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REPORT OF THE INDIVIDUAL REVIEW OF THE GREENHOUSE GAS INVENTORY OF DENMARK SUBMITTED IN THE YEAR 2002¹

Centralized review

I. OVERVIEW

A. Introduction

1. The Conference of the Parties (COP), by its decisions 6/CP.5 and 34/CP.7, requested the secretariat to conduct individual reviews of greenhouse gas (GHG) inventories submitted by Parties included in Annex I to the Convention (Annex I Parties), according to the “UNFCCC guidelines for the technical review of GHG inventories from Annex I Parties”, hereinafter referred to as the UNFCCC review guidelines.² The principal objectives³ of the review of the GHG inventories are to ensure that the COP has adequate information on GHG inventories and GHG emission trends, and to examine the information submitted by Annex I Parties in accordance with the UNFCCC reporting guidelines⁴ for consistency with those guidelines.

2. The centralized review of Denmark took place from 9 to 13 September 2002. It was carried out by a team of nominated experts (expert review team, ERT) from the roster of experts, working at the headquarters of the UNFCCC secretariat in Bonn. The assignments of the experts were as follows: generalists – Mr. Bernd Gugele (European Community) and Mr. Marius Taranu (Republic of Moldova); energy – Mr. Lambert Schneider (Germany) and Mr. Mohammad Soltanieh (Iran); industrial processes – Ms. Deborah Shafer (USA) and Mr. Mauro Meirelles de Oliveira Santos (Brazil); agriculture – Ms. Anna Romanovskaya (Russian Federation) and Mr. Tomoyuki Aizawa (Japan); land-use change and forestry (LUCF) – Mr. Aquiles Neuenschwander (Chile) and Mr. Daniel Martino (Uruguay); and waste – Mr. Davor Vešligaj (Croatia) and Mr. Jens E. Frøiland Jensen (Norway). Mr. Jens E. Frøiland Jensen and Mr. Marius Taranu were the lead reviewers for this centralized review. The review was coordinated by Ms. Astrid Olsson and Ms. Sevdalina Todorova-Brankova (UNFCCC secretariat).

3. In accordance with the UNFCCC review guidelines, 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.

¹ In the symbol for this document, 2002 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.

² For the UNFCCC review guidelines and decision 6/CP.5 see document FCCC/CP/1999/7, pages 109 to 114 and 121 to 122, respectively.

³ For the objectives of the review of GHG inventories see document FCCC/CP/1999/7, page 109, paragraph 2.

⁴ The guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories (FCCC/P/1999/7) are referred to in this report as the UNFCCC reporting guidelines.

B. Inventory submission and other sources of information

4. In its 2002 submission, Denmark submitted common reporting format (CRF) tables for the years 1990–2000. In 2002, it submitted a national inventory report (NIR), mainly including limited general information on the database, methods, emission factors, activity data, recalculations, uncertainties, key source analysis and emission trends, and references to other material. The submission was received in the secretariat on 15 April 2002.

5. The 2002 status report and the draft 2002 synthesis and assessment (S&A) report, together with the previous status reports and S&A reports, and the report of the desk review of Denmark's 2001 GHG inventory,⁵ were made available to the review team. The country provided additional information and clarification during the review upon request from experts. The Party's responses are taken into consideration in this report. The full list of materials used during the review is provided in annex I to this report. Denmark, in its response to the draft version of this report, commented that although the desk review report of the 2001 submission was made available to the ERT, Denmark did not have the opportunity to improve the 2002 submission, based on the 2001 review report, as it was finalized at the same time as the 2002 submission was due. Thus some of the comments from the 2001 report are repeated in this report.

C. Emission profile, trends and key sources

6. In the year 2000, the most important GHG in Denmark was carbon dioxide (CO₂), which accounts for 77.1 per cent of total⁶ national GHG emissions expressed in CO₂ equivalent, followed by nitrous oxide (N₂O), 13.3 per cent, and methane (CH₄), 8.4 per cent. Emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF₆) are quite small and contributed in 2000 1.2 per cent of the overall GHG emissions in the country. By source, energy accounts for 77.5 per cent of total emissions, agriculture 17.3 per cent, industrial processes 3.3 per cent, waste 1.7 per cent and solvent and other product use 0.2 per cent.

7. Over the period 1990–2000, CO₂ emissions without LUCF show almost the same level in 2000 as in 1990, manifesting only a 0.4 per cent growth. CO₂ emissions from transport (+15.9 per cent) and manufacturing industries (+3.9 per cent) were growing in the 1990s, whereas in 2000 CO₂ emissions from energy use (–16.5 per cent) and energy industries (–3.6 per cent) were below 1990 levels. CH₄ emissions decreased over the period 1990–2000 by 1.6 per cent. N₂O emissions were some 16.2 per cent below the 1990 level, mainly because of emission cuts from agricultural soils (–19.8 per cent). HFC and PFC emissions increased significantly from 1995 (no such emissions were reported for the year 1990), by 208 per cent and 2,879 per cent, respectively. SF₆ showed a decrease in 2000 by 45 per cent compared with the 1995 level. Total GHG emissions (without CO₂ from LUCF) decreased by 1.2 per cent between 1990 and 2000.

8. Denmark used the quantitative IPCC tier 1 approach to identify its key sources for 2000, in accordance with the *IPCC good practice guidance and Uncertainty Management in National Greenhouse Gas Inventories*, hereinafter referred to as the IPCC good practice guidance. The base year for the trend analysis was 1995 for HFCs, PFCs and SF₆, and 1990 for the other gases. This fact, and the more detailed fuel split used in the Danish approach, may be the most important reasons for the differences between the Danish key source analysis and the preliminary analysis performed by the secretariat.⁷

⁵ See document FCCC/WEB/IRI(1)/2001/DNK.

