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**Report of the individual review of the greenhouse gas inventory of Greece  
submitted in 2006 \***

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\* In the symbol for this document, 2006 refers to the year in which the inventory was submitted, and not to the year of publication

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## I. Overview

### A. Introduction

1. This report covers the in-country review of the 2006 greenhouse gas (GHG) inventory submission of Greece, coordinated by the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, in accordance with decision 19/CP.8. The review took place from 23 to 28 April 2007 in Athens, Greece, and was conducted by the following team of nominated experts from the roster of experts: generalist – Mr. Paul Filliger (Switzerland); energy – Mr. Matej Gasperič (Slovenia); industrial processes – Mr. Teemu Oinonen (Finland); agriculture – Mr. Erda Lin (China); land use, land-use change and forestry (LULUCF) – Mr. Héctor D. Ginzo (Argentina); waste – Mr. Jose Ramon T. Villarin (Phillipines). Mr. Teemu Oinonen and Mr. Jose Ramon T. Villarin were the lead reviewers. The review was coordinated by Ms. Keryn Oude-Egberink and Mr. Javier Hanna (UNFCCC secretariat).

2. In accordance with the UNFCCC guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention, (hereinafter referred to as the UNFCCC review guidelines), a draft version of this report was communicated to the Government of Greece.

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

3. In its 2006 submission, Greece submitted a complete set of common reporting format (CRF) tables for the years 1990–2004 and a national inventory report (NIR). The full list of materials used during the review is provided in the annex to this report.

### C. Emission profiles and trends

4. In 2004, the most important GHG in Greece was carbon dioxide (CO<sub>2</sub>), contributing 80.1 per cent to total<sup>1</sup> national GHG emissions expressed in CO<sub>2</sub> equivalent (eq), followed by nitrous oxide (N<sub>2</sub>O), 9.6 per cent, and methane (CH<sub>4</sub>), 6.1 per cent. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF<sub>6</sub>) taken together contributed 4.2 per cent of the overall GHG emissions in the country.

5. The energy sector accounted for 78.6 per cent of the total GHG emissions followed by industrial processes (10.3 per cent), agriculture (8.7 per cent) and waste (2.4 per cent) and solvent and other product use (0.1 per cent). In 2004, total GHG emissions (excluding LULUCF) amounted to 137,633.02 Gg CO<sub>2</sub> eq and increased by 26.6 per cent from the base year<sup>2</sup> to 2004. For the same period CO<sub>2</sub> increased by 30.8 per cent, while the total F-gases increased by 383.8 per cent. HFCs increased by 510.6 per cent and PFCs decreased by 72.6 per cent. CH<sub>4</sub> decreased by 8.1 per cent and N<sub>2</sub>O decreased by 6.8 per cent. The strongest increase in emissions was observed in the industrial processes sector (59.9 per cent), followed by the energy sector (32.3 per cent). The most significant reduction in emissions occurred in waste (26.6 per cent) and agriculture (11.7 per cent). The LULUCF category was a net sink in 2004 (5,402.32 Gg CO<sub>2</sub> eq).

6. Tables 1 and 2 show the GHG emissions by gas and by sector, respectively.

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<sup>1</sup> In this report, the term total emissions refers to the aggregated national GHG emissions expressed in terms of CO<sub>2</sub> eq excluding LULUCF, unless otherwise specified.

<sup>2</sup> The base year in this report refers to 1990. The total emissions (excluding LULUCF) reported by Greece were 108,742.26 Gg CO<sub>2</sub> eq in 1990.

Table 1. Greenhouse gas emissions by gas, 1990–2004

GHG emissions	Gg CO <sub>2</sub> eq								Change BY–2004 (%)
	Base year (Convention)	1990	1995	2000	2001	2002	2003	2004	
CO <sub>2</sub> (with LULUCF)	81 065.36	81 065.36	83 019.15	100 820.92	100 886.22	100 445.45	104 380.92	104 865.64	29.4
CO <sub>2</sub> (without LULUCF)	84 313.57	84 313.57	87 426.12	103 962.81	106 209.85	105 905.19	109 914.39	110 280.16	30.8
CH <sub>4</sub>	9 169.37	9 169.37	9 222.40	9 116.51	8 585.37	8 556.05	8 481.74	8 423.10	–8.1
N <sub>2</sub> O	14 118.51	14 118.51	13 076.83	13 425.20	13 219.65	13 169.25	13 252.12	13 156.35	–6.8
HFCs	935.06	935.06	3 421.01	5 282.43	5 203.33	5 297.55	5 558.78	5 709.43	510.6
PFCs	257.62	257.62	82.97	148.38	91.38	88.33	77.30	71.71	–72.2
SF <sub>6</sub>	3.07	3.07	3.59	3.99	4.06	4.25	4.25	4.47	45.6

Note: BY = Base year; LULUCF = Land use, land-use change and forestry.

Table 2. Greenhouse gas emissions by sector, 1990–2004

Sectors	Gg CO <sub>2</sub> eq								Change BY–2004 (%)
	Base year (Convention)	1990	1995	2000	2001	2002	2003	2004	
Energy	81 762.63	81 762.63	84 570.34	101 508.11	103 791.84	103 726.47	107 820.03	108 135.69	32.3
Industrial processes	8 845.58	8 845.58	11 549.86	13 801.99	13 715.32	13 664.52	13 942.41	14 142.91	59.9
Solvent and other product use	169.71	169.71	154.65	157.33	154.67	155.12	155.50	155.87	–8.2
Agriculture	13 519.23	13 519.23	12 486.24	12 357.76	12 144.28	12 079.00	11 998.61	11 936.71	–11.7
LULUCF	–3 193.27	–3 193.27	–4 368.69	–2 958.93	–5 298.43	–5 456.21	–5 528.53	–5 402.32	69.2
Waste	4 445.10	4 445.10	4 433.54	3 931.16	3 482.32	3 391.97	3 367.09	3 261.83	–26.6
Other	NO	NO	NO	NO	NO	NO	NO	NO	NA
<b>Total (with LULUCF)</b>	105 548.99	105 548.99	108 825.94	128 797.42	127 990.00	127 560.88	131 755.11	132 230.70	25.3
<b>Total (without LULUCF)</b>	108 742.26	108 742.26	113 194.63	131 756.36	133 288.43	133 017.08	137 283.64	137 633.02	26.6

Note: BY = Base year, LULUCF = Land use, land-use change and forestry.

#### D. Key categories

7. Greece has reported a key category tier 1 analysis, both level and trend assessment for 2004, as part of its 2006 inventory submission and has included the LULUCF sector in its key category analysis. The level assessment of the key category analyses performed for 2004 by Greece and the secretariat<sup>3</sup> produced similar results. The trend assessment of the key category analyses performed by Greece and the secretariat for the period 1990–2004, however, produced different results. The differences are explained by the selection of the starting year for the trend analysis. The secretariat selected 1990 as the starting year, while Greece selected 1995, as this is the base year for HFCs, PFCs and SF<sub>6</sub>. The key category analysis undertaken by Greece is used to prioritize the development of the inventory. The expert review team (ERT) recommends that Greece include in its next submission a key category analysis for 1990 and develop, if possible, a tier 2 key category analysis.

#### E. Main findings

8. Greece's inventory is broadly consistent with the 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 (hereinafter referred to as the UNFCCC reporting guidelines, Part I); and generally in line with the *Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines), and 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).

9. During the in-country review, the ERT identified a number of categories where methods, activity data (AD) or emission factors (EFs) used were not fully transparent and in accordance with the IPCC good practice guidance and it requested Greece to submit revised estimates for the following categories in its next inventory submission: CO<sub>2</sub> emissions from public electricity and heat production (1.A.1(a)); N<sub>2</sub>O emissions from the combustion of solid and liquid fuels used in energy industries (1.A.1) and in manufacturing industries and construction (1.A.2); CO<sub>2</sub> emissions from coal mining and handling – surface mines – mining and post-mining activities (1.B.1.a.ii.); CH<sub>4</sub> and CO<sub>2</sub> emissions – natural gas – other leakage (1.B.2.b.v); and CH<sub>4</sub> and N<sub>2</sub>O from the consumption of gaseous fuels in manufacturing industries and construction – chemicals (1.A.2.c). A detailed description of the categories where methods, AD or EFs were not fully transparent and in accordance with the IPCC good practice guidance are provided under the relevant sectors.

10. The main findings include the need for Greece to investigate significant statistical differences in its energy balance; to improve the accuracy of the estimates of key categories in the energy sector; to work on completeness – including potential emissions of F-gases (HFCs, PFCs and SF<sub>6</sub>); and to plan and implement a procedural system for periodically estimating biomass growth rates in order to improve LULUCF estimates of CO<sub>2</sub> removals.

