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Report of the individual review of the greenhouse gas inventory of Denmark submitted in 2005*

* In the symbol for this document, 2005 refers to the year in which the inventory was submitted, and not to the year of publication.

CONTENTS

I. Overview

A. Introduction

1. This report covers the centralized review of the 2005 greenhouse gas (GHG) inventory submission of Denmark, coordinated by the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, in accordance with decision 19/CP.8. The review took place from 3 October to 8 October 2005 in Bonn, Germany, and was conducted by the following team of nominated experts from the roster of experts: Generalists – Ms. Mirja Kosonen (Finland) and Mr. Jim Penman (United Kingdom); Energy – Ms. Sumana Bhattacharya (India), Mr. Christov Christo (Bulgaria) and Mr. Hugh Saddler (Australia); Industrial Processes – Mr. Jochen Harnisch (Germany) and Mr. Stanford Mwakasonda (Republic of South Africa); Agriculture – Mr. Samuel Adejuwon (Nigeria) and Mr. Leonard Brown (New Zealand); Land Use, Land-use Change and Forestry (LULUCF) – Mr. Hector Ginzo (Argentina) and Mr. Zoltan Somogyi (Hungary); Waste – Mr. Carlos Lopez (Cuba) and Mr. Takashi Morimoto (Japan). Mr. Carlos Lopez and Mr. Jim Penman were the lead reviewers. The review was coordinated by Mr. Matthew Dudley (UNFCCC secretariat).

2. In accordance with the "Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention", 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 2005 submission, Denmark submitted a complete set of common reporting format (CRF) tables for the years 1990–2003 and a national inventory report (NIR). 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 the annex to this report.

C. Emission profiles and trends

4. In 2003, the most important GHG in Denmark was carbon dioxide (CO_2), contributing 80.5 per cent to total[1] national GHG emissions expressed in CO_2 equivalent, followed by nitrous oxide (N_2O), 10.7 per cent, and methane (CH_4), 7.8 per cent. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) taken together contributed 0.99 per cent of total national GHG emissions. The Energy sector accounted for 78.6 per cent of total GHG emissions, followed by Agriculture (13.1 per cent), Industrial Processes (4.1 per cent) and Waste (1.9 per cent). Total GHG emissions amounted to 75,485 Gg CO_2 equivalent and had increased by 6.8 per cent from 1990 to 2003.

D. Key categories

5. Denmark has reported tier 1 key category analyses by both level and trend as part of its 2005 submission. The analyses performed by the Party and the secretariat[2] produced similar coverage,

[1] In this report, the term total emissions refers to the aggregated national GHG emissions expressed in terms of CO_2 equivalent excluding LULUCF, unless otherwise specified.

[2] The secretariat identified, for each individual Party, those source categories which are key categories in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the Intergovernmental Panel on Climate Change *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.* Key categories 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 category analysis, the key categories presented in this report follow the Party's analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key category assessment conducted by the secretariat.

although Denmark's used greater disaggregation, resulting in 21 key categories as compared to the secretariat's 16. Off-road Mobile Combustion is a new key category in both the secretariat's list and the Party's.

E. Main findings

6. The Danish NIR is structured along the lines suggested in 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" and the CRF tables. The inventory makes extensive use of 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) supplemented with national models, and there is a substantial programme of development in place. The inventory has a series of annexes on methodologies. There is recognition of the importance of cross-cutting issues. Quality assurance/quality control (QA/QC) is discussed at the sectoral level and a draft overall QA/QC plan is included. Although this review identifies areas for individual sectors where methodologies, transparency, completeness or time-series consistency can be improved, the inventory is generally complete, except for the LULUCF sector, where all the revised tables have been provided but some estimates are missing, and significant methodological development is currently underway.

F. Cross-cutting topics

1. Completeness

7. The Party has provided inventory data for the years 1990–2003 and included all required tables. The notation keys are used in most sectoral and background tables. Denmark has provided the LULUCF reporting tables as required by decision 13/CP.9 for the years 1990–2003. The submission is for the Kingdom of Denmark, including Greenland and the Faroe Islands as annexed tables. The inventory is complete apart from minor omissions noted below under Industrial Processes and Agriculture. Denmark intends to include these in its next inventory. Waste-water handling has been introduced into this submission in response to earlier reviews.