⁶ Total national GHG emissions refer to aggregate emissions of CO₂, CH₄, N₂O, PFCs, HFCs and SF₆, all expressed in terms of CO₂ equivalent, excluding CO₂ emissions/removals from LUCF.

⁷ The UNFCCC 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. They may differ from the key sources identified by the Party itself.

D. General assessment of inventory

9. The NIR submitted by Denmark is generally in conformity with the UNFCCC reporting guidelines. The methodology used to estimate the GHG emissions seems to be broadly consistent with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, hereinafter referred to as IPCC Guidelines and the IPCC good practice guidance, but extended information in the NIR is needed in order to improve the transparency of the submission. A number of areas for further improvements are identified in paragraphs 16 and 17 below for the general aspects of the inventory and in sections II–VI for the sector-specific aspects.

1. Completeness

10. Denmark submitted inventory data for the years 1990–2000 using the CRF. The submission included most tables requested and all the gases requested were estimated. However, some sectoral background data tables (2(II).F, 3.A–D, 4.C, 4.E, 5.A, 5.B, 5.C and 5.D) were not provided. The ERT notes that, according to the response of Denmark to the draft 2002 S&A report, tables 4.C, 4.E and 4.F are not relevant for Denmark. CRF tables 3, 7 and 9 were provided only for the year 2000. Notation keys were used in a limited manner, although the effort of the Party on introduction of the notation keys in the CRF for year 2000 which should be same in the CRFs for the years 1990–1999 is encouraging. It was also noted that the CRF information on feedstocks is limited. Emission data from other territories (Greenland and the Faroe Islands) are not included in the CRF; CO₂ emissions from fuel combustion are provided separately for these territories in the NIR, but no sectoral split is available.

2. Transparency

11. The NIR for Denmark provides only a very general description of the inventory process and the underlying data and methodologies. Although the ERT notes that the transparency of the Danish submission has improved in comparison with previous submissions, it could be further improved, in particular by providing detailed information on methodologies and emission factors used (especially for those sectors where country-specific methods and models are used). The more extensive use of the notation keys in the CRF would also increase the transparency of the Danish submission. In its response to the draft version of this report, Denmark commented that the 2001 review report was finalized at the same time as the 2002 submission was due and thus the suggested improvement could not be taken into account in the 2002 submission.

3. Recalculations

12. Denmark provided recalculated estimates (tables 8(a) for 1990–1999) for energy (CO₂, CH₄ and N₂O), industrial processes (HFCs, PFCs and SF₆) and agriculture (N₂O). Table 8(b) of the CRF with explanations for the recalculations was provided for energy and industrial processes; these explanations were also provided in the NIR. The effect of recalculations for the base year was a reduction of 0.86 per cent and 0.85 per cent in total CO₂ equivalent emissions including and excluding LUCF, respectively. The percentage changes in total CO₂ equivalent for all GHGs as shown in Denmark's recalculation tables for the inventory years 1990 and 1999 matched the independent estimates of percentage changes calculated by the secretariat. The main sectors for which recalculations were made were energy (1990, 1999) and industrial processes (1999). For 1999, the gases were recalculated as follows: CO₂ +0.48 per cent, CH₄ +0.17 per cent, N₂O –3.13 per cent, HFCs –0.86 per cent, PFCs –34.12 per cent and SF₆ +0.96 per cent. The main reasons for recalculations are:

- (a) For energy in 1990: the revision of Danish energy statistics;
- (b) For energy in 1999: the updating of activity rates of flaring in gas and oil extraction (1.B.2.c) and the correction of minor errors of emission factors;

(c) For industrial processes in 1999: the updating on HFCs, PFCs and SF₆ (F-gases) according to a model documented in 2001.

4. Uncertainties

13. Uncertainty estimates were given only at an aggregate level for total emissions of CO₂, CH₄, N₂O, CO, nitrogen oxide (NO_x) and non-methane volatile organic compounds (NMVOC), and for the total inventory in terms of CO₂ equivalent, without disaggregation into sectors and source categories. The NIR states that uncertainty values were combined using the methodology stated in annex I of the reporting instructions of the IPCC Guidelines. Table 7 (overview table for national GHG inventories) of the CRF was also provided with some qualitative assessment of the inventory.

5. Quality assurance / quality control (QA/QC)

14. Denmark has no formal QA/QC procedures for the inventory, though some QC was performed in the preparation of the Danish annual emission inventories. Apart from the UNFCCC reviews, QA with independent review of the inventories has not yet been carried out.

6. Issues relating to previous reviews

15. Issues and problems identified in the desk review of the 2001 inventory submission (UNFCCC secretariat, 2002) were unavailable for the Party and the submission of the 2002 GHG inventory as the draft version of the desk review report was received by the Party after the submission. Thus, the noted improvements are the result of general improvement efforts implemented in the 2002 submission: CRF tables 3, 7, 8(b) and 9 were partly completed, except for LUCF; the tables for the reference approach were provided, including some data on feedstocks; notation keys were used, although only in a limited way; the omissions in the national inventory relating to waste-water handling and waste incineration were explained in the NIR; and indications of the methods used in the agriculture and waste sectors, as well as indications of the rationale and complexity of these methodologies, were provided.

7. Areas for further improvement

16. Denmark has not noted any area for further improvement in its 2002 submission (except that further study of how formal QA/QC procedures could be implemented is planned). Previous submissions also indicated as ongoing work that Denmark planned:

(a) The allocation of bunker fuels relating to transport between Denmark, Greenland and the Faroe Islands. In its response to the draft version of this report, Denmark stated that the allocation of bunker fuels has been included in the 2003 submission.

(b) An independent review of the inventories.