11. The Ministry for the Environment, Physical Planning and Public Works is the designated entity with the overall responsibility for GHG inventory. The National Observatory of Athens, was contracted by the Ministry for the preparation of Greece's 2006 GHG inventory submission. NOA's contract ended in 2007. During the review, Greece informed the ERT that the technical responsibility for the

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<sup>3</sup> The secretariat identified, for each Party, those source categories that are key categories in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the IPCC good practice guidance for LULUCF. Key categories according to the tier 1 trend assessment were also identified for those Parties that provided a full set of CRF tables for the base year. Where the Party 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.

development of future national inventories had been transferred from NOA to the Division of Atmospheric Pollution Control, Ministry for the Environment, Physical Planning and Public Works.

12. The ERT recommends that in the light of the changes to its institutional arrangements, Greece in its next inventory submission include a detailed description of the new institutional arrangements with regard to the planning and preparation of the national inventory, in particular the arrangements for the technical competence of the staff involved in the inventory development process, and their capacity for timely performance in the preparation of Greece's national inventory.

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

### **1. Completeness**

13. The 2006 inventory submission is complete in terms of geographical coverage. For the period 1990–2004, the coverage of years, sectors, categories and gases is generally complete. However, some categories are missing, for example, in the industrial processes sector, HFCs, PFCs and SF<sub>6</sub> from fire extinguishers, foam blowing and aerosols, and, in the energy sector, CH<sub>4</sub> leakage from the residential and commercial sectors and from industrial plants and power stations.

14. The CRF tables are completely filled in, but for many categories the notation key “not estimated” (“NE”) is used, for example, for the consumption of halocarbons and SF<sub>6</sub> (2.F) – HFCs, PFCs and SF<sub>6</sub>. Greece states that these sources are mostly of very minor importance. The ERT recommends that Greece prepare and report estimates for categories that are currently “NE” and report these in its future inventory submissions.

### **2. Transparency**

15. The CRF tables and the NIR are generally transparent. The NIR is well structured and broadly follows the UNFCCC reporting guidelines, Part I. However, some additional information could improve the transparency of the NIR. For example, it is recommended that Greece in its next NIR provide more detailed information about AD, EFs and selected methods for the key categories; improve its documentation of expert judgments, and improve the references to literature sources. The ERT also recommends that Greece include more information on the key categories in its next NIR.

### **3. Recalculations and time-series consistency**

16. Recalculations are performed by Greece as a result of methodological changes or refinements, updates and revision of AD, changes in the allocation of emission estimates to different sectors and/or categories, and the inclusion of categories which were not addressed previously. The recalculations performed in the 2006 inventory submission cover practically all sectors. For example, in the waste sector recalculations have resulted from the use of a tier 2 methodology for solid waste disposal on land (SWDL), and in industrial processes, estimates for HFC emissions from commercial refrigeration are included for the first time. The recalculations have resulted in improvements to the inventory. The total effect of the recalculations is a decrease in the estimates of emissions of 0.3 per cent in 2003 and of 0.6 per cent in 1990. Information on the basis for the recalculations is provided by Greece in both the NIR and CRF table 8(b).

### **4. Uncertainties**

17. In its 2006 GHG inventory Greece has provided for the first time a tier 1 uncertainty analysis following the IPCC good practice guidance. Uncertainty estimates are available for all categories. Uncertainty values for AD and EFs are taken from the IPCC good practice guidance and from national expert judgement. Uncertainty estimates have been calculated for total emissions with and without LULUCF and for the different GHGs. Greece is using the results of the uncertainty analysis to prioritize improvements in the inventory.

18. The rationale provided by Greece for the selection of the uncertainty levels for the different categories, however, is not well explained in the NIR. The ERT recommends that Greece include information on the rationale for the selection of uncertainty values in each sectoral chapter in its next NIR and develop, if possible, a tier 2 uncertainty analysis.

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

19. Greece has elaborated a quality assurance/quality control (QA/QC) plan in accordance with the IPCC good practice guidance. Greece's QA/QC system is based on International Organization for Standardization (ISO) standard 9001:2000. It includes procedures on general quality management, QC, archiving of inventory information, QA, estimation of uncertainties and inventory improvement.

20. Source/sink category-specific procedures (tier 2) for key categories, and for those individual categories in which significant methodological and/or data revisions have occurred, have not yet been developed. The implementation of the QA/QC plan is under way but not well advanced. The ERT recommends that Greece focus on the implementation of the QA/QC plan, as well as the implementation of tier 2 procedures and report this information in its next NIR.

21. A periodic internal review (reliability check) was done for the 2006 submission by technical staff within NOA during the preparation of the inventory. Drafts of the NIR and the CRF tables were prepared by NOA and submitted to the Ministry for the Environment, Physical Planning and Public Works, after which cross-consultation with relevant ministries took place. No domestic review by independent experts, however, was undertaken. The ERT recommends that for its next inventory submission Greece improve its QA by carrying out a review of the inventory by independent national experts.

#### 6. Follow-up to previous reviews

22. The national GHG inventory of Greece has steadily improved in a number of areas over recent years. In the 2006 GHG inventory the ERT noted that many recalculations have been carried out since the last inventory submission (2005). For example, for the first time Greece has estimated CO<sub>2</sub> emissions from ferroalloys production, HFCs from commercial refrigeration, SF<sub>6</sub> from electrical equipment, and CH<sub>4</sub> from sewage sludge. Methodological refinements have also been introduced, including the use of tier 2 methodology for SWDL. The ERT commends Greece on these improvements.

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

#### 1. Identified by the Party

23. In the NIR Greece identifies several areas for improvement. It plans to implement improvements to the centralized archiving of information, and the specification of procedures for the evaluation and consideration of the verified reports submitted by Greek installations under the European Union (EU) emissions trading scheme (EU ETS); to revise the national energy balance; to enhance the completeness of the inventory; and to use higher-tier methods for some key categories (e.g. tier 2 methodology for the estimation of CH<sub>4</sub> emissions from the enteric fermentation of cattle). Greece has also indicated that it is working to improve its estimation on areas of land use and areas included in land-use conversion, for which Greece intends to implement a land-measuring system equivalent to a tier 2 approach, as described in the *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF).

#### 2. Identified by the ERT

24. The ERT identifies the following cross-cutting issues for improvement and recommends that Greece implement these changes in its next inventory submission:

- (a) Describe in detail Greece's institutional arrangements for the planning and preparation of the national inventory, including the arrangements for the technical competence of the staff involved in the inventory development process and their capacity for timely performance in the preparation of the Party's national inventory;
- (b) Improve the accuracy of the estimates of key categories in the energy sector addressing the issues identified by the ERT during the in-country review. For instance, collect information on combustion technologies and implement a tier 2 method for estimating N<sub>2</sub>O emissions from the combustion of solid and liquid fuels from the categories of energy industries (1.A.1), and manufacturing industries and construction (1.A.2);
- (c) Improve the transparency of the estimates by providing more precise descriptions and documentation of methods and provide more detailed information about AD and EFs for all key categories;
- (d) Improve completeness, by preparing and reporting estimates for categories currently "NE", for example: CO<sub>2</sub> emissions from coal mining and handling – surface mines – mining and post-mining activities (1.B.1.a.ii.); CH<sub>4</sub> and CO<sub>2</sub> emissions – natural gas – other leakage (1.B.2.b.v); and sub-categories of consumption of halocarbons and SF<sub>6</sub>. The ERT also recommends that Greece establish a data-collection scheme that allows the reporting of potential emissions of F-gases;
- (e) Further develop the QA/QC system and subsequently implement QA/QC procedures in the inventory preparation, particularly by carrying out a domestic review of the inventory by independent national experts; and include more information on QC activities in each sectoral chapter of the NIR;
- (f) Use tier 2 methods for key categories in accordance with the IPCC good practice guidance, in particular for key categories under LULUCF, for example, for the estimation of CO<sub>2</sub> emissions from forest land remaining forest land (5.A.1), and cropland remaining cropland (5.B.1);
- (g) Include information on the rationale for the selection of uncertainty levels in each sectoral chapter of the NIR.

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

## II. Energy

### A. Sector overview

26. In 2004, the energy sector in Greece accounted for 78.6 per cent of total national GHG emissions. Fuel combustion contributed 77.3 per cent to the total national emissions. Total GHG emissions from the energy sector increased by 32.3 per cent from 1990 to 2004, and by 0.3 per cent from 2003 to 2004. In 2004, the most important categories in the energy sector were energy industries and transport, contributing 55.3 and 20.6 per cent, respectively, to the total GHG emissions from this sector.

27. Greece's key category analysis for the energy sector is consistent with the assessment conducted by the secretariat. Greece identified ten key categories: CO<sub>2</sub> from stationary combustion from solid, liquid and gaseous fuels (1.A.1, 1.A.2, and 1.A.4), civil aviation (1.A.3.a), road transportation (1.A.3.b) and navigation (1.A.3.d); N<sub>2</sub>O emissions from stationary combustion of solid fuels and from road

transportation (1.A.3.b); and CH<sub>4</sub> emissions from coal mining and handling – surface mines – mining and post-mining activities (1.B.1.a.ii).

