and including goats and CO<sub>2</sub> emissions from agricultural soils. The Party is also encouraged to improve the data and notation keys provided in the CRF to make them completely consistent with the NIR and to include more detailed information on country-specific methodological issues.

## **B. Key sources**

### Enteric fermentation – CH<sub>4</sub>

49. Denmark has estimated CH<sub>4</sub> emissions from enteric fermentation using IPCC tier 2 method for cattle and IPCC tier 1 method for the remaining animal species, which is in line with the IPCC good practice guidance. Country-specific EFs were produced for cattle and IPCC default values were applied to the other animal species. The estimates were classified as of high quality.

50. Some inaccuracies were found in the CRF tables, and between them and the data included in the NIR: the values of EFs and IEFs show some differences. Not enough information is provided to allow a clear understanding of the value of some IEFs. The ERT found that the NIR could include more clarifications to make it easier to understand the methodological approach.

### Manure management – CH<sub>4</sub>

51. Denmark has applied the IPCC tier 2 method along with country-specific EFs, which is in line with the IPCC good practice guidance.

52. Some inconsistencies were found between emission trends and animal population trends, which seem to be produced by some inconsistencies in the data needed on population size. Some inaccuracies involving double counting of the poultry population and the calculation of volatile solids also need to be corrected. Although it is recognised that Denmark reported this double counting in the NIR (Appendix 9, section 9.4.3), the ERT found that the NIR should include more detailed explanation to make clear the methodology for estimating CH<sub>4</sub> emissions.

### Agricultural soils – direct N<sub>2</sub>O emissions

53. Denmark reports the use of a country-specific method and EFs, based on the NH<sub>3</sub> system, to estimate N<sub>2</sub>O emissions from agricultural soils and manure management. However, it seems that it has been used in combination with the IPCC method and EFs. The information provided is not sufficient to allow a full understanding of the scope and technicalities of the methods and source of the EFs. The quality of estimates was reported as medium.

54. Some probable inconsistencies were found for EF values between the CRF and the NIR, for example, the IEF for animal wastes applied to soil. Denmark, in its comments to the draft version of this report, noted that this mistake was made at a stage where it had no influence on the calculation of N<sub>2</sub>O emissions. Another inconsistency is found in the EF for histosols, which was changed to 8.0 in the 2001 inventory whereas a value of 5.0 was used for the rest of the series. Denmark, in its comments to the draft version of this report, noted that it will review this point for the next submission.

## **C. Non-key sources**

### Manure management – N<sub>2</sub>O emissions

55. Denmark does not report the method or the source of the EFs used in the CRF. However, information on the use of a country-specific approach is provided in the NIR. The ERT encourages Denmark to provide more information to clarify this issue. The quality of estimates was reported as medium.

56. IEFs for some animal waste management systems (AWMS) are reported only in the 2001 CRF tables. However, emission estimates were provided for the whole time series. Some differences were found between the data contained in the CRF and the NIR, for example, the EF for solid storage, which is 0.015 in the CRF and 0.020 in the NIR. Denmark, in its comments to the draft version of this report, noted that the inconsistency will be corrected for the next submission.

## V. LAND-USE CHANGE AND FORESTRY

### A. Sector overview

57. The relative importance of the LUCF sector is limited for Denmark; net removals of CO<sub>2</sub> in 2001 amounted to 3,531 Gg.

58. Recalculations have led to an increase in CO<sub>2</sub> removals for the entire period 1990–2000 (an increase of 253.5 per cent in 2000). The resulting increase in net removals is more than 2,000 Gg, or more than 200 per cent on average over the period. The rationale for the recalculation is that a new forestry census was carried out in the year 2000 and that new methods have been applied in connection with this census. With the new methodological assumptions, the biomass stocks and the annual increment of forests show higher values than previously reported. The recalculation also changes the base year net emissions for Denmark.

59. Although the NIR has a specific appendix with rather detailed information about the LUCF sector, the new methods are not transparently described. Thus it is difficult to verify the plausibility of the recalculated information. The ERT recommends that Denmark provide a transparent description of these methods in its future submissions. Denmark, in its comments on the draft version of this report, noted that will address this recommendation, together with those raised in paragraphs 60 to 62, in future reports.

60. No discussion is provided regarding the uncertainty of estimates for the LUCF sector. It is likely that the uncertainties are high because the information is derived from questionnaires to which forest owners have responded. The ERT encourages Denmark to provide a discussion of this issue in future submissions. The NIR does not provide information regarding QA/QC or verification procedures for the LUCF sector.

61. The CRF tables for the LUCF sector are not filled in completely; in many cases cells are left blank. The ERT recommends that for future reporting Denmark fill in the CRF tables more comprehensively and use the notation keys not estimated (“NE”) or not occurring (“NO”) as necessary. The Party could also provide data (based on assumptions in some cases) for emissions that most likely do occur in Denmark although they are not reported, for example, emissions of CO<sub>2</sub> from soils due to agricultural practices.

### B. Sink and source categories

#### Changes in forest and other woody biomass stocks – CO<sub>2</sub>

62. CO<sub>2</sub> is the only GHG covered in the LUCF sector and Denmark only reports on emissions/removals resulting from changes in biomass stocks. A country-specific methodology is used whereby census data are used in connection with growth modelling and site index data. The method is not transparently described. Harvest is estimated from trade statistics. The ERT encourages Denmark to provide better descriptions of the methodologies used for estimating both annual increments and annual harvest.