17. The ERT noted the following with regard to future inventories: there is a need to further improve transparency as regards the use of methodologies and emission factors, as well as to make more use of explanatory notes, documentation boxes and the notation keys in the CRF tables. Denmark may also wish to apply the IPCC good practice guidance on a larger scale, including uncertainty analysis and QA/QC. Denmark may wish to consider including in its NIR sections summaries of emissions trends and any major developments since the last report, as well as the areas for further improvement. As regards the key source analysis, it might be helpful to provide the rationale for using the very detailed category and fuel split. In addition, conclusions and future improvements based on the findings of the key source analysis might be elaborated. Denmark, in its response to the draft version of this report, stated that many of the matters brought up by the ERT have been included in the 2003 submission. Denmark further notes the wish of the ERT for future improvements based on the key source analysis.

II. ENERGY

A. Sector overview

18. The energy sector contributed 77.5 per cent to total GHG emissions (without LUCF) of Denmark in 2000. Emissions from energy industries are the largest source in this sector, accounting for 47 per cent of overall emissions in the energy sector in 2000. Between 1990 and 2000, fuel combustion and GHG emissions varied considerably. In the energy sector they were at their lowest in 1990 and highest in 1996, when they increased by 42.5 per cent above the 1990 level. Between 1996 and 2000, GHG emissions decreased significantly, being in 2000 only 1 per cent above the 1990 level. In appendix 2 of the NIR, Denmark provides additional information on emission trends with data which have been adjusted for electricity exchange and inter-annual temperature variations.⁸ According to these data, GHG emissions decreased by about 9 per cent between 1990 and 2000. Thus, electricity exchange with other countries and inter-annual temperature variations appear to be important drivers for GHG emissions in Denmark's energy sector.

19. Generally, for the energy sector the NIR provides only very general information regarding methodologies, emission factors, underlying assumptions, specific references to sources, descriptions of the models, and explanations of trends and the special circumstances of Denmark. Some useful background information can be found in Fenhann (2001) and in the description of the CORINAIR emission inventory system in appendix 5 of the 2000 NIR submission. The ERT strongly encourages Denmark to incorporate all available information in the NIRs or to provide clear references to other documents. In its response to the draft version of this report, Denmark stated that much of the requested information has been included in the 2003 submission.

20. Denmark provides all relevant CRF tables for GHG emissions from the energy sector. However, for some sources notation keys are not used and emissions from fuel combustion in the manufacturing industries and construction (1.A.2) are not disaggregated, emissions from the Faroe Islands and Greenland are not included in the national totals in the CRF (see para. 9 above). The ERT encourages Denmark to make the CRF tables more complete. Denmark, in its response to the draft version of this report, commented that work is ongoing with the Danish Energy Authority and Statistics Denmark to disaggregate the energy statistics so in the future reporting will be possible at the requested disaggregated level.

21. A recalculation has been carried out for the years 1990–1999.⁹ The recalculation affects emissions from fuel combustion for all years (1990–1999) and fugitive emissions for the period 1994–1999. The CO₂ emissions have been recalculated from –1.39 per cent in the previous submission to +0.99 per cent. CH₄ emissions have been revised significantly, for example, emissions in the energy industry sector changed ten-fold in 1997 compared with the previous submission (see also below). Revised N₂O emissions in the energy sector are approximately 20–23 per cent lower in all years. Denmark provides some general information on the recalculations in the NIR and the relevant CRF tables. According to this information, activity data have been changed following revisions to the statistical data, and new emission factors have been estimated for stationary engines and gas turbines. In the transport sector, a new COPERT (a computer programme calculating emissions from road transport developed by the European Community) emission calculation model version has been incorporated. Furthermore, calculations of aircraft emissions have changed as a result of the findings of a research project conducted by National Environment Research Institute (NERI) in 2001. The information provided is relatively

⁸ According to UNFCCC and IPCC guidelines, inventory data should not be adjusted. In accordance with these guidelines, the CRF contains data which have not been adjusted. Parties can provide adjusted data as additional information.

⁹ The NIR states that a recalculation of the energy sector has been carried out for the years 1990–1997 (due to new energy statistics for these years). The recalculations for the years 1998 and 1999 have other reasons and are not due to changes in energy statistics.

general and does not allow a thorough assessment of the recalculations. It is not indicated which specific emission factors have been revised (e.g., from values in appendix 4 of the NIR 2000 submission), which sources of information have been used for the newly adopted data or which specific activity data are affected by the recalculation. The ERT recommends that more specific background information be provided on the recalculations in the NIR.

B. Key sources

1. Stationary combustion

22. Denmark uses several sources to estimate emission factors from stationary combustion. According to the NIR, emission factors are based on four different sources: the Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook, the IPCC Guidelines, Danish legislation and measurements in Danish plants. Underlying emission factors are provided in appendix 4 of the NIR with the relevant SNAP codes of the CORINAIR system.

23. For the year 2000, sources of information are provided for almost all CO₂ emission factors. However, for other years and other gases no specific information on the sources is provided. To further improve the transparency of the inventory, the ERT recommends that Denmark provide the relevant sources of information for all emission factors, and explanations where emission factors change over time. In the NIR 2000 submission, Denmark provided in appendix 4 a table where all emission factors for stationary and mobile combustion are summarized in a quite transparent manner, indicating the sector, the fuel type and the relevant period. However, in this table several emission factors are only provided until 1997. According to the data in the NIR appendix 4 of the 2002 submission, several emission factors changed from 1997 to 1998, for example the CO₂ emission factor for petroleum coke changed from 102 kg/GJ for the period 1990–1997 to 92 kg/GJ for the period from 1998–2000. However, no explanation for such changes is provided in the NIR. The ERT encourages Denmark to include in each submission a table similar to that in appendix 4 of the 2000 NIR, in which all relevant years should be reflected, sources of emission factors should be indicated and any changes to previous submissions should be documented transparently and explained. In the response to the draft version of this report, the Party explained that the CO₂ emission factor used for petroleum coke since 1998 refers to a calculation carried out by Sjællandske Kraftværker, SK Energy, in 1999. Using this emission factor for all years is under consideration for the next submission.