28. The NIR and the CRF tables provide estimates for all direct and indirect greenhouse gases from 1990 to 2004 from fuel combustion. Time-series consistency has been improved significantly by using relevant AD and EFs received from comprehensive industry questionnaires from the EU ETS allocation plan for Greece. The ERT commends Greece for this improvement and encourages Greece to use verified reports from installations under the EU ETS as an additional QC check for its future submissions.

29. During the in-country review, the ERT identified a number of categories where methods, AD or EFs used were not fully transparent and in accordance with the IPCC good practice guidance, for example, a number of over-estimations in the base year were identified for the following categories: the estimation of CO<sub>2</sub> emissions from the consumption of lignite for public electricity and heat production (1.A.1.a.); the estimation of N<sub>2</sub>O emissions from the combustion of solid and liquid fuels used in energy industries (1.A.1) and in manufacturing industries and construction (1.A.2); CO<sub>2</sub> emissions from the consumption of solid fuels (lignite) for ammonia production (1.A.2.c); CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O emissions from civil aviation (1.A.3.a); CO<sub>2</sub> emissions from energy combustion of lubricants from road transportation (1.A.3.b); and CH<sub>4</sub> and N<sub>2</sub>O emissions from residential biomass consumption (1.A.4.b). The ERT recommends that Greece report these estimates in its next inventory submission.

30. Furthermore underestimations in the latest year, 2004, were also identified: CH<sub>4</sub> and N<sub>2</sub>O emissions from solid fuel use in railways (1.A.3.(c)); CO<sub>2</sub> emissions from coal mining and handling – surface mines – mining and post-mining activities (1.B.1.a.ii.); and CH<sub>4</sub> and CO<sub>2</sub> emissions – natural gas – other leakage (1.B.2.b.v); CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O emissions from other sectors (1.A.4); CH<sub>4</sub> and N<sub>2</sub>O emissions from chemicals (1.A.2.c). Underestimations in other years were also identified, for example, CH<sub>4</sub> and N<sub>2</sub>O emissions from the consumption of gaseous fuels in manufacturing industries and construction – chemicals (1.A.2.c) are reported “NO” for 1990 and 1995–1997; and CH<sub>4</sub> and N<sub>2</sub>O emissions from solid fuel use in railways (1.A.3.c) are reported “NE” for 1990–1997 and “NO” for 1998–2003. The ERT recommends Greece to revise its estimation or report these estimates in its next inventory submission.

31. According to the NIR, the category agriculture/forestry/fisheries is not accounted for under other sectors (1.A.4). The ERT recommends that Greece make efforts to obtain the necessary AD in order to report these sub-sectors appropriately in its future submissions.

32. Fugitive emissions are estimated mainly for CH<sub>4</sub> and CO<sub>2</sub>. In comparison with its previous submission, Greece has made significant improvements in terms of the disaggregation of fugitive emissions into the relevant IPCC categories, and completeness of reporting. Greece also reports N<sub>2</sub>O from the flaring of oil and gas. The ERT would like to further encourage Greece to continue these improvements in its future submissions and to estimate fugitive emission from sources such as CO<sub>2</sub> from mining and post-mining activities, and CH<sub>4</sub> from leakage at industrial plants and in the residential and commercial sectors.

33. The overall transparency of the inventory is satisfactory; however the ERT identified a number of transparency issues relating to the energy sector. Greece uses the COPERT III model for estimating GHG emissions from road transportation. Information is not, however, available on the length of trip (ltrip) parameters, or on the assumptions made with regard to the vehicle fleet and mileage for liquefied petroleum gas (LPG)-fuelled passenger cars. The ERT recommends that Greece document these assumptions in its next NIR.

34. In addition, information on technology type for the estimation of emissions from stationary sources is not provided in the NIR, although Greece uses the CORINAIR methodology for estimating N<sub>2</sub>O emissions for these categories. There is also no information in the NIR on the allocation of the

consumption of lubricants in road transportation (1.A.3(b)) and aviation fuel used for domestic flights. Furthermore, the ERT found in the NIR an inconsistency in the AD for biomass consumption reported for the energy sector and the LULUCF sector.

35. The ERT recommends that Greece further improve documentation in its next inventory submission on methodological choices and their rationale, the choice of AD and sources, and references used for emissions estimations.

36. Greece has included an overall national energy balance for 1990–2004 and increased the level of disaggregation of each subcategory, as recommended in previous review reports.

37. Recalculations for the overall energy sector resulted in an increase in CO<sub>2</sub> (0.2 per cent) for 1990, and decreases for CH<sub>4</sub> (0.5 per cent) and N<sub>2</sub>O (2.4 per cent). In 2003, recalculations for the overall energy sector resulted in an increase in CO<sub>2</sub> (0.2 per cent) and in N<sub>2</sub>O (0.4 per cent), and a decrease in CH<sub>4</sub> (5.7 per cent). Recalculations were performed on the basis of improved data collection and revisions to the Greek energy balance. Some recalculations were also made due to the correction of errors (e.g. typing errors and the number of decimal places reported). Recalculations of GHG emissions from stationary combustion have decreased emissions in 1990 by 0.1 per cent and in 2003 by 0.1 per cent.

38. Estimates of emissions from the transport sector were recalculated for 1992 and 1999–2003. The recalculations resulted in an overall increase of 0.02 per cent in the figures for emissions from transport in 2003.

39. The recalculation of fugitive emissions of CH<sub>4</sub> from oil and natural gas for the period 1990–2000 resulted in significant increases in CH<sub>4</sub> emissions for the energy sector. CH<sub>4</sub> emissions were recalculated using the IPCC tier 1 methodology. This resulted in an increase in CH<sub>4</sub> fugitive emissions from fuels (4.6 per cent) in 1990 and a decrease in CH<sub>4</sub> emissions in 2003 (4.1 per cent). In the 2004 inventory submission, CO<sub>2</sub> and N<sub>2</sub>O emissions from oil and natural gas were estimated for the first time.

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

### **1. Comparison of the reference approach with the sectoral approach and international statistics**

40. Greece has applied both the reference approach and the sectoral approach for calculations of CO<sub>2</sub> emissions from fuel combustion for the entire time series. For 2004, Greece attributes the difference (1.14 per cent) between the two approaches mainly to statistical differences for liquid fuels. The ERT is of the opinion that an additional reason for the difference could be the way in which non-energy fuel use (especially natural gas) is treated in the estimations. The ERT therefore recommends that Greece investigate this difference and provide information on it in its future submissions.

### **2. International bunker fuels**

41. According to the NIR, the allocation of fuel consumption between domestic and international transport is based on data contained in the national energy balance, while the allocation of aircraft landings and take-offs (LTOs) between domestic and international aviation is based on data from the Civil Aviation Organisation (CAO). Greece estimated GHG emissions from international aviation using the IPCC tier 2a methodology and default EFs for CO<sub>2</sub>, and tier 2a EFs for N<sub>2</sub>O and CH<sub>4</sub> emissions, while for international navigation the CORINAIR methodology and corresponding EFs were used. Inconsistencies between the time series of LTOs and energy consumption are acknowledged by Greece in the NIR.

42. The ERT recommends that Greece obtain information for its next submission on the structure of the air fleet operating on domestic and international flights and that it provide background documentation on how aviation fuel is allocated to international flights in order to explain the discrepancies and revise

the emissions estimation on this basis. If this cannot be done, the ERT recommends that Greece determine whether the amount of fuel in the latest years, including 2004, corresponds to the number of domestic flights, revise the GHG estimates using the number of LTOs as a driver, and extrapolate fuel consumption back to 1990. Such a revision may have implications for the total amount of fuel allocated and the corresponding emissions for the civil aviation category for the complete time series.

### 3. Feedstocks and non-energy use of fuels

43. The non-energy use of bitumen, lubricants, naphtha, natural gas, other oil products and petroleum coke is taken into account in both the reference and the sectoral approaches; the resulting CO<sub>2</sub> emissions in the production of metals and in the chemical industry are estimated and reported by Greece in an aggregated manner for each fuel type, using mostly IPCC default values for the fraction of carbon stored. The non-energy use of lignite in the chemical industry in the period 1990–1991 is also taken into account and reported.

44. Greece states in the NIR that AD on the non-energy consumption of fuels are derived from the national energy balance. The non-energy use of lignite for ammonia production in the national energy balance is included in the non-energy consumption of the chemical industry but the available information does not allow for allocation of individual fuel consumption to individual industrial categories. Thus, CO<sub>2</sub> emissions from ammonia production are included in chemicals (1.A.2.c) and reported under the energy sector instead of the industrial processes sector. The ERT recommends that Greece thoroughly examine the allocation of the non-energy use of fuels throughout the energy sector, particularly in the chemicals category (liquid and gaseous fuels) and provide more transparent documentation on such allocation in its next inventory submission.