2. Transparency

8. The NIR submitted by the Party includes information on key categories, methods, data sources, uncertainty estimates, QA/QC procedures, verification activities and so on. The NIR includes a comprehensive conceptual analysis for the QA/QC plan, which will be based on ISO 9000 quality management practices.

3. Recalculations and time-series consistency

9. The ERT noted that recalculations reported by the Party of the time series 1990–2002 had been undertaken to take into account new and more accurate data. Recalculations of the time series have resulted in both increases and decreases in the estimates of emissions, and the total effect on the trend is relatively small, amounting to increases in the estimates to total emissions of 2.84 per cent and 2.81 per cent for 1990 and 2002, respectively. With LULUCF the increases are 7.5 per cent and 6.6 per cent, respectively. Following the recommendations of previous reviews, the recalculations include: revision of the estimates of CO_2 emissions and removals from soils; the inclusion of waste-water handling as a new source; and the introduction of a new methodology for calculating CO_2 emissions from solvent and other product use.

4. Uncertainties

10. The Party has reported a tier 1 uncertainty analysis covering most emission sources. In addition, CRF table 7 includes qualitative evaluations of the estimates. These evaluations indicate that in some

key categories the emissions estimates are of low or medium quality. Denmark has identified that uncertainty estimates are mainly based on default uncertainty levels for activity rates and emission factors (EFs) and intends to include more country-specific uncertainty estimates in its future inventories.

5. Verification and quality assurance/quality control approaches

11. The Party has presented the structure of the national inventory system. The Danish National Environmental Research Institute (NERI) under the Ministry of Environment is responsible for the annual preparation of the inventory. Formalized agreements with data contributors are being prepared. The Party has also reported the structure of QA/QC procedures, which use automated data processing techniques. Sector-specific reviews by independent experts are used for verification.

6. Follow-up to previous reviews

12. The 2004 inventory reviews had a direct influence in recalculations as described in the NIR and summarized above (paragraph 9).

G. Areas for further improvement

1. Identified by the Party

13. The planned inclusion of all LULUCF categories to the inventory will be a major improvement. Although the inventory is otherwise mainly complete, there are some gaps, and Denmark has announced its intention to include estimates for CO_2 from soda ash use and limestone and dolomite use in its next inventory submission.

2. Identified by the ERT

14. The ERT recognized the effort that has been devoted to the preparation of the inventory and the amount of technical information provided. The rationale for the detail (e.g. the need to relate to CORINAIR classification) could usefully be clarified. Similarly, more transparent information could be provided on the models used in the Agriculture sector, either by providing succinct summaries of technical material in annexes to the NIR or by giving references to background reports (in translation). The ERT understands that this is in hand. The ERT had some concerns about the constancy of most fossil fuel carbon EFs and suggests that this should be reviewed. Other recommended improvements relating to specific source/sink categories are presented in the relevant sector sections of this report.

II. Energy

A. Sector overview

15. The Energy sector is the largest source of emissions in Denmark. In 2003 it accounted for 78.6 per cent of total national GHG emissions and the volume of sectoral emissions grew by around 13 per cent (from 52,390 to 59,318 Gg CO_2 equivalent) between 1990 and 2003. Within this total, emissions from the Transport sector grew by 22 per cent, mainly due to increasing road traffic. Relatively large fluctuations in the emissions time series are due to variations in regional electricity trade and consequent variations in the quantities of coal consumed in Denmark. Thus high emissions in 1991, 1996 and 2003 reflect relatively high electricity exports, and the low emissions in 1990 are due to relatively high imports of electricity. Between 2002 and 2003 CO_2 emissions from the sector increased by about 9 per cent; this is attributed to low winter temperatures, leading to higher demand for power and heating, and an increase in exports of electricity. CH_4 emissions are also increasing due to increased use of gas engines in decentralized co-generation plants.

Recalculations

16. Section 8 of annex 3A of the NIR identifies a number of improvements and recalculations. These include a disaggregation of fuel consumption and emissions to separate sectors of manufacturing industry on a pro rata basis. However, the same EFs for CH_4 and N_2O are used, and thus no account is taken of the differences in emission characteristics between the different branches of the manufacturing industry. The Party has advised that this is because of the use of CORINAIR/SNAP codes in inventory development, and that the detailed energy consumption data needed to estimate sectoral EFs are not available.