24. The CO₂ implied emission factor (IEF) for liquid fuels is relatively low compared with these of other reporting countries. In its response to the draft 2002 S&A report, Denmark explains that this is due to the inclusion of municipal solid waste (MSW) under liquid fuels. For the plastic fraction within the waste an emission factor of 19.2 kg/GJ is used, which lowers the average IEF for liquid fuels. However, according to the description of the inventory system in appendix 5 of the 2000 NIR submission, waste is stated to be included under solid fuels. The ERT recommends that the combustion of MSW be included under “Other fuels” in accordance with the IPCC Guidelines. In the response to the draft version of this report, Denmark explained that in the CORINAIR system municipal waste is considered as solid fuel, but while transferring to the CRF the plastic part of municipal waste is considered as liquid fuel.

25. Methane emission factors for gaseous fuels have been partly recalculated (see above). The IEF for methane in the whole energy sector amounts to 7.32 kg/TJ in 1990, while values of approximately 106–116 kg/TJ for the period 1996–2000 appear to be very high compared with those reported by other countries. In its response to the draft 2002 S&A report, Denmark provides the explanation that a large number of cogeneration plants with reciprocating engines causes this considerable increase of the IEF. The ERT encourages Denmark to provide the relevant background information, including activity data and emission factors in the NIR (like those included in the Appendix 4 of the NIR). This may also help other countries with a large share of cogeneration plants in improving their estimates.

2. Fugitive emissions

26. Denmark estimates partly fugitive emissions from oil and natural gas and storage of coal. In the NIR no information on methodologies used to estimate fugitive emissions is provided. Some background information can be found in Fenhann (2001).

C. Reference and sectoral approaches

27. CO₂ emissions from fuel combustion were calculated using the reference and the sectoral approaches. The difference between the two approaches is small, 0.24 per cent in 2000 and never over 1.5 per cent in 1998. Denmark assumed in the reference approach that all carbon is oxidized. The ERT recommends applying specific values for the different fuel types.

28. The draft 2002 S&A report indicates that overall differences between the fuel combustion reported in the CRF and that reported to IEA (International Energy Agency) are very small in 2000 (0.4 per cent). However, the allocation between different fuel types is different. In the CRF the reported consumption of gasoline is 11,395 TJ higher than in the report to the IEA. Denmark also reported a consumption of refinery feedstocks of 10,889 to the IEA, whereas no consumption is reported in the CRF. The consumption of coke oven/gas coke was reported to the IEA, but not in the CRF.

D. Bunker fuels

29. Denmark uses a tier 2 approach to separate domestic from international fuel use for aviation with a model developed by the National Environment Research Institute. The NIR does not describe the methodology applied; however, some information can be found in Fenhann (2001) and in appendix 5 of the 2000 NIR submission. No information is available on the methodology for separation of marine bunker fuels. Fuels from transportation between Denmark, the Faroe Islands and Greenland are not included in national totals in accordance with IPCC Guidelines, but Denmark states that it will include them in the near future. The ERT encourages Denmark to address transportation between Denmark, the Faroe Islands and Greenland and to provide more detailed information regarding the methodology and the model applied for separation of marine and aviation bunker fuels. In its response to the draft version of this report, Denmark stated that emissions from fuels used for flights between Denmark, the Faroe Islands and Greenland have been included for the years 1990–2001 in the 2003 submission.

E. Feedstocks and non-energy use of fuels

30. Denmark does not provide a description of the methodology applied to estimate fraction of fuels used as feedstocks. Denmark applies a correction in table 1.A(c) under “Other fuels” for emissions from plastic in MSW, which is not very clear. The ERT recommends that it provide additional information on the underlying assumptions and the approach regarding MSW in the NIR. Denmark noted this recommendation in its response to the draft version of this report.

III. INDUSTRIAL PROCESSES AND SOLVENTS USE

A. Sector overview

31. In 2000, industrial processes emissions accounted for 3.3 per cent of the total CO₂ equivalent (without LUCF), 1.5 per cent more than in 1990. Emissions of CO₂ were 64 per cent of the CO₂ equivalent emissions in industrial processes in 2000, with cement production being responsible for 92.8 per cent of this CO₂. In the period 1990–2000, the increase of industrial processes CO₂ equivalent emissions was 116.6 per cent, mainly owing to fluorinated gases (emissions from cement production increased by 52.7 per cent in the same period). As discussed below, the current NIR and CRF are not fully transparent for emissions from industrial processes, but Denmark has outlined a plan to increase transparency. The ERT notes some large changes (greater than 10 per cent) in total CO₂ emissions: from

1990 to 1991, from 1992 to 1993 and from 1996 to 1997, yielding a 44 per cent increase from 1999 to 2000.

B. Key sources

32. Denmark has performed a key source analysis, identifying the same two key source categories as the secretariat.

1. Cement production

33. Denmark's CO₂ IEF is the second-highest among the reporting Parties (0.54 t/t). The ERT recommends the Party to provide more detail regarding its CO₂ emission calculation, identifying and quantifying the various types of cement manufactured. Denmark, in its response to the draft version of this report, commented that there is only one producer of cement in Denmark which reports the emissions. Furthermore Denmark stated that it will consider providing more details in future submissions.