45. No data regarding non-energy use of fuels in the iron and steel industry are reported in the national energy balance, therefore CO<sub>2</sub> emissions from the use of fuels as reduction agents are reported by Greece under the industrial processes sector. As available information on non-energy use of laterite in the ferroalloys sub-sector does not allow more detailed disaggregation, CO<sub>2</sub> emissions from ferroalloys production are reported under the energy sector instead of the industrial processes sector. The ERT encourages Greece in its future submissions to use available data on non-energy use of fuels and carbon stored from plants participating in the EU ETS, and improve the allocation of emissions under the relevant categories.

### 4. Country-specific issues

46. In CRF table 1.B.2, geothermal energy production is reported as a potential source of fugitive emissions, but emissions are reported as “NE”. The ERT notes that this issue is not addressed in the NIR. The ERT recommends that Greece discuss this issue in the NIRs of its future submissions.

## C. Key categories

### 1. Stationary combustion: solid fuels – CO<sub>2</sub>

47. Stationary combustion of fossil fuels is dominated by lignite consumption in thermal power plants, and the allocation of energy consumption by technology is made on the basis of data provided by the 1993 study of the Public Power Corporation (PPC), entitled "Estimation of the CO<sub>2</sub> emission factors for the lignite used by the PPC", (Athens, 1994) (hereinafter referred to as the PPC study). This study developed the estimation of CO<sub>2</sub> EFs for lignite based on the installed capacity and the characteristics of electricity production plants. However, exact values from this study were not used for the CO<sub>2</sub> emission estimates (average value of 122 t CO<sub>2</sub>/TJ).

48. Emissions from domestic lignite with a relatively low net calorific value (NCV) (5–5.71 MJ/kg) account for more than 90 per cent of the solid fuels used in Greece in the base year. Dry lignite of a higher NCV, and other bituminous coal and coke oven gas are also combusted for energy purposes.

49. During the in-country review the ERT assessed the calculations for CO<sub>2</sub> emissions from the public electricity and heat production category and noticed discrepancies in the CO<sub>2</sub> EF. Greece does not use the derived CO<sub>2</sub> EF of the lignite used for electricity production from the PPC study, (122 t CO<sub>2</sub>/TJ including oxidation factor) but a slightly higher CO<sub>2</sub> implied emission factor (IEF) (122.173 t CO<sub>2</sub>/TJ) which the Party explained is derived from a rounded estimate of the carbon content of 34 t C/TJ, and an IPCC default oxidation factor of 0.98. Although the PPC study is referenced in the NIR, no background information is provided in the NIR with regard to the carbon content used for CO<sub>2</sub> emission estimates.

50. The energy balance of Greece reports 579,000 t of lignite for “non-energy use”, while the *Statistical Yearbook of Greece 1990–1991* reports 79 kt<sub>oe</sub><sup>4</sup> (3,307.57 TJ) of lignite consumption for “non-energy use” in 1990. During the in-country review, using these data, the ERT calculated the NCV for lignite, obtaining a value of 5.71 MJ/kg (3,307.57 TJ/579 kt), which corresponds to the NCV used for lignite in the energy industries (1.A.1) category. However, using the 4,862.86 TJ of lignite reported in CRF table 1.A(d) used as feedstock for ammonia production, and the 579,000 t of lignite for “non-energy use” (energy balance of Greece), the calculation results in an NCV of 8.399 MJ/kg which is much higher than that used for lignite in the energy industries category (1.A.1). For 1991 the calculation results in an NCV of 8.323 MJ/kg. The ERT identified a lack of transparency in the NCV of lignite used to estimate AD and CO<sub>2</sub> emissions from ammonia production, particularly in 1990. The ERT concluded that the NCV of lignite for ammonia production in 1990 and 1991 was much higher than the NCV of lignite used for electricity generation. The ERT recommends that Greece revise its CO<sub>2</sub> emissions for the applicable years from the combustion of solid fuels (lignite) for ammonia production by using the lignite NCV of 5.71 MJ/kg.

51. Greece also reports the use of smaller amounts of lignite in other sectors (1.A.4). According to the information provided to the ERT Greece calculates the NCV in other sectors (1.A.4) as a weighted average of the NCV for lignite used in power generation and the NCV for lignite used in the manufacturing industry and construction (1.A.2). Since the amount of lignite used in power generation is in an order of magnitude higher than the value used in industry, (i.e the weighted NCV is very low – 5.109 MJ/kg in 2004) it is unlikely that lignite with such a low NCV would be used in commercial and residential boilers. Therefore the ERT recommends that Greece, in estimating CO<sub>2</sub> emissions from lignite used in other sectors (1.A.4), adopt a similar NCV for lignite consumption to the one used for manufacturing industry and consumption (1.A.2).

52. The ERT recommends that Greece revise its estimates for CO<sub>2</sub> emissions from the use of lignite for the complete time series in its next inventory submission.

## 2. Stationary combustion: solid and liquid fuels – N<sub>2</sub>O

53. The N<sub>2</sub>O IEFs resulting from N<sub>2</sub>O estimations for 2004 from the combustion of solid fuels in the categories energy industries (15.95 kg N<sub>2</sub>O/TJ); and manufacturing industries and construction (12.48 kg N<sub>2</sub>O/TJ) are several times higher than the IPCC default value (1.4 kg N<sub>2</sub>O/TJ). During the in-country review Greece explained that it used a mean value of EFs for non-specified sources from CORINAIR 90, as information on the technology was not available. According to the IPCC good practice guidance decision tree for non-CO<sub>2</sub> emissions from stationary combustion (figure 2.3), Greece should use IPCC default tier 2 EFs if there are no direct measurements of emissions or regional or country-specific EFs.

54. The ERT recommends that Greece revise its estimates in energy industries (1.A.1) and manufacturing industries and construction (1.A.2) by using the CORINAIR N<sub>2</sub>O EF of 0.8 g /GJ, or use the default IPCC N<sub>2</sub>O EF for solid fuels (1.4 kg/TJ) and the default value IPCC N<sub>2</sub>O EF for liquid fuels (0.69 kg/TJ). The ERT recommends that Greece revise such estimates in its next inventory submission.

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<sup>4</sup> kt<sub>oe</sub>: kilo ton oil equivalent.

55. As detailed information on biomass consumption in the residential sector is not available, Greece uses a constant value of 29,393 TJ over the 1990–2004 period. The ERT recommends that Greece develop estimates of biomass use in the residential sector, and report such data, including emission estimates, in its next inventory submission.

### 3. Stationary combustion: liquid fuels – CO<sub>2</sub>

56. The ERT acknowledges the improvements made by Greece in the 2006 submission to increase the transparency of the inventory by disaggregating fuel combustion emissions from manufacturing industries and construction to the corresponding categories (chemicals, pulp, paper and print, food processing, beverages and tobacco). The ERT recommends that Greece, as a next step in improving future submissions, exclude the use of liquid fuels as feedstocks currently reported under the chemicals subcategory (1.A.2.c), and report only the energy consumption of liquid fuels under this subcategory.

57. The ERT also recommends that Greece consider investigating the statistical differences in the energy balance between the supply and demand for diesel oil and heavy fuel oil. For example, statistical differences are as high as 1.9 per cent of the total domestic supply for diesel oil and 3.3 per cent of the total domestic supply for heavy fuel oil in 2004. The ERT recommends that Greece report on this in its next inventory submission.

### 4. Stationary combustion: gaseous fuels – CO<sub>2</sub>

58. Greece indicates in the NIR that while the production of natural gas over the 1990–2004 period decreased, consumption increased due to the introduction of imported natural gas after 1997 (which corresponded to the beginning of the commercial use of natural gas in Greece) and the expansion of the gas network. The ERT recommends that Greece improve the transparency of its next NIR by including information on the NCV of domestic and imported natural gas. The CO<sub>2</sub> IEFs for gaseous fuels in manufacturing industries and construction (40.55–52.87 t/TJ) across the entire time series are among the lowest of reporting Parties. During the in-country review Greece explained that the low IEFs are related to the fact that non-energy consumption is included in the AD. The ERT recommends that Greece in its future inventory submissions only report the amount of gaseous fuels used for energy purposes under this category, and include a brief discussion of the use of natural gas in the production of ammonia and the energy and non-energy consumption pattern since 1990 in its next NIR.