B. Reference and sectoral approaches

17. The calculations in the reference and sectoral approaches agree to within 1.5 per cent throughout the time series. The ERT noted that the oxidation factor for both approaches is taken to be 1.00 for all fuels and combustion technologies. The *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines) recommend that fuel-specific or country-specific (by fuel and technology) oxidation factors should be applied for both the reference and the sectoral approaches. Use of an oxidation factor of 1 will tend to produce a slight overestimate of emissions in both the reference and the sectoral approaches, so the agreement between the two is unlikely to be affected. Country-specific oxidation factors of course should be used if possible in accordance with the Revised 1996 IPCC Guidelines to improve the accuracy of both estimates.

1. International bunker fuels

18. Aviation and marine emissions are allocated to the domestic or international category on the basis of statistics on the start- and end-point of journeys. The Faroe Islands and Greenland are counted as domestic destinations. The NIR observes that the method of allocating marine fuel sales between domestic and international is not perfect, that is, some fuel that is used on domestic voyages is classified as international and vice versa. However, since the errors occur only with some fuel sold in Greenland and the Faroe Islands, and fuel sold in Denmark used on voyages to those places, the NIR concludes that the errors are not large. The ERT concurs with this assessment.

2. Country-specific issues

19. Denmark's Energy sector GHG inventory is based on the CORINAIR methodology and the National Atmospheric Inventory under the Long Range Pollution Convention of the Economic Commission for Europe to the United Nations Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (UNECE/EMEP). This affects the source categories used. The NIR usefully provides information showing how the categories relate to each other.

20. The ERT noted that the provision of a time series that is adjusted for electricity trade and ambient temperature is of interest for interpreting trends for policy purposes, but is not required for inventory reporting under the Revised 1996 IPCC Guidelines, and the adjusted time series has not been included in the national totals reported to the UNFCCC in the CRF.

C. Key categories

1. Stationary combustion, natural gas – CO_2

21. The NIR does not explain which industry is responsible for the energy use in subsector 1.A.1c Manufacture of Solid Fuels and Other Energy Industries, but it can be deduced that it is probably natural gas processing. The ERT noted that annex table 3A-38 lists only one point source in this subsector, accounting for only 0.32 PJ out of a total of 26.61 PJ used by the subsector. More information should be provided about this subsector, which accounts for 4 per cent of Energy sector emissions. If it is natural

gas processing, the Party should review the EF value because upstream gas producers commonly use raw gas, which has a different composition from pipeline gas, at gas processing plants.

2. Fuel combustion, stationary combustion – all gases

22. CO_2 EFs have been kept constant over time, with the exception of natural gas and municipal waste. This could introduce significant error depending on the origin and other characteristics of the coal and other fuels, and the combustion technologies, used. Denmark has advised that in future inventories CO_2 EFs from large plants will be used as they will be available due to the Danish laws on CO_2 quotas.

3. Transport

23. The off-road subcategory of the Residential and Agriculture and Forestry subsectors and on-site transport in industry are considered under combustion of the respective sectors and in subcategory 1.A.2(f) Other rather than under Transport. This reflects the derivation from CORINAIR.

D. Non-key categories

1. Fugitive emissions: Coal mining and handling – CH_4

24. The ERT understands that Denmark intends to remove the estimates of CH_4 from the storage and handling of imported coal used at power stations which are currently included in the Danish inventory. This is consistent with the IPCC good practice guidance since there is no coal production in Denmark.

2. Fugitive emissions: Oil and natural gas – CH_4 and CO_2

25. Reported fugitive emissions from natural gas distribution are extremely low. The implied emission factor (IEF) for distribution is significantly lower than that for gas transmission; normally it would be expected to be significantly higher. The IEF value of volume of gas distributed is much lower than the corresponding values reported by other Parties. It is generally considered that fugitive emissions from the distribution of gas are closely related to the length of the gas distribution pipes, but these data are not provided. The reported emissions are based on work undertaken by the Danish Gas Technology Centre. The ERT recommends that the basis for these estimates be reviewed.