2. Consumption of halocarbons and SF₆

34. Currently, Denmark's NIR and CRF are not fully transparent regarding emissions of fluorinated gases. The English summary of a report referenced by Denmark (Ozonelagsnedbrydende stoffer og drivhusgasser-2000, Tomas Sander Poulsen) is more helpful, but could be improved by adding leak rates to table 2.3, briefly explaining the source of the consumption, stock and leak rate estimates, and adding a table to provide results by chemical species rather than blend. This last enhancement would permit cross-checking between the values provided in the report and those provided in the CRF tables. Denmark states in its response to the draft 2002 S&A report that it plans to provide future yearly reports on emissions of the fluorinated gases in English and to present the key parameters of the model in table 2(II).F. These additions would both considerably improve the transparency of Denmark's HFC, PFC and SF₆ inventory. In addition, the ERT recommends that Denmark include a summary of the report, including relevant tables, in the NIR itself. The ERT further recommends that Denmark should not remove the estimates of potential emissions from table 2(II) in the CRF. Although actual emissions may not be calculated from potential emissions, the ratio of actual to potential emissions provides a useful measure for comparing countries' estimates to one another. In its response to the draft version of this report, Denmark commented that as part of its improvement plan some of the matters raised by the ERT have been included in the 2003 submission.

35. The Danish per capita emission rate for HFCs from air conditioning and refrigeration (100 Gg/million people) exceeds those for the other countries being reviewed in this centralized review (20–70 Gg/million), despite the climatic and geographical similarities among these countries. A comparison between the Danish and Swedish HFC inventories (and supplemental information supplied at the request of the ERT) shows that Danish per capita emission estimates exceed Swedish estimates by almost a factor of four. Denmark's per capita bank estimates are about 40 per cent higher than Sweden's, but most of the difference in emission estimates appears to result from the use of different emission factors, with Danish emission factors exceeding Swedish ones by factors of 2–3. The Party may wish to re-evaluate its emission factors in the light of this information and the fact that many countries have observed declines in emission factors for this sector over the last decade. Denmark commented, in its response to the draft version of this report, that it will consider this matter further after the review of the Danish 2003 submission.

C. Non-key sources

1. Lime production

36. The ERT recommends that the Party review its activity data for lime production. Following the information on how the corresponding emission factor is calculated (Fenhann, 2001), there is confusion

when two different units, kg lime and kg brick, are summed together to give the overall activity data. The ERT recommends that Denmark include more information on the calculation of the emissions, information on the methodology used to estimate the emissions, and the activity data and emission factors used in future submissions. In its response to the draft version of this report, Denmark stated that it would consider to report lime and bricks separately in future submissions. Detailed information corresponding to this separation is already included in the NIR submitted 2003. Denmark further explained that it would consider the ERT's recommendation in its improvement plan for the industrial processes sector, now being implemented.

2. Ammonia production

37. The ERT recommends the Party to assess whether it has any CO₂ emissions associated with ammonia production, in view of the fact that the United Nations reports a small amount of ammonia production in Denmark. In addition, the ERT recommends that Denmark use notation keys (i.e., NO (not occurring), IE (included elsewhere) etc.) as appropriate in the CRF tables for this source. Denmark, in its response to the draft version of this report, explained that it would consider the ERT's recommendation in its improvement plan for the industrial processes sector, now being implemented.

3. Nitric acid production

38. Activity data are reported as well as NO_x emissions but no N₂O emissions. The ERT recommends the Party to provide information on the methodology used to estimate emissions from nitric acid production and encourages Denmark to calculate N₂O emissions, as they do occur during nitric acid production, or provide information on why they are not estimated. In addition, information on the type of reduction technology used for the N₂O emissions and the type of acid production process (i.e., direct strong or low pressure) should be included. The Party should also make use of notation keys. Denmark, in its response to the draft version of this report, explains that it will consider the ERT's recommendation in its improvement plan for the industrial processes sector, now being implemented.

4. Iron and steel production

39. The ERT recommends the Party to assess whether it has any CO₂ emissions associated with steel production in view of the fact that the United Nations reports steel production in Denmark. The ERT also recommends that Denmark use notation keys as appropriate. Denmark, in its response to the draft version of this report, explained that it would consider the ERT's recommendation in its improvement plan for the industrial processes sector, now being implemented.

5. Aluminium production

40. As noted in the draft 2002 S&A report, emissions from aluminium production are not quantified, although UN statistics report some production of aluminium in Denmark. In its response to the draft 2002 S&A report, Denmark states that it is investigating its aluminium production. The ERT encourages the Party to continue the investigation of its aluminium production so as to complete the information on related emissions.

6. SF₆ used in magnesium foundries

41. Denmark appears to have adequately addressed the issues raised by the draft 2002 S&A report in this area. To facilitate the comparison of Denmark's emission estimates with those of other countries, the ERT recommends that Denmark present magnesium production as the activity data in the sectoral background tables (or in the documentation box) if these data are available and not confidential. In its response to the draft version of this report, Denmark commented that, as part of its improvement plan, some of the matters raised by the ERT have been included in the 2003 submission.

7. Electrical equipment – SF₆

42. In general, Denmark appears to have adequately addressed the issues raised by the draft 2002 S&A report in this area. However, as noted above, the ERT recommends that Denmark continue to present estimates of potential emissions for this and other sectors. In its response to the draft version of this report, Denmark commented that as part of its improvement plan some of the matters raised by the ERT have been included in the 2003 submission.

D. Solvent and other product use

43. Although CO₂ and NMVOC emissions from 3.A Paint application are reported, the associated activity data are not reported. No notation keys are used. The Party answered, in its response to the draft 2002 S&A report, that activity data are not available. The ERT also noted that, although NMVOC emissions 3.B Degreasing and dry cleaning were reported, the associated activity data were not reported. N₂O emissions were not reported. The ERT recommends the Party to estimate the missing emissions and make use of notation keys to complete the information in this sector. Denmark noted this recommendation in its response to the draft version of this report.