### 5. Road transportation – CO<sub>2</sub> and N<sub>2</sub>O

59. In response to the recommendations of the 2005 review report, Greece provided in the NIR detailed information on the vehicle fleet, EFs and other parameters used as input to the COPERT III model, except for the assumptions made with regard to the vehicle fleet and mileage for LPG-fuelled passenger cars. Greece has also reported the use of natural gas in road transportation since 1990. The ERT recommends that Greece improve its future submissions by including appropriate, relevant AD in the NIR, and more information on the assumptions used concerning its vehicle fleet (e.g. kilometres driven per vehicle type, average speed, ltrip, and the vehicle fleet and mileage for LPG-fuelled passenger cars) in its next NIR.

60. CO<sub>2</sub> emissions from the energy combustion of lubricants from road transportation in 2004 are several times higher than the calculations based on fleet data and distance travelled. No additional information was provided during the in-country review with regard to the methodology used to determine the part of the lubricants that are combusted, or details on the split in the different types of lubricants used. The ERT and the Greek inventory team during the in-country visit compiled a proxy bottom-up calculation for possible lubricant combustion in road transportation which resulted in lower CO<sub>2</sub> emissions estimates which were comparable with estimates from a selected group of countries.

61. The ERT recommends that Greece revise its emission estimates from energy use of lubricants and provide relevant bottom-up GHG emissions estimates based on the vehicle fleet and assumptions on the amount of kilometres travelled annually, as used in the COPERT III model, the specific consumption of lubricants, and other relevant drivers in order to ensure a comparable lubricant/fuel consumption ratio in road transportation. The ERT recommends that Greece revise such estimates for its next inventory submission.

#### 6. Navigation – CO<sub>2</sub>

62. CO<sub>2</sub> emissions are estimated according to the default methodology of CORINAIR. Greece also reports energy use of lubricants in navigation (1.A.3.d); however, this information is not consistent with the data in the Greek national energy balance. From the NIR it is also not clear how lubricants are allocated to this particular category. The ERT recommends that, in order to improve transparency in its next NIR, Greece clarify the energy use of lubricants in this category and revise the EFs, AD and assumptions as appropriate.

#### 7. Civil aviation – CO<sub>2</sub>

63. CO<sub>2</sub> emissions from civil aviation are estimated according the IPCC tier 2a method based on aircraft movements, following the Revised 1996 IPCC Guidelines. As raised in previous in-country reviews, Greece has separately reported emissions from aviation gasoline and jet kerosene.

64. CO<sub>2</sub> emissions from jet kerosene are calculated using IPCC default EFs, and tier 2a EFs for N<sub>2</sub>O and CH<sub>4</sub> emissions. Consumption of fuels is from the national energy balance, while LTO data are provided by the CAO. In Greece, the number of LTOs (landing and take offs) from domestic aviation increased by 71.3 per cent over the period 1990–2004, however, over the same period fuel consumption decreased by 15.6 per cent. This issue was identified in previous in-country reviews and acknowledged by Greece as an area for improvement in the NIR.

65. During the in-country review the ERT recommended that Greece make additional efforts to obtain more disaggregated and detailed data on the structure of the air fleet included in the information on LTOs. Provision of such information could clarify discrepancies between information on the number of passengers travelling on domestic flights, LTOs and fuel consumption trends. It is also recommended that Greece provide the rationale for how fuel consumption is allocated to domestic flights in the energy balance. If this is not possible the ERT recommends that Greece, in accordance with the number of LTOs and the trend in domestic flights, revise the emission estimates of CO<sub>2</sub> from civil aviation as well as the emission estimates of CH<sub>4</sub> and N<sub>2</sub>O. Such calculations should assist Greece to revise such estimates for its next inventory submission.

#### 8. Coal mining and handling – CH<sub>4</sub> and CO<sub>2</sub>

66. CH<sub>4</sub> emissions from surface mining of lignite (1.B.1.a.ii) have been calculated according to the IPCC tier 1 methodology, although this is a key category. The ERT recommends that Greece develop country-specific EFs, as recommended by the IPCC good practice guidance. In addition, CO<sub>2</sub> emissions from surface mines are “NE” for the period 1990–2004. The ERT encourages Greece to estimate fugitive CO<sub>2</sub> emissions from this category according to the IPCC 1996 Revised Guidelines.

### **D. Non-key categories**

#### 1. Stationary combustion: biomass – CH<sub>4</sub> and N<sub>2</sub>O

67. Biomass consumption in the residential sector (1.A.4.b) remains constant over the period 1990–2004 (29,393 TJ). During the in-country review, the ERT identified a discrepancy in the NIR between the AD reported by Greece on biomass consumption and the AD on fuel wood-harvesting as reported under the LULUCF sector. Greece estimates annual carbon loss in living biomass as the sum of

losses due to commercial round wood felling, fuel wood-harvesting and wildfires. For example, the annual carbon loss in living biomass in 1990 was approximately equivalent to the biomass allocated for combustion, an assumption which the ERT considered to be incorrect.

68. In order to ensure consistency of AD between the energy sector and the LULUCF sector, the ERT recommends that Greece revise the AD for biomass consumption in the residential sector (1.A.4.b) for the period 1990–2004 for its next submission, taking into account drivers such as:

- the total amount of commercial felling;
- the amount of wood used in other sectors and/or for other purposes using relevant drivers;
- heating degree days over the period 1990–2004;
- trends in the total area of dwellings;
- trends of other energy use in the residential sector;
- administrative bans on solid biomass use for energy purposes (due to air quality issues).

## 2. Oil and gas operations – CH<sub>4</sub>, CO<sub>2</sub> and N<sub>2</sub>O

69. Fugitive emissions from several oil and gas operations, such as leakages at industrial and power plants and in the residential and commercial sectors (1.B.2.b.v) are reported as “NE”.

70. The ERT noted that from 1990 to 1995, although emissions from other natural gas fugitive sources are included under natural gas production/processing (1.B.2.b.ii), some activities such as natural gas transmission (1.B.2.b.iii) are reported as “NO”. The ERT noted that Greece reported in the NIR that until 1996 the supply of natural gas existed exclusively of small quantities for domestic primary production. The ERT encourages Greece to further improve the completeness and transparency of its inventory with respect to the estimation of fugitive emissions from oil and gas operations by calculating emissions from “NE” categories and using notation keys, as appropriate.

### **III. Industrial processes and solvent and other product use**

#### **A. Sector overview**

71. In 2004, industrial processes contributed 10.3 per cent (14,142.91 Gg CO<sub>2</sub> eq) of total national GHG emissions. The majority of industrial process emissions were due to CO<sub>2</sub> from cement production (4.6 per cent). Other major sources of GHG emissions in 2004 were HFCs from refrigeration and air conditioning equipment (2.3 per cent), and HFC-23 from production of HCFC-22 (1.9 per cent).

72. The ERT noted that estimates of emissions of F-gases from category 2.F may be partly estimated, in terms of both emission categories and gases. For example, emission estimates of F-gases for the following sub-categories of refrigeration and air conditioning (2.F.1): industrial refrigeration and transport refrigeration, were not provided, including emission estimates of HFC-143a and HFC-152a, which are typical components of common refrigerant mixtures. Also, emission estimates for the categories foam blowing (2.F.2), fire extinguishers (2.F.3), aerosols and metered dose inhalers (2.F.4), solvents (2.F.5) and semiconductor manufacturing (2.F.7) were not estimated, which may also add to the underestimation. The ERT recommends that Greece report estimates for these categories and gases in its future inventories, and, as appropriate, set up a system for the gathering of data, and apply the methods described in the IPCC good practice guidance.

73. Greece has recalculated the emissions (HFC-134a) for the category refrigeration and air conditioning (2.F.1) by including estimates for the subcategory commercial refrigeration, thus improving completeness of this particular category. However the ERT considers that the transparency of the recalculated level of emissions is unclear, since estimates of potential emissions are not provided. The effect of the recalculations on the estimates of total national emissions in 2003 is 1.4 per cent. The ERT therefore recommends that Greece implement the IPCC good practice guidance by developing a data-gathering system to enable the reporting of potential emissions. The recommendation has a twofold

function: firstly, this will assist Greece in fulfilling the requirements of the UNFCCC reporting guidelines, Part I; secondly, it provides a tier 2 QC check for the level and trend of emissions from refrigeration and air conditioning equipment, since potential emissions for a category may be viewed as an upper limit for emissions.

74. The key category analysis performed by Greece and the secretariat produced similar results. PFCs from aluminium production (2.A.1) identified by the secretariat were not, however, identified as a key category in the key category analysis performed by Greece. This difference is due to the different base years used in the two analyses: 1990 was used by the secretariat and 1995 was used by Greece.

## **B. Key categories**

### **1. Cement production – CO<sub>2</sub>**

75. Greece uses a tier 2 methodology and a national EF (0.5428 t CO<sub>2</sub>/t clinker production) to estimate emissions from cement production. The ERT commends Greece for using the tier 2 methodology and a country-specific EF for this key category.