26. The activity data (AD) for gas flaring are highly variable. Between 1999 and 2003, there was a rapid decrease of about 40 per cent. Denmark has advised that the high value in 1999 was attributable to the opening of new gas fields in that year; a brief explanation should be added to the NIR to improve transparency.

27. No mention is made of venting of CO_2 from acid gas stripping at gas processing plants. This can be a very large source of emissions if raw gas contains high levels of CO_2. Because Denmark is an important gas-producing country, the NIR should explicitly state (if this is the case) that all gas produced in Denmark is "sweet" and that no stripping and venting of CO_2 takes place.

III. Industrial Processes and Solvent and Other Product Use

A. Sector overview

28. In 2003, emissions from the Industrial Processes sector of Denmark amounted to 3,129 Gg CO_2 equivalent, or 4.1 per cent of total national emissions. The breakdown of emissions from the sector was as follows; Mineral Products – 1,486 Gg CO_2 (47.48 per cent); Chemical Industry – 897 Gg CO_2 equivalent (28.68 per cent); and Consumption of Halocarbons and SF_6 – 746 Gg CO_2 equivalent (23.85 per cent). Metal production and production of halocarbons and SF_6 do not occur in Denmark.

Overall sectoral emissions increased by 45.2 per cent from 1990 to 2003, with the highest increase noted in CO_2 emissions from cement production and emissions of fluorinated gases (F-gases).

29. Emissions from solvent and other product use are reported in the CRF tables as amounting to 206 Gg CO_2 equivalent, or 0.3 per cent of total national emissions in 2003.

30. Industry sector emissions have been recalculated to include hydrated lime production for the first time, to take account of improved methodologies, and to take into account more accurate data for consumption of halocarbons and SF_6.

31. Denmark reports a number of QA/QC measures and uncertainty analyses that are specific to sector and subsector sources. Currently the Party does not provide a clear link between the description of methodological issues and the figures in the uncertainty analysis. It would be helpful if Denmark could do this.

B. Key categories

1. Cement production – CO_2

32. Denmark states that the method used to derive the EF in production of clinker (based on loss on ignition), as applied by the one cement producer, deviates from the IPCC good practice guidance. However, the descriptions of the method used and of the AD are not detailed enough to relate them to the IPCC good practice guidance. As noted in the 2004 review report, it is good practice to base emissions estimates for cement production on clinker rather than cement production. The Party is encouraged to use this approach from the IPCC good practice guidance in its future submissions and the ERT understands on the basis of information received from Denmark that a dialogue with the industry is underway to facilitate this.

2. Nitric acid production – N_2O

33. The NIR provides brief details of the estimation of emissions from nitric acid production, based on data from the one producing company in Denmark. The EF, not included in the NIR but later provided directly to the ERT as 7.5 kg N_2O/ton nitric acid, was derived by the company in 2002 and was applied to estimate emissions for the whole time series. The plant ceased operation in 2004. This ERT understands that this information will be included in the NIR published in 2006.

3. Consumption of halocarbons – HFCs and PFCs

34. The Party reports actual and potential emissions estimates based on a combination of bottom–up and top–down tier 2 methods, based on the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. The discussion on EFs is generic and the Party is encouraged to provide more information on the choice of EFs and the specific modelling approaches applied.

C. Non-key categories

Soda ash use and limestone and dolomite use – CO_2

35. The Party aims to include estimates for these sources in its next inventory submission.

IV. Agriculture

A. Sector overview

36. In 2003 the Agriculture sector contributed 9,898 Gg CO_2 equivalent or 13.1 per cent of Denmark's total GHG emissions, a decrease of 23 per cent from the 12,845 Gg CO_2 equivalent reported

for 1990. N_2O emissions fell by 31 per cent because of legislation to increase the utilization of manure nitrogen (N). CH_4 emissions from enteric fermentation also decreased because of decreases in the numbers of cattle. Emissions from manure management increased because of the use of more slurry stable systems.

37. Denmark has made improvements and carried out recalculations as a result of improved information becoming available on calves, including biogas from slurry, and updated AD for N-fixing crops. The combined effect is, however, small. Other improvements include greater transparency and better estimation of uncertainties.