IV. AGRICULTURE

A. Sector overview

44. In 1990 Denmark reported approximately 14,309 Gg CO₂ equivalent emissions from the agricultural sector and in 2000 this amount had decreased to 11,824 Gg CO₂ (-21 per cent). The contribution of agriculture to the total national GHG emissions is estimated at approximately 20.6 per cent and 17.3 per cent in 1990 and 2000, respectively. The inventory is not complete: emissions from Greenland and the Faroe Islands are not included. Denmark reports its agricultural inventory using tables 4.A, 4.B (a), and 4.D. In table 4.B(b) activity data were not provided (except population size). The source categories 4.C (Rice cultivation) and 4.E (Prescribed burning of savannas) were not filled in. In its response to the draft 2002 S&A report Denmark, indicated these activities as not NO. In the information box of table 4.F for 2000 (Field burning of agricultural residues) this activity has been noted as forbidden. Table 4.F for other years is not filled in. GHGs reported in agricultural sector are CH₄ and N₂O. The NIR provided references for the methodology used for every source and a short description for them. Activity data are based on information of Statistics Denmark. The methodology used is a combination of country-specific methodology, CORINAIR and the IPCC Guidelines and good practice guidance (tier 1 and tier 2). No uncertainty estimates according to the IPCC good practice guidance were provided for the agricultural sector. Qualitative uncertainty estimates were included in table 7. No QA/QC check according to the IPCC good practice guidance has been performed in the sector. The ERT suggests that the Party submit annually a description of the methodology used in the NIR and the CRF. This was also noted in the desk review report 2001 (FCCC/WEB/IRI(1)/2001/DNK). In its response to the draft version of this report, Denmark explained that the description of the agricultural sector has been elaborated in the 2003 submission and that a revision of the sector will be carried out.

B. Key sources

1. Enteric fermentation – CH₄

45. Comparison of livestock data reported in the CFR (table 4.A) reveals differences compared to the Food and Agriculture Organization (FAO) data (year 2000) for sheep and swine. Large annual fluctuations in populations of sheep, swine and horses were noted (see the draft 2002 S&A report). According to comments made by the Party, the aggregation of sub-categories for sheep and swine in 1999 and 2000 was different from that described in the NIR 2000. The ERT suggests adequate recalculation of data for 1990–1998. The NIRs 2000 and 2002 indicate the use of tier 2 method for cattle; however, no information on average daily uptake and CH₄ conversion factor is provided in table 4.A. Additional

information on weight, milk yield, pregnancy and digestibility of feed is presented in the CRF only for 2000 for dairy cattle (the data for other years were supplied at the request of the ERT). The IEF for non-dairy cattle is low compared to those of other reporting Parties, which was explained by Denmark with reference to higher energy consumption and optimized composition of the food for energy used. The ERT encourages Denmark to provide the additional information used for tier 2 in the CRF and the NIR annually. The ERT recommends that the Party indicate default emission factors applied for sheep, swine and horses as “D” in the table Summary 3 of the CRF. Denmark, in its response to the draft version of this report, noted the recommendation by the ERT, and, although of minor importance for the contribution to emissions, the time series for livestock for sheep, swine and horses will be reconsidered as a part of the revision of the agricultural sector.

2. Manure management – CH₄

46. Information on daily excretion and CH₄-producing potential is provided only for 2000. The additional information table was not provided. Available references, mentioned in the documentation box of table 4.B(a) and in the NIR, do not provide these data (most data were supplied at the request of the ERT). The ERT suggests that Denmark provide the additional information used in the CRF and the NIR annually. Annual fluctuations were noted for the IEFs of dairy cattle, sheep, swine and horses due to incorrect values on the animal population in table 4.B.(a) for 1990–1998. In its response to the draft version of this report, Denmark welcomed the ERT’s recommendation and Denmark will revise its estimates for the next submission.

3. Agricultural soils – direct N₂O

47. In 2000, the IEF was 0.0117 kg N–N₂O/kg N, but the NIR 2000 indicates the use of a default factor (0.0125). However, the CRF (2000 year only) table Summary 3 indicates country specific model (CS/M) for methodology and EFs. According to the Party’s comments, for 2000 the amount of synthetic fertilizers was wrongly entered and a default emission factor was used. The ERT encourages the Party to correct these data in the next submission. If data on the use of mineral fertilizers presented in table 4.D show information before excluding NH₃ evaporation, the Party may wish to indicate that in the documentation box of the CRF for animal wastes applied to soil and crop residues, references mentioned in the NIR 2000 (Andersen et al., 1999; Grant et al., 1999) were in Danish and could not be considered. However, the IEF for manure is the lowest among the Parties. The ERT recommends the Party to indicate clearly what methodology and emission factor have been used and to present relevant background information in the future NIRs and the CRF. In its response to the draft version of this report, Denmark explained that it would consider the recommendations for future submissions. Furthermore Denmark stated that, in future submissions, references to reports in Danish only will not be included or that translation of the relevant parts of the reports will be provided.

C. Non-key sources

1. Agricultural soils – animal production

48. References mentioned in the NIR 2000 (Andersen et al., 1999; Grant et al., 1999) were in Danish and could not be considered in this review. The IEF for pasture range and paddock used for 1990–1998 and 2000 (0.0186) is low compared to those of other reporting Parties. For 1999, the IEF was 0.0179 kg N–N₂O/kgN. The ERT recommends that the Party indicate clearly what methodology and emission factor are used and present relevant background information in future NIRs and the CRF. In its response to the draft version of this report, Denmark explained that it would consider the recommendations for future submissions.