76. The ERT analysed Greece's clinker production data using a statistical data analysis technique. Analysis of the AD by the ERT revealed an unexplained shift in the production level between 1994 and 1995, amounting to 1 million tonnes of clinker produced. During the in-country visit, the ERT had access to plant-specific clinker production data, and verified that the shift was due to an increase in production for one particular installation plant. Greek experts explained that the shift was due to a change of ownership, which had resulted in the increased use of the existing production capacity. The ERT recommends that Greece include this explanation in the NIR of its future submissions.

77. The ERT encourages Greece to further improve the transparency of its reporting by including an explanation in the NIR of how the calcium oxide (CaO) and magnesium oxide (MgO) contents are calculated for each year.

### **2. Nitric acid production – N<sub>2</sub>O**

78. For this category Greece has used an average of the IPCC default EFs from the Revised 1996 IPCC Guidelines, which is not in line with the IPCC good practice guidance. The IPCC good practice guidance states that if the subcategory nitric acid production is a key category, then plant-level emissions and destruction data should be collected. This condition applies to Greece. Greece has already collected plant-specific data on destruction technologies, as recommended in the previous (2005) review. The ERT therefore recommends that Greece in its future submissions follow the IPCC good practice guidance and continue to collect plant-specific emissions data. The ERT also recommends that this development be appropriately documented in the NIR. In particular, it recommends that Greece in its future submissions follow the IPCC good practice guidance by implementing tier 2 QC checks when undertaking recalculations.

### **3. HCFC-22 production – HFC-23**

79. Greece's reporting of the AD and EF for this category was limited due to data confidentiality. The AD and the EF were made available to the ERT during the review. The ERT concludes that the EF used by Greece is reasonable, and that the year-to-year changes observed in emissions corresponded to changes in AD. The ERT recommends that Greece provide information that explains the fluctuations in its next NIR.

80. The EF used, while considered reasonable, was not, however, based on plant-specific data. The IPCC good practice guidance states that an approach not based on measurements should be used only in rare circumstances. The ERT recommends that since this is a key category, Greece should obtain direct

measurements of emissions which are in line with the IPCC good practice guidance, and recalculate emissions based on these measurements.

#### 4. Iron and steel production – CO<sub>2</sub>

81. The description of the methodology and the AD used was not fully transparent in the NIR. This was also the conclusion of the ERT following the centralised review of Greece's 2005 submission. The ERT recommends that Greece provide more detailed information in its next NIR on the AD used for the estimation of CO<sub>2</sub> emissions from this category, including the assumptions used for estimating emissions for those years where AD was unavailable. The ERT also recommends that Greece provide information in its next inventory submission on the reasons for the increasing trend associated with the IEF for CO<sub>2</sub> emissions.

### C. Non-key categories

#### 1. Aluminium production – PFCs

82. There is only one producer of aluminium in Greece. Consequently the assumptions used in the estimation of emissions of carbon fluoride (CF<sub>4</sub>) and hexafluorethane (C<sub>2</sub>F<sub>6</sub>) emissions are confidential. During the in-country review the ERT was given access to this information, including AD, EFs, and the methodology used.

83. The ERT recommends that Greece describe in its next inventory submission the process of preparing emission estimates for CF<sub>4</sub> and C<sub>2</sub>F<sub>6</sub>, a description of the QA/QC procedures associated with the estimation of emissions from this category and a qualitative description of Greece's PFC emission profile as compared to other Parties.

#### 2. Electrical equipment – SF<sub>6</sub>

84. In its 2006 inventory submission, Greece estimates SF<sub>6</sub> emissions from electrical equipment for the first time. Emission estimates were obtained from the PPC. The method of extrapolation was applied for those years where estimates from the PPC were unavailable.

85. The ERT recommends that for its next inventory submission Greece should include the following information: a description of how the measurements of SF<sub>6</sub> are undertaken; typical leakage rates deduced from such measurements; the total amount of SF<sub>6</sub> stored in electrical equipment; and information on SF<sub>6</sub> recovery practices. The ERT also reiterates the importance of obtaining import, export and sales statistics for the calculation of potential SF<sub>6</sub> emissions.

## IV. Agriculture

### A. Sector overview

86. In 2004, emissions from the agriculture sector in Greece amounted to 11,936.71 Gg CO<sub>2</sub> eq, (8.7 per cent of total national GHG emissions). GHG emissions from agriculture decreased by 11.7 per cent between 1990 and 2004, with an average annual rate of decrease of 0.9 per cent, mainly due to the decrease of N<sub>2</sub>O emissions from agricultural soils. The submission is generally complete in terms of gases, categories and years covered.

87. Greece's key category analysis in this sector is consistent with that performed by the secretariat. The ERT recommends that more information on sectoral archiving and documentation procedures be provided in the NIR.

88. Greece has made sound improvements in the agriculture sector following the 2005 review, correcting some problems which were previously identified, and has provided a more comprehensive NIR, for example, by adopting a three-year average for animal population numbers. Recalculations have

been undertaken for all years. The results show that there are still some uncertainties caused by the estimation of AD for animal populations, in particular sheep. The ERT recommends that Greece improve its system for collecting AD (animal population statistics) and report such data in its next NIR. Planned improvements are provided in the NIR for emissions from enteric fermentation, such as updating AD as soon as they become available.

89. A general description of the QA/QC activities is provided in the introduction chapter of the NIR, but no detailed QA/QC information is provided in the agricultural sector overview or at the individual category level. The ERT recommends that in its next NIR Greece provide more information on the QA/QC procedures specific to the sector and their implementation, sectoral archiving and documentation procedures.

## **B. Key categories**

### **1. Enteric fermentation – CH<sub>4</sub>**

90. In Greece enteric fermentation is a key category, mainly due to the large sheep population. CH<sub>4</sub> emissions from the enteric fermentation of sheep are estimated according to the IPCC tier 2 methodology and country-specific EFs. CH<sub>4</sub> emissions from enteric fermentation have been recalculated for the complete time series because of the use of a three-year average for the sheep population, resulting in a higher estimate of emissions for the year 1990 in the 2006 submission compared with the 2005 inventory submission. This approach needs to be maintained in future because of the large fluctuations in the AD (animal population statistics). In the interest of greater transparency and comparability with the annual international statistics, the ERT recommends that Greece report in its NIR of future inventory submissions sheep population data for every year, including the three-year average for 1990, so that the trend is more clearly presented.

91. In Greece, CH<sub>4</sub> emissions from enteric fermentation from other animals are estimated according to the IPCC tier 1 methodology, using IPCC default EFs. The application of this methodology requires livestock population data and EFs per animal species. The selection of the EFs for dairy cattle and non-dairy cattle corresponds to the characteristics of Eastern Europe and was based on data from the National Statistical Service of Greece (NSSG) on milk production per animal. However, data on milk production per animal for the years 2001–2004 are derived from data from the Food and Agriculture Organization of the United Nations (FAO), and they fluctuate from 3,400 kg in 2001 to 3,800 kg in 2004. This has introduced inconsistencies in the time series on milk production. Because of a larger fluctuation in milk production, the ERT recommends that Greece in its next inventory submission develop a country-specific EF, rather than use the EF for Eastern Europe.

### **2. Agricultural soils – N<sub>2</sub>O**

92. Both direct and indirect N<sub>2</sub>O emissions from soils and N<sub>2</sub>O emissions from pasture, range and paddock manure were key categories in 2004 according to the level and trend assessment by both Greece and the secretariat.

93. N<sub>2</sub>O emissions from agricultural soils (4.D) are estimated according to the tier 1a IPCC methodology. However, some methodological details are not transparently reported in the NIR. In order to improve transparency the ERT recommends that Greece in its future submissions provide more information on N<sub>2</sub>O emissions from pasture, range and paddock manure (i.e. animal production), such as the amount of nitrogen (N) excreted from animal manure, and information on N volatilization from animal manure.

94. As there is a four-year delay in obtaining final AD on synthetic fertilizers from national sources for a specific year, extrapolation is necessary to obtain provisional statistical data, in particular for the most recent years. An appropriate method of extrapolation is therefore needed. The ERT recommends that Greece extrapolate the annual quantities of synthetic fertilizers consumed in the country during the

period 2003–2004 based on the trends observed for the years 1990–1998 and 1998–2002, and then compare the extrapolated results with updated data from the FAO or national sources. Greece should then determine the most appropriate trend as the basis for extrapolation of the AD. When the final AD are received from the NSSG, the provisional data should be updated.

### **C. Non-key categories**

#### Manure management – CH<sub>4</sub> and N<sub>2</sub>O

95. N<sub>2</sub>O emissions from manure management are estimated by using the EFs for N excretion described in the Revised 1996 IPCC Guidelines. For N excretion Greece uses the values provided for Mediterranean countries. CH<sub>4</sub> emissions are estimated using a tier 1 methodology and default EF. AD are not based on observation but are provided by experts from the Ministry of Rural Development and Food (MRDF). Different types of manure management systems have been identified, but the MRDF does not provide data on all systems. The ERT recommends that Greece collect more complete data on animal waste management systems existing in the country and report detailed background information on this in its next NIR (e.g. more detail on the share of each animal type and the treatment of manure). The ERT also recommends that Greece establish a process for collecting field data to improve the estimates for this category in its future inventories.