38. The reporting is generally complete. Emissions from rice production, burning of savannas and crop residues do not occur and, as requested by the 2004 review, the notation key "not occurring" ("NO") is used for the corresponding entries in tables 4.C, 4.E and 4.F. Emissions from enteric fermentation linked to fur farming and poultry are not reported because of the lack of IPCC default EFs and because of difficulties with the CRF software. Denmark anticipates that the new software will allow these emissions to be reported.

39. Emissions from enteric fermentation, manure management and agricultural soils are calculated on the basis of an integrated model, the Danish Integrated Emission Model for Agriculture (DIEMA). The Danish Institute of Agricultural Sciences (DIAS) provides Danish standards for livestock production. From 2001 the standards have been updated annually.

40. The ERT noted the comprehensive documentation and tabular data Denmark has included in the NIR for livestock production and stable systems. Because the DIEMA model covers almost the entire sector, Denmark is encouraged to include the detailed description of the model in the next submission. Also, the livestock production standards include information on key country-specific variables, for example, the digestibility of feed, and the ERT recommends that Denmark include a summary of the methodologies used, for example, the number and distribution of trials used for the livestock productivity standards, to support the values of these variables.

B. Key categories

1. Enteric fermentation – CH_4

41. Emissions from enteric fermentation decreased by 12 per cent between 1990 and 2003 because of declining numbers of cattle. Cattle produce 85 per cent of these emissions and an enhanced classification is used for cattle. The dairy cattle CH_4 IEF increased by 5.9 per cent between 1993 and 1994 because of an update in feed consumption data. This jump actually reflects changes which occurred from 1990 to 1993, and the ERT encourages Denmark to consider interpolating between 1990 and 1993 in order to remove the time-series inconsistency. The IEF remains constant for the period 1998–2001; the Party should check whether the feed consumption data are consistent with this.

42. The IEF for CH_4 from enteric fermentation in sheep is 17.2 kg CH_4/head/yr. This is twice the IPCC default and 70 per cent higher than that of any other Party. The NIR states that the IEFs are based on Danish norm (standard practice) data. The number of sheep reported in the NIR is 177 per cent higher than the number given by the Food and Agriculture Organization of the United Nations (FAO). The NIR states that this is because Statistics Denmark does not include livestock on farms less than 5 ha in size, and figures for livestock for the smaller farms are added later for the reporting to the UNFCCC. The ERT recommends that Denmark include in the NIR additional information on the method used to obtain the additional population information, and improve the consistency of its reporting to the different international bodies, taking account of the relevant guidance.

2. Manure management – CH_4

43. Swine produce 71 per cent of the emissions in this category. Denmark calculates the amount of manure for each livestock subcategory and stable type combination on the basis of the DIEMA model. The IPCC default values for methane-producing capacity (B_o) and methane correction factor are used. A methane correction factor of 10 per cent from the Revised 1996 IPCC Guidelines is used by Denmark rather than the updated value of 39 per cent. The NIR does reference studies supporting use of the 1996 value.

44. Denmark provides a very detailed description of livestock allocation to stable type (as encouraged by the 2004 review). An increase in the proportion of slurry-based stable systems is responsible for the increase in emissions from manure management. The details on the distribution of animals between stable types are sourced from the Danish Agricultural Advisory Centre (DAAC) but there is no documentation on how the DAAC obtains the information. The ERT encourages Denmark to include this information.

3. Manure management – N_2O

45. Slurry produces 70 per cent of the emissions in this category. The IPCC default emission values are applied for the animal waste management systems (AWMS). Emissions are reduced by the use of slurry in biogas plants, with the result that the IEF for liquid AWMS falls to 0.086 per cent. An average N content for pig and cattle slurry is reported in the NIR, but it is unclear from the NIR whether the average N value is used or whether an annual N content that reflects the decrease in the nitrogen excretion (Nex) is used. In response to the ERT, Denmark stated that it reflects the development of the average annual N-excretion for each animal category and that this will be further clarified in future submissions.

4. Direct emissions from agricultural soils – N_2O

46. The discussion of emissions from the cultivation of histosols is separated from other activities in the NIR, although the emissions are correctly assigned in table 4D. Denmark should consider reordering the presentation in the NIR of its future submissions.