63. Denmark has provided a good description of the country-specific density and biomass expansion factors used, and has provided an explanation regarding the use of these and the differences between these and the IPCC defaults.

#### All other categories

64. Denmark does not report any emissions or removals in other categories within the LUCF sector and has not provided notation keys in the CRF. The ERT recommends that for future reporting Denmark use the appropriate notation keys.

## VI. WASTE

### A. Sector overview

65. Emissions from the Waste sector contributed 1.7 per cent to national total GHG emissions in 2001. The sector accounted for 1,310 and 1,168 Gg of CO<sub>2</sub> equivalent in 1990 and 2001, respectively, representing a 10.9 per cent decrease over the period. The only significant sectoral source category reported is CH<sub>4</sub> from solid waste disposal on land, which is identified as a key source by level assessment. The decreasing trend of CH<sub>4</sub> emissions is due to increasing waste incineration and CH<sub>4</sub> recovery for energy production.

66. A list of references and documentation on methodologies and country-specific EFs is mostly provided in the NIR. However, detailed information on AD and methodological choices in the documents referenced is not included in the NIR. Transparency has been improved compared with the previous submission. However, relevant additional information should be provided in CRF tables 6.A and 6.C, and appropriate and consistent notation keys should also be used in all the CRF tables. The ERT recommends that uncertainty analysis should be conducted in the Waste sector, particularly for the key source of the sector, namely solid waste disposal on land.

67. The inventory is practically complete in terms of gases, sources and years covered. CH<sub>4</sub> and N<sub>2</sub>O emissions from waste-water handling are not estimated. The ERT notes that CO<sub>2</sub> emissions from solid waste disposal on land should be reported as “NE” instead of “NO” because CO<sub>2</sub> emissions from biogenic sources are occurring, but are not added to national totals in accordance with the IPCC methodology.

### B. Key sources

#### Solid waste disposal on land – CH<sub>4</sub>

68. CH<sub>4</sub> emissions from solid waste disposal on land are estimated using a country-specific model based on the first-order decay (FOD) model. The ERT notes that the composition of waste has been changing as a result of increased waste incineration driven by national legislation, which reduces the quantity of organic waste disposed to landfill. The ERT encourages Denmark to undertake a survey to determine the effect of the changing composition of waste on the estimates.

69. The methodology, EFs and AD provided in the NIR are comparable to those reported by other Parties. The ERT encourages Denmark to provide relevant additional information in CRF tables 6.A and 6.C. It is good practice to estimate emissions using the IPCC default method as this allows cross-comparison with data from other countries as an internal QA/QC procedure.

70. CH<sub>4</sub> recovery is reported in the NIR and accounted for under the Energy sector as biogas combustion. Denmark should also report the activity data in sectoral background data tables 6.A and 6.C.

71. CH<sub>4</sub> emissions in the CRF in the period 1996–1999 are different from the recalculated values reported in the NIR. Denmark explains in the NIR that there are minor errors in the figures in the CRF, which will be addressed in the next submission.

### C. Non-key sources

#### Waste-water handling – CH<sub>4</sub> and N<sub>2</sub>O

72. CH<sub>4</sub> and N<sub>2</sub>O emissions from waste-water handling are reported as “NE”. The NIR explains that the Danish waste-water handling systems are aerobic, and emissions are therefore considered to be negligible. The ERT encourages Denmark to estimate N<sub>2</sub>O emissions from waste-water handling. Otherwise, Denmark should provide documentation or references on aerobic waste-water handling systems to justify its statement that N<sub>2</sub>O emissions are negligible.

Waste incineration

73. Emissions from biogenic waste incineration are reported under memo items consistent with IPCC good practice guidance and IPCC Guidelines and also explained in CRF table 9 (completeness). However, the ERT notes that notation key “included elsewhere”, “IE” should be used in CRF tables 6.A and 6.C to indicate that the biogenic emissions are reported elsewhere.

## ANNEX 1: MATERIALS USED DURING THE REVIEW

### A. Support materials used during the review

- 2002 and 2003 Inventory submissions of Denmark. 2003 submission including CRF for years 1990–2001 and an NIR.
- UNFCCC secretariat. “Report of the individual review of the greenhouse gas inventory of Denmark submitted in the year 2002 (Centralized review).” FCCC/WEB/IRI(3)2002/DNK (available at <http://unfccc.int/program/mis/ghg/countrep/dencentrev02.pdf>).
- UNFCCC secretariat. “2003 Status report for Denmark” (available at [http://ghg.unfccc.int/download/reviews2003/Denmark\\_SR2003.zip](http://ghg.unfccc.int/download/reviews2003/Denmark_SR2003.zip)).
- UNFCCC secretariat. “Synthesis and assessment report of the greenhouse gas inventories submitted in 2003. Part I.” FCCC/WEB/SAI/2003 (available at [http://ghg.unfccc.int/download/reviews2003/S&A\\_Part\\_I.zip](http://ghg.unfccc.int/download/reviews2003/S&A_Part_I.zip)), and Part II – the section on Denmark (unpublished).
- Denmark’s comments on the draft “Synthesis and assessment report of the greenhouse gas inventories submitted in 2003” (unpublished).
- UNFCCC secretariat. “Review findings for Denmark (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

Responses to questions during the review were received from Malene Nielsen (Danish National Environmental Research Institute).