## **V. Land use, land-use change and forestry**

### **A. Sector overview**

96. In 2004 the LULUCF sector offset 4.9 per cent of the total GHG emissions (including LULUCF). The category was a net sink from 1990 to 2004. Net GHG removals increased 69.2 per cent, from 3,193.27 Gg CO<sub>2</sub> eq in 1990 to 5,402.32 Gg CO<sub>2</sub> eq in 2004. Interannual fluctuations in net GHG removals were mostly due to carbon biomass losses from forest fires, which increased in 1997 and 1999. Annual harvesting of wood showed a decreasing trend from 1990 to 2004, which contributed to the increasing trend in net CO<sub>2</sub> removals. The forest land (5.A) category accounted for 78.9 per cent of the net GHG removals for the LULUCF sector in 2004. The cropland category (5.B) accounted for the rest of the net GHG removals (21.1 per cent). The emissions and removals of CO<sub>2</sub> from the category grassland (5.C) were reported as “included elsewhere” (“IE”) and “not occurring” (“NO”). In 2004 net GHG emissions from the categories wetlands (5.D), settlements (5.E) and other land (5.F) were reported as either “NO”, “NE” or both.

97. Greece’s 2006 submission reporting is generally complete and is transparent with respect to the description of methodologies and sources of AD. Greece has estimated emissions and removals of CO<sub>2</sub>, and emissions of CH<sub>4</sub> and N<sub>2</sub>O from the LULUCF sector using either the tier 1 or the tier 2 method according to the IPCC good practice guidance for LULUCF. The AD used are country-specific and EFs are either IPCC default or country-specific. However, for some categories, for example, grassland converted to forest land (5.A.2.2), land converted to wetlands (5.D.2), and land converted to settlements (5.E.2), the notation key “NE” is used. The ERT encourages Greece to report in its next submission CO<sub>2</sub> emissions or removals which are “NE”, even if they are minor, and to allocate CO<sub>2</sub> emissions and removals to the appropriate categories. The ERT, however, acknowledges the improvements made by Greece since the previous review (2005) in the consistency of reporting between the NIR and CRF tables for LULUCF. A major improvement in the inventory was the inclusion of the LULUCF sector in the key category analysis for 2004.

98. Uncertainties were calculated using a tier 1 method according to the IPCC good practice guidance for LULUCF for the key categories. Uncertainties were calculated for the estimation of emissions for CH<sub>4</sub> and N<sub>2</sub>O from forest land remaining forest land (5.A.1) and grassland remaining grassland (5.C.1). The uncertainty values in the NIR are similar to those reported in the 2005 submission.

99. Emissions and removals of GHG from some land conversions in 2004 have not been separately reported. For example, CO<sub>2</sub> from the changes in soil carbon stocks in cropland converted to grassland (5.C.2.2) and cropland converted to forest land (5.A.2.1) were reported under cropland remaining cropland (5.B.1). The ERT recommends that Greece establish a system for the identification of land use and measurement of land-use change similar to any of those classified as tier 2 approaches by the IPCC good practice guidance for LULUCF.

100. GHG emissions and removals from forest land (5.A) and cropland (5.B) were recalculated, but Greece has not provided a comparison of the recalculated data with the data from its 2005 submission. The ERT recommends that Greece provide these comparisons in its next inventory submission, and also explain the basis for the recalculations.

101. QA/QC procedures are neither reported for the sector nor for its categories. The ERT recommends that sectoral QC measures be implemented as part of the Greek QA/QC plan.

## **B. Key categories**

### **1. Forest land remaining forest land – CO<sub>2</sub>**

102. CO<sub>2</sub> from forest land remaining forest land (5.A.1) in 2004 is identified by the secretariat and Greece as a key category by level and trend. In 2004 net CO<sub>2</sub> removals from this category accounted for 70.6 per cent of the net CO<sub>2</sub> removals in the LULUCF sector and increased by 85.2 per cent from 1990 (2,042.79 Gg) to 2004 (3,820.49 Gg). The trend was largely linear. The estimated annual rate of net CO<sub>2</sub> removal was 117 Gg CO<sub>2</sub> per year.

103. The methodology used for estimating the changes in the carbon stocks in living biomass is a tier 2 approach using both country-specific EFs and IPCC default EFs from the IPCC good practice guidance for LULUCF. The ERT recommends that Greece replace default EF values with country-specific values in its future submissions.

104. The estimation of the changes in living biomass carbon stocks assumes an annual rate of above-ground biomass increase which is based on the average of all major tree species. This annual rate was assumed to be constant over the period 1990–2004. However, this assumption requires supporting field data, given that Greece went through several dry seasons in the period 1990–2004. The frequency of forest fires is an indicator of dry periods. In this regard, the ERT recommends that Greece plan and implement a procedural system for periodically estimating biomass growth rates.

105. The methodology used for estimating the changes in the carbon stocks in dead organic matter uses a combination of a tier 1 (for unburnt areas) and tier 2 approach (for burnt areas) which is in line with the IPCC good practice guidance for LULUCF. The methodology combines both country-specific AD and IPCC default parameter values. Changes in forest soil carbon stocks are assumed to be zero over the period 1990–2004 and are reported as “NO” (tier 1). The ERT encourages Greece to measure changes in the carbon stocks of soil organic matter in the future, and because this pool is part of a key category the ERT also recommends that Greece use a tier 2 approach in its future submissions for the estimation of this carbon pool.

### **2. Land converted to forest land – CO<sub>2</sub>**

106. In 2004 the secretariat and Greece identified CO<sub>2</sub> emissions from land converted to forest land (5.A.2) as a key category by trend assessment. The methodology used for estimating changes in living biomass stocks uses a combination of tier 1 and tier 2 methods using both country-specific EFs and IPCC default EFs from the IPCC good practice guidance for LULUCF. Removals of CO<sub>2</sub> accruing from changes in soil carbon stocks, were reported as “IE”.

107. As land converted to forest land is a key category, the ERT recommends that Greece develop country-specific parameter values for the tier 2 approach used for estimating removals of CO<sub>2</sub> for living biomass. It is also recommended that Greece develop a system for accurately identifying the areas of land-use conversions, for example, based on approach 2 in the IPCC good practice guidance for LULUCF.

### 3. Cropland remaining cropland – CO<sub>2</sub>

108. In 2004 the secretariat and Greece identified CO<sub>2</sub> from cropland remaining cropland (5.B.1) as a key category by level and trend assessment. In 2004, this category accounted for 21.1 per cent of the LULUCF net CO<sub>2</sub> removals. Net CO<sub>2</sub> removals from cropland remaining cropland are mainly the result of changes in living biomass stocks. In estimating net CO<sub>2</sub> removals from cropland remaining cropland Greece uses a combination of default EF (tier 1) and country-specific AD (tier 2) which are in accordance with the IPCC good practice guidance for LULUCF.

109. Although the ERT acknowledges the improvements implemented by Greece in response to recommendations from the previous review, the ERT recommends that Greece upgrade its methodology to a tier 2 method by estimating changes in soil carbon stocks using country-specific EFs because cropland remaining cropland is a key category.

110. On the estimation of CO<sub>2</sub> emissions from changes in soil carbon stocks, the ERT concludes that the reporting of emissions from this category is not entirely transparent as CO<sub>2</sub> emissions from changes in soil organic carbon due to the conversion of cropland to forest land (5.A.2.1) and cropland to grassland (5.C.2.2) are included under the category cropland remaining cropland (5.B.1). As Greece does not have a comprehensive land use and land-use change area matrix for 1990, the ERT recommends that it establish a system for the identification of land use and measurement of the areas of land-use change similar to any of the various methods included in methodological approach 2 in the IPCC good practice guidance for LULUCF.

## **VI. Waste**

### **A. Sector overview**

111. In 2004 GHG emissions from the waste sector accounted for 2.4 per cent of Greece's total national emissions. In that same year, waste-related emissions decreased by 26.6 per cent, relative to 1990 levels. This decrease is attributed largely to a reduction in CH<sub>4</sub> emissions associated with aerobic treatment of domestic wastewater.

112. Recalculations of GHG emissions for the whole time series were performed by Greece. The recalculations undertaken were mainly due to the application of a tier 2 first order decay (FOD) method for estimating CH<sub>4</sub> emissions from SWDL; the exclusion of biogenic CO<sub>2</sub> emissions from biogas flaring; the separation of municipal sludge from wastewater; and the use of updated data on industrial wastewater. For 2003 the recalculations result in a 35.0 per cent reduction in the estimate of GHG emissions from the waste sector, from 5,178.94 Gg CO<sub>2</sub> eq (in the 2005 submission) to 3,367.09 Gg CO<sub>2</sub> eq (in the 2006 submission).