47. The IPCC tier 1a methodology has been used to calculate the direct N_2O emissions. Denmark provides detailed fertiliser AD. $Frac_{GASF}$ and $Frac_{GASM}$ are back-calculated from national data on fertilizer use and the estimated ammonia emissions from the Danish Institute of Agricultural Sciences (DIAS) ammonia emissions inventory. It should be noted that the value for $Frac_{GASF}$ is 20 per cent of the IPCC default. Detailed methodologies for the DIAS ammonia inventory are not given in the current NIR. Denmark is encouraged to include the detailed description of the model in the next submission.

48. Emissions from N-fixing crops include emissions from clover grass, a source which is not provided for in the IPCC good practice guidance. Although background data are given for clover grass, Denmark does not provide detailed information on the methodologies used to calculate the EF. It would be useful to include this information in the NIR.

5. Indirect emissions from agricultural soils – N_2O

49. Indirect N_2O emissions decreased between 1990 and 2003 due to a decline in total ammonia over the period. The $Frac_{LEACH}$ value is still the highest among the reporting Parties. Denmark states that it uses national modelling methodologies in estimating leaching and run-off (and therefore $Frac_{LEACH}$), and the ERT noted that this methodology would produce more accurate emissions estimates than tier 1. The ERT encourages Denmark to provide summary descriptions of the models in the NIR. Emissions from

atmospheric deposition are derived from the national ammonia inventory and, as in paragraph 47; Denmark is encouraged to include additional information on the ammonia inventory in its 2006 NIR.

C. Non-key categories

Animal production – N_2O

50. Denmark assumes that 15 per cent of the N from dairy cattle is excreted on grass. This assumption is based on expert judgement from studies undertaken in England and the Netherlands. An ammonia volatilization factor of 7 per cent is used. The ERT noted that neither the Revised 1996 IPCC Guidelines nor the IPCC good practice guidance consider volatilization of animal waste deposited directly on pasture and encourages Denmark to provide additional supporting information on this volatilization in the NIR.

V. Land Use, Land-use Change and Forestry

A. Sector overview

51. In 2003 the LULUCF sector in Denmark was a net sink of around 1.6 per cent of total national GHG emissions. However, Denmark does not provide CO_2 emissions/removals estimates for some categories. The Party is planning to incorporate all LULUCF categories in the inventory; to carry out an evaluation of carbon (C) stock changes in mineral soils; and progressively to substitute the current forest inventory, based on questionnaires, with one that is based on sample plots. These will be major changes, which Denmark plans to implement from the 2008 submission because of the timetable for availability of the new data.

52. The methodology used for estimating the size of the reported CO_2 sink does not allow a reliable quantitative estimation of uncertainties. However, the Party is aware that uncertainties are likely to be high, so the reported size of the CO_2 sink should be interpreted with caution. Uncertainty values are given for some subcategories within categories 5.B Cropland and 5.D Wetlands, and for liming of soils. For 5.A Forest Lands, possible sources are identified qualitatively. This is certainly part of the uncertainty assessment; however, in order to see what conclusions should be drawn with respect to the need for further improvements, quantitative assessments are needed. The ERT understands that quantitative estimates will be included when the plot data are introduced.

B. Sink and source categories

1. Forest land remaining forest land and land converted to forest land – CO_2

53. The Overview in section 7.1 of the NIR says that forest sinks account for approximately 3,500 Gg CO_2 per year; more precisely this is the figure in recent years. CRF table 10 shows that the average for the years 1990–2003 is about 3,000 Gg CO_2 per year. The Overview also states that cropland accounts for approximately 2,400 Gg CO_2 net emissions annually, whereas the average for 1990–2003 shown in CRF table 10 is 2,600 Gg CO_2 – this is a large discrepancy. Table 7.2 of the NIR reports a total wooded area of 417,089 ha in 1990, and 473,320 ha in 2000. However, the data presented in CRF table 5.A give 412,120 and 460,100 ha for 1990 and 2000, respectively. There is also an apparent discrepancy between the area reported for broadleaves and conifers in 2000 in table 7.2 of the NIR and the corresponding values reported in CRF table 5.A. Moreover, on page 163 of the NIR it is stated that the forested area with trees in 2000 was 468,000 ha, a figure which differs from the one in table 7.2 and from that obtained from the CRF tables. Furthermore, according to table 7.6 of the NIR, the increase in afforested area amounts to some 20,000 ha between 1990 and 2000, while the CRF tables report an increase of forest area of 30,000 ha and table 7.2 shows an increase of 56,000 ha. The ERT understands

that these apparent discrepancies can be reconciled and suggests that the NIR should do this more clearly, especially as the new data become available over the next two years.