V. LAND-USE CHANGE AND FORESTRY

A. Sector overview

49. The total gross emissions of Denmark in 2000 amounted 68,505 Gg CO₂ equivalent, while net emission were 67,510 Gg CO₂ equivalent. LUCF represents a net carbon removal of 995 Gg CO₂ equivalent, corresponding to 1.5 per cent of total 2000 GHG emission. The trend in LUCF carbon stocks from 1990 to 2000 shows a smooth increase in annual amounts of net CO₂ removal, based only on the growing rates of forests planted since 1990, while CO₂ uptake due to net increment in forests existing before 1990 remains constant. The NIR contains a reference to the 2001 NIR where relevant information on LUCF can be found for Denmark, Greenland and the Faroe Islands. Although LUCF activities in Greenland and the Faroe Islands are likely to be minimal, ERT recommends that Denmark describe the forest situation in these territories in its next submission. In its response to the draft version of this report, Denmark explained that data for CO₂ uptake in Danish forests was revised considerably in the 2003 submission and that the suggestions and recommendations made in the review report will be considered for future submissions.

50. Only CRF table 5 was completed for the whole time series 1990–2000 and sectoral background data tables 5.A, 5.B, 5.C and 5.D were not provided. The ERT recommends the Party to complete and provide these tables for the next submission. The methodology included in the NIR 2001 states that the standing stock of wood was obtained from the Danish National Forest Inventory (NFI) of 1990, from which most of the reliable information on land use and forestry could be obtained, in order to fill in CRF sectoral tables 5.A to 5.D. This was noted in the desk review report 2001 and the ERT recommends the Party to take it into consideration for future submissions. The LUCF methodology described in NIR 2001 covers CO₂ sequestration in existing forests and in new forests. Although the CO₂ uptake in forest soils is mentioned and appears to be important, it is assumed that part of it is included in the biomass expansion factor (2.0), used as a country-specific factor instead of the default IPCC factor (1.9). In these circumstances, CRF table 5.D on carbon stock changes in forest soils was not reported.

51. Non-CO₂ GHG emissions from forest soils and grassland conversion were not provided, as the Party considers them as being negligible. ERT recommends that in future submissions an estimation of these gases or an explanation as to why they are not considered should be included.

52. The LUCF methodology described in NIR 2001 establishes country-specific factors for wood carbon content that are 1.07 t CO₂/m³ for broadleaf and 0.69 t CO₂/m³ for coniferous forest. This means that wood density was assumed as 0.58 t/m³ for broadleaf and 0.38 t/m³ for coniferous forest, values that are lower than the IPCC default factors of 0.65 t/m³ and 0.45 t/m³, respectively. Moreover, the biomass expansion factor used (2.0) included roots and soil carbon, and was higher than IPCC default factors of 1.75 for undisturbed forests and 1.9 for logged forests. Consequently, the Danish calculations are similar to those of IPCC in the case of broadleaf and lower in coniferous. The ERT recommends that the basic information on wood density and biomass expansion factors be more explicit in future submissions, in order to facilitate the review process.

53. CO₂ uptake by existing forests was calculated by a forest inventory of 1990, showing a total standing volume over bark (stem wood) of 55.15 Mm³, and an annual increment of 3.1 Mm³ which applying the conversion factors mentioned above, means a CO₂ uptake of 5,950 Gg CO₂ per year in total biomass, including non-stem biomass. Annual agricultural statistics show that in the period 1990–1999 the annual harvest for timber and fuel wood was about 1.7 to 2.0 Mm³, although it is mentioned that total consumption is 0.6–0.7 Mm³ of broadleaf and 1.7–2.0 Mm³ of coniferous forest, which would add up to an average of 2.5 Mm³ per year. Additionally, it is recognized that harvest statistics underestimate the total harvest because a large part of the cutting is not reported and included in the statistics. The report concludes that the average real net increment in the period 1990–1999 was 0.6 Mm³, equivalent to

916 Gg CO₂ per year, which could not be properly confirmed due to a lack of more detailed information. The ERT recommends the Party to include more detailed information on growth and harvest in future NIRs.

B. Sink and source categories

1. Changes in forest and other woody biomass stocks

54. Net CO₂ removals by forest biomass are reported as 916 Gg CO₂ in 1990 and 995 Gg CO₂ in 2000, with an increment of 8.6 per cent for the period as a whole. It is assumed that forests existing in 1990 grew at a constant rate of 916 Gg CO₂ per year during the period, and the totality of the increment is due to the growth of forests planted after 1990. The CO₂ sequestration in new forests is calculated using models that are not sufficiently explained. According to appendix 8 of the 2000 NIR, the Danish LUCF methodology for year 1998 used growth models based on an afforestation period of 150 years, and showed an average CO₂ binding rate of 0.41 ktCO₂ per km² per year, equivalent to 4.1 t CO₂/ha/year. The ERT recommends the Party to present a more detailed explanation on average growth rates of broadleaf and coniferous species considered in forests planted since 1990.

2. Forest and grassland conversion

55. No information is provided on land conversion, burned biomass or non-CO₂ GHG emissions as CH₄ and N₂O. The ERT recommends that Denmark estimate these emissions in order to improve the completeness of estimates of GHG sources and removals in LUCF sector.

3. Abandonment of managed lands

56. No information is reported and ERT recommends Denmark to include some estimates in this source category or provide documentation to justify its exclusion.

4. CO₂ emissions and removals from soil

57. In NIR 2001, the LUCF methodology recognizes that, according to the IPCC, carbon stock estimates should include total organic carbon content to a depth of 30 cm in mineral soils and in the organic layer. Although a current Danish study on quantifying soil carbon is mentioned, no official estimates of changes in the carbon stock of forest soils were made in the 2002 inventory, since it is assumed that the rather large biomass expansion factor of 2 includes some forest soil carbon. The ERT recommends that Denmark provide in its NIR an estimate of the cultivation of mineral and organic soils and liming in agricultural soils.