113. The ERT affirms the previous recommendation from the 2005 review that Greece include in its NIR a description of QA/QC steps that have been undertaken in the waste sector. The ERT also recommends that Greece include in the chapter on waste in the NIR explanations to support the uncertainty analyses associated with the estimation of GHG emissions from the waste sector.

## B. Key categories

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

114. The ERT commends Greece for using a tier 2 FOD method for estimating CH<sub>4</sub> emissions from SWDL. This has led to a decrease in 1990 emissions in this category by 32.6 per cent, and of 2003 emissions by 42.9 per cent since the 2005 submission.

115. The assumed CH<sub>4</sub> recovery rate for three out of the four recovery sites is 60 per cent. The recovery rate at the Athens recovery facility is approximately 30 per cent, which is constant for the time series. During the review the ERT noted a possible overestimation of the rate of CH<sub>4</sub> recovery from solid waste disposal sites, leading to an underestimation of CH<sub>4</sub> emissions for the period 1990–2004. The ERT recommends that Greece adopt a more accurate value for CH<sub>4</sub> recovery in three of the four sites and revise the estimates of CH<sub>4</sub> emissions from SWDL in its next inventory submission.

116. Annual growth rates in SWDL suddenly increased from approximately 1 per cent per year to approximately 5 per cent per year from 1992 onwards. This inconsistency is due to an abrupt rise in the interannual change of the per capita waste generation rate (from 0.007 kg/person/day/year to 0.028 kg/person/day/year). The ERT recommends that Greece reconcile these two interannual changes in per capita waste generation rate to maintain time series consistency.

### 2. Wastewater handling – CH<sub>4</sub>, N<sub>2</sub>O

117. The key driver for the overall downward trend in Greece's waste emissions is the reduction in CH<sub>4</sub> emissions from wastewater handling. As this is a key category, the ERT encourages Greece to make greater efforts to ensure accuracy in estimating these emissions, particularly in the determination of the aerobic treatment of domestic and commercial wastewater and the emissions associated with the treatment of industrial wastewater.

118. For greater transparency, Greece is encouraged to provide the sectoral background information on wastewater in both the CRF tables and the NIR, and also to describe the distribution and function of the different wastewater handling systems in Greece in its next NIR.

## C. Non-key categories

### Waste incineration – CO<sub>2</sub>

119. In CRF table 6.C, the notation key "NE" is used for CO<sub>2</sub> emissions from other – (non-biogenic) – other non-specified (6.C.b). The use of the notation key "NE" for this category suggests that the CO<sub>2</sub> estimates from waste incineration may be incomplete. The ERT recommends that, if CO<sub>2</sub> emissions from this category (6.C.b) do not occur in Greece, then the notation key "NE" should be changed to "NO".

## VII. Conclusions and recommendations

120. Greece submitted a complete set of CRF tables for the years 1990–2004 and an NIR which is complete in terms of geographic coverage, years and sectors, and fairly complete in terms of categories and gases. Its 2006 inventory submission is also generally accurate and transparent as defined in the UNFCCC reporting guidelines, Part I, and broadly consistent with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. However, the ERT identified a number of categories, in particular in the energy sector, where methods, AD or EFs used were not fully in accordance with these guidelines for which the ERT recommended that Greece provide revised estimates.

121. After the in-country review, Greece did not provide such revised estimates and the ERT repeats its recommendation that Greece revise its estimates for these categories in its next inventory submission.

122. In the course of the review, the ERT formulated a number of recommendations relating to the accuracy, transparency and completeness of Greece's, 2006 GHG inventory submission. The key recommendations for the future development of the national inventory are as follows:

- (a) Demonstrate and report in detail the institutional arrangements in place in Greece for the planning and preparation of the national inventory, including the arrangements for the technical competence of the staff involved in the inventory development process and their capacity for timely performance in the preparation of the Party's national inventory;
- (b) Further develop its QA/QC system and consequently implement QA/QC procedures in the inventory preparation, particularly by carrying out a domestic review of the inventory by independent national experts, and include more information on QC activities in each sectoral chapter of the NIR;
- (c) Address all the methodological issues in the energy sector where methods, AD or EFs used are not fully in accordance with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance;
- (d) Improve the accuracy of the estimation of GHG emissions of key categories in the energy sector by collecting information on combustion technologies and implementing a tier 2 method for estimating N<sub>2</sub>O emissions from solid fuels and liquid fuels for the categories energy industries (1.A.1) and manufacturing industries and construction (1.A.2);
- (e) Improve the completeness of the inventory by preparing and reporting estimates for categories that are currently "NE", including estimates for subcategories of consumption of halocarbons and SF<sub>6</sub>, and estimates of potential emissions of fluorinated gases that could be obtained by establishing a relevant data-gathering system;
- (f) Improve the transparency of the estimates by providing more precise descriptions and documentation of the methods used, and more detailed information about AD and EFs for all key categories;
- (g) Include information on the rationale for the selection of uncertainty values in each sectoral chapter of the NIR;
- (h) Apply tier 2 methods for key categories in accordance with the IPCC good practice guidance, for example, for the estimation of CO<sub>2</sub> emissions from forest land remaining forest land (5.A.1) and cropland remaining cropland (5.B.1);
- (i) Adopt and implement at least a tier 2 methodology for the identification and measurement of land use and land-use changes, as described in the IPCC good practice guidance for LULUCF.

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/gp/landuse/gp/landuse.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 Greece. 2006. Available at: <<http://unfccc.int/resource/docs/2006/asr/grc.pdf>>.
- UNFCCC secretariat. Synthesis and assessment report on the greenhouse gas inventories submitted in 2006. FCCC/WEB/SAI/2006. Available at: <[http://unfccc.int/files/national\\_reports/annex\\_i\\_ghg\\_inventories/inventory\\_review\\_reports/application/pdf/sa\\_2006\\_part\\_i\\_final.pdf](http://unfccc.int/files/national_reports/annex_i_ghg_inventories/inventory_review_reports/application/pdf/sa_2006_part_i_final.pdf)>.
- UNFCCC secretariat. Greece: Report of the individual review of the greenhouse gas inventory submitted in the year 2005. FCCC/WEB/IRI/2005/GRC. Available at: <<http://unfccc.int/resource/docs/2006/arr/grc.pdf>>.

### **B. Additional information provided by the Party**

Responses to questions during the review were received from Mr. Paris Zikos, Ms. Elpida Politi, (Ministry for the Environment, Physical Planning and Public Works), Mr. Dimitrios Lalas, Mr. Giannis Sarafidis, Ms. Elena Georgopoulou, Ms. Dimitra Koutentaki, Mr. Sebastian Mirasgentis, Ms. Katerina Papagiannaki and Mr. Babis Petsikos (National Observatory of Athens), Mr. Eleftherios Papavasiliopoulos, and Mr. Ioannis Pappas (National Center for the Environment and Sustainable Development).

FAO. ForeSTAT statistics. Available at: <<http://faostat.fao.org/site/381/default.aspx>>.

General Secretariat of National Statistical Service of Greece. *Statistical Yearbook of Greece 1990–1991*.

Head of the Division of Atmospheric Pollution Control (P. Zikos). Answers to the questions raised by ERT on 24 April 2007. Athens, Greece, 28 April 2007.

Hellenic Republic, Ministry for the Environment, Physical Planning and Public Works Division of Air Pollution and Noise Control. Additional information provided by Greece to the potential problems and further questions from the ERT formulated in the course of the in-country review of Greece's initial report under the Kyoto Protocol and the 2006 inventory submission. Covering letter to UNFCCC secretariat, with 13-page annex. Athens, Greece, 8 June 2007.

Hellenic Republic, Ministry for the Environment, Physical Planning and Public Works Division of Air Pollution and Noise Control. Additional information provided by Greece to the potential problems and further questions from the ERT. Letter to UNFCCC secretariat with 2-page annex concerning the national system. Athens, Greece, 12 June 2007.

Hellenic Republic, Ministry for the Environment, Physical Planning and Public Works Division of Air Pollution and Noise Control. Additional information provided by Greece to the ERT's request for additional information as part of the procedures for the calculation of adjustments. Athens, Greece, 23 July 2007.

Hellenic Republic. Law no. 3017/2002 for the ratification of the Kyoto Protocol (in Greek). Athens, Greece 2002.

Hellenic Republic. Common Ministerial Decision 54409/2632/2004 (in Greek). Athens, Greece, 2004.

Ministry for Development (MD). *National Energy Balance, 1990–2003*. Directorate for Energy Policy, Athens.

Public Power Corporation (PPC). Estimation of the CO<sub>2</sub> emission factors for lignite used by the PPC. Athens, 1994.

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