54. The minimum area of a forest is defined as around 0.5 ha. Considering that the total forest area is made up of many fragmented blocks (see page 169 of the NIR), many of which are small (i.e. <0.5 ha), it could be argued that a smaller minimum area may be needed. More information would be useful on the likely extent of the unregistered area and on the meaning of the term "open woodland".

55. The NIR notes several times that areas of forest by species and age classes, as well as information on site productivity, are obtained from questionnaires. On the other hand, standing volume and increment are based on the use of standard yield tables, and the advice on page 164 of the NIR that the estimated gross wood increment is based on questionnaires should be corrected accordingly. In the ERT's view all data need to be systematized and verified, or replaced with more accurate surveys, and the ERT acknowledges Denmark's plan to start in 2007 to use the tracking of sample plots to collect its forest inventory data.

56. The NIR does not provide definitions of volume (e.g. minimum top diameter, inclusion or exclusion of bark and stumps, etc.) or of the biomass expansion factors (BEFs), so it is impossible to judge whether the BEFs are correctly applied. This cross-referencing should be clarified and the BEFs verified, and/or country-specific values developed.

57. Uptake of CO_2 is estimated using a carbon (C) storage model that is based on country-specific yield tables for Norway spruce (as typical for conifers) and oak (as typical for broadleaves). The yield tables are valid for yield class 2; however, no information is given on the meaning of the yield classes used, nor on how the uptake of CO_2 has been estimated for other yield classes. This should be clarified in the NIR.

2. Cropland remaining cropland – CO_2

58. The CO_2 EFs from organic soils are reported to be based on country-specific emissions data from Denmark, as well as data from other countries. It would be useful to obtain truly country-specific values. Emissions and removals from mineral soils under croplands are not reported. Denmark is planning to report them from next year on, and the ERT noted that this may be an important category.

VI. Waste

A. Sector overview

59. In 2003 the Waste sector contributed 1.9 per cent of the GHG emissions of Denmark, representing a slight decrease since 1990, when its contribution was 2.3 per cent. Over the period 1990–2003 the total CO_2 equivalent emissions in this sector decreased by 10.1 per cent (164 Gg CO_2 equivalent), with some fluctuations imposed upon a mostly decreasing trend. This fall in emissions is attributed mainly to a reduction of emissions from managed waste disposal sites because increasing amounts of waste have been recycled or incinerated. CH_4 emissions from the sector in 2003 represented 23.7 per cent of total national CH_4 emissions and showed a decrease by 6.5 Gg CH_4 since 1990. The main contribution of CH_4 was from solid waste disposal on land (82.5 per cent of the sectoral total); the remainder (17.5 per cent) came from waste-water handling. Denmark has introduced considerable improvements in this inventory submission compared to the previous one: for example, CH_4 and N_2O emissions from waste-water handling have been estimated for the first time, and detailed information on the methodology, AD and parameters used is provided in the NIR.

B. Key categories

Solid waste disposal on land – CH_4

60. CH_4 emissions from this source category in 2003 amounted to 54.9 Gg and had declined by 13.6 per cent (8.6 Gg CH_4) since 1990 due to increasing recycling and incineration. CH_4 emissions have been calculated using a model suited to Danish conditions which is based on the IPCC tier 2 approach and the first-order decay (FOD) method. The parameters used for the calculation are provided and documented in the NIR. The specific values used for degradable organic carbon (DOC), the fraction of DOC dissimilated (DOC_F), the methane correction factor, and the oxidation factor (OX) are within the range of recommended values in the IPCC good practice guidance. In the model a half-life of 10 years has been used, corresponding to k = 0.07 $year^{-1}$. However, different types of waste could require the use of different values of k. The ERT understands that Denmark will consider developing a model with k-values for different waste types and to carry out sensitivity analyses on the use of k values. The ERT recommends that Denmark conduct the analysis and provide the results in the NIR in the future submission.