VI. WASTE

A. Sector overview

58. Emissions from the waste sector represent approximately 1.7 per cent of total GHG emissions in 2000, and there has been a 9 per cent decline since 1990, mostly as a result of changes in solid waste management practices and reduced landfilling. Land disposal of solid waste is the only source category with estimated emissions in this sector. Waste incineration is reported in the energy sector, while emissions from waste-water handling and human sewage are not estimated. The First-Order Decay method (FOD) with country-specific parameters is used for estimating CH₄ emission from solid waste disposal sites (SWDS). Comprehensive statistical data on MSW and industrial waste are provided for the period 1971–2000. The assumptions and methodology used for estimating methane emissions from SWDS are described in a background document referred to in the NIR. There is a detailed list of national references giving information additional to the NIR. The notation keys used in the CRF are not explained and additional information tables are not filled in. The methodology and emission factors given in the CRF

and the NIR are comparable to those from other Parties. The CRF table with additional information should be filled in, in order to achieve greater comparability. All the CRF tables from 1990 to 2000 are submitted but they are not completely filled in, particularly the additional information. The FOD method used for estimating emissions in the period 1990–2000 is consistent with the IPCC Guidelines.

Quantitative uncertainty assessments were not performed in the waste sector, but qualitative uncertainty indicators are reported in CRF table 7. Methane emissions from SWDS in the period 1990–2000 are not recalculated in the 2002 submission.

B. Key sources

1. Solid waste disposal on land

59. The main parameters being used in the FOD model are described in the reference materials. The half-life value used in the FOD model requires historical data on waste disposal at least 30 years prior to the base year. Depending on disposal technique (cover material, regular disposal), sewage sludge could have a significant but varying influence on gas potential. Additional information in the CRF for waste generation, recycling and treatment is not provided. The draft 2002 S&A report and previous review reports have addressed the issues of providing additional information on waste and details on the FOD model used in Denmark. The ERT recommends Denmark to include data on MSW disposed in the period before 1971, preferably from 1950 to 1970, in order to achieve higher accuracy of emissions estimations; to review the amount of sludge disposed as a cover material in order to estimate the actual amount of sludge in fact undergoing aerobic process; and to provide additional information in the CRF, including all IEFs, updated waste composition and so on. In its response to the draft version of this report, Denmark noted the recommendations and will consider them for future submissions.

C. Non-key sources

1. Waste-water handling

60. Emissions of methane and nitrous oxide from waste-water handling were considered to be insignificant. Therefore, emissions from waste-water handling were not further elaborated in the NIR, and in the CRF it was indicated as NE (not estimated). Indirect emissions of nitrous oxide from human sewage were not estimated in either the NIR and the CRF. The ERT recommends that Denmark calculate emissions of nitrous oxide from human sewage in order to improve future inventory submissions. It is, however, important to point out that this source is of minor importance in comparison to key source(s). In its response to the draft version of this report, Denmark noted the recommendations and will consider them for future submissions.

2. Waste incineration

61. Waste incineration is reported in the energy sector because all waste being incinerated is used for electricity and heat production. The ERT recommends that Denmark provide some additional information on emissions from incinerated waste according to the IPCC Guidelines. In its response to the draft version of this report, Denmark noted the recommendations and will consider them for future submissions.

ANNEX I: MATERIALS USED DURING THE REVIEW

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

Sources of information used during the review include:

- 2000, 2001 and 2002 *Inventory submissions of Denmark*. 2002 submissions including CRF for years 1990–2000 and an NIR.
- UNFCCC secretariat. *2001 Status report for Denmark* [available at <http://unfccc.int/program/mis/ghg/statrep01/den01.pdf>].
- UNFCCC secretariat. *2002 Status report for Denmark* [available at <http://unfccc.int/program/mis/ghg/statrep02/den02.pdf>].
- UNFCCC secretariat. *Synthesis and assessment report of the greenhouse gas inventories submitted in 2000*. FCCC/WEB/SAI/2000 [available at <http://unfccc.int/program/mis/ghg/sai2000.pdf>].
- UNFCCC secretariat. *Synthesis and assessment report of the greenhouse gas inventories submitted in 2001*. FCCC/WEB/SAI/2001 [available at <http://unfccc.int/program/mis/ghg/sai2001.pdf>].
- UNFCCC secretariat. *Draft synthesis and assessment report of the greenhouse gas inventories submitted in 2002* (Part I 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 2002 [unpublished].
- UNFCCC secretariat (2002). *Report of the individual review of the greenhouse gas inventory of Denmark submitted in the year 2001 (Desk review)*. FCCC/WEB/IRI(1)/2001/DNK [available at <http://unfccc.int/program/mis/ghg/countrep/dendeskre.pdf>].
- UNFCCC secretariat. *Key source analysis for the year 2000* [unpublished].
- UNFCCC secretariat. *Handbook for review of national GHG inventories*. Draft 2002 [unpublished].
- UNFCCC secretariat. *UNFCCC guidelines on reporting and review*. FCCC/CP/1999/7 [available at <http://www.unfccc.int/resource/docs/cop5/07.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>].
- http://www.ens.dk/graphics/publikationer/klima_UK/ReportGHG5dk_3may2001.pdf.
- Statistical data from IEA, provided by IEA on request by the secretariat.
- Fenhann, Jørgen, “Denmark’s Greenhouse Gas Projections until 2012”, Systems Analysis Department, Risø National Laboratory 2001, p. 25, available at http://www.ens.dk/graphics/publikationer/klima_UK/ReportGHG5dk_3may2001.pdf.

B. Additional materials provided by the Party

Responses to questions within the sectors Industrial Processes and Solvents use and Agriculture during the review were received from Ms. Jytte Illerup and Mr. Erik Lyck (Danish National Environment Research Institute), including additional material on the methodology and assumptions used.

Activity data for 1995 on enteric fermentation of cattle (animal weight, weight gain, feeding situation, pregnancy, digestibility of feed, etc.) and information on manure management (excretion rates, types of AWMS (animal waste management system), CH₄ conversion factor, etc.) were provided by Mr. Erik Lyck on request by the ERT.

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