61. According to annex 3E of the NIR, the starting year for the FOD model used was 1960. However, the NIR specifies that the amount of waste has only been registered since the beginning of the 1990s in order to measure the effects of action plans on waste management. Denmark has provided the ERT with information on the source of the amount of waste data before 1994. The ERT recommends Denmark to include this in the NIR. According to table 8.8 in the NIR, annual net emissions in 2003 (54.9 Gg) are the result of subtracting biogas collected (8.3 Gg) from the annual emissions (63.2 Gg). CH_4 recovered must be subtracted from the amount generated before applying the oxidation factor. Denmark recognizes the problem and will consider changing this in the 2007 submission. The ERT encourages Denmark to make the appropriate revisions and recalculate emissions from this source.

62. The NIR provides detailed information on the data used for the calculation, including the composition of the different waste types. Also in CRF table 6.A additional information is provided and explanations are included in the documentation box. However, there are some blank cells in CRF table 6.A. The Party is recommended to report values or use the appropriate notation key.

63. The emissions calculated by the FOD method were compared with the IPCC default method. The results obtained show that the default method underestimates both the amounts of waste deposited and the CH_4 emissions by a factor of 2–3, because, as applied, it does not include industrial waste.

C. Non-key categories

1. Waste-water handling – CH_4

64. CH_4 emissions from waste-water handling (6.B.1 Industrial Wastewater, and 6.B.2 Domestic and Commercial Wastewater) in 2003 amounted to 11.6 Gg and contributed 17.5 per cent to total CH_4 emissions in the Waste sector. The level of emissions showed a general tendency to increase, with fluctuations in specific years. The methodology used follows the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. Most waste water is treated in centralized municipal waste-water treatment plants, including a significant part of industrial waste water. No data exist to make it possible to separate these domestic/municipal contributions from industrial contributions, and no data regarding industrial on-site waste-water treatment or final sludge disposal are available. In addition it was not possible to differentiate the CH_4 emissions from sludge from those from waste water. The ERT encourages Denmark to estimate the domestic and industrial contributions separately.

2. Waste-water handling – N_2O

65. According to the NIR, in 2003 N_2O emissions from this source category amounted to 0.20 Gg, or about 0.8 per cent of total national N_2O emissions. They have been calculated as the sum of contributions from waste-water treatment processes at the waste-water treatment plants and sewage effluents. The methodology used considered both the direct emissions originating from waste-water treatment processes at the waste-water treatment plants and indirect emissions originating from the nitrogen compounds contained in the waste water. In 6.B.2.2 Human Sewage, N_2O emissions not only from human sewage but also from the effluent discharged sewage N load are reported. In the interests of comparability, only N_2O emissions from human sewage should be reported in 6.B.2.2 (Human Sewage), and N_2O emissions from the effluent discharged sewage N load should be reported in 6.B.2.1 (Domestic and Commercial Wastewater). The ERT understands that Denmark plans to report N_2O emissions from human sewage in 6.B.2.2 and emission from wastewater effluent N load in 6.B.2.1. The ERT encourages Denmark to make the appropriate revisions as soon as practicable.

3. Waste incineration – CO_2, CH_4 and N_2O

66. Emissions from waste incineration are included in the Energy sector (1.A Public Electricity and Heat Production), since all waste incinerated in Denmark is used for energy production.

Annex

Documents and information used during the review

A. Reference documents

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

IPCC. Good practice guidance for land use, land-use change and forestry, 2003. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.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>.

UNFCCC. 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/SBSTA/2004/8. Available at: <http://unfccc.int/resource/docs/2004/sbsta/08.pdf>.

UNFCCC. 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. Status report for Denmark. 2005. Available at <http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/2005_status_report_denmark.pdf>.

UNFCCC secretariat. Synthesis and assessment report on the greenhouse gas inventories submitted in 2005. FCCC/WEB/SAI/2005. Available at <http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/sa_2005_part_i_final.pdf>.

UNFCCC secretariat. Denmark: Report of the individual review of the greenhouse gas inventory submitted in the year 2004. FCCC/WEB/IRI/2004/DNK. Available at <http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/2004_irr_centralized_review_denmark.pdf>.

B. Additional information provided by the Party

Additional information was provided to the ERT after Denmark reviewed the draft centralized review report. This information was provided by Mr. Erik Lyck (Danish National Environment Research Institute).

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