



**UNITED
NATIONS**



**Framework Convention
on Climate Change**

Distr.
GENERAL

FCCC/ARR/2009/LIE
19 March 2010

ENGLISH ONLY

**Report of the individual review of the annual submission of Liechtenstein
submitted in 2009***

* In the symbol for this document, 2009 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 centralized review of the 2009 annual submission of Liechtenstein, coordinated by the UNFCCC secretariat, in accordance with decision 22/CMP.1. The review took place from 31 August to 5 September 2009 in Bonn, Germany, and was conducted by the following team of nominated experts from the UNFCCC roster of experts: generalists – Ms. Anke Herold (European Union) and Mr. Harry Vreuls (Netherlands); energy – Ms. Maria Lidén (Sweden) and Mr. Jongikhaya Witi (South Africa); industrial processes – Mr. Teemu Oinonen (Finland) and Mr. Samir Tantawi (Egypt); agriculture – Mr. Steen Gyldenkærne (Denmark); land use, land-use change and forestry (LULUCF) – Mr. Rizaldi Boer (Indonesia) and Mr. Daniel Martino (Uruguay); and waste – Ms. Tatiana Tugui (Republic of Moldova). Ms. Herold and Mr. Martino were the lead reviewers. The review was coordinated by Mr. Javier Hanna (UNFCCC secretariat).

2. In accordance with the “Guidelines for review under Article 8 of the Kyoto Protocol” (decision 22/CMP.1), a draft version of this report was communicated to the Government of Liechtenstein, which provided comments that were considered and incorporated, as appropriate, into this final version of the report.

B. Emission profiles and trends

3. In 2007, the main greenhouse gas (GHG) in Liechtenstein was carbon dioxide (CO₂), accounting for 86.8 per cent of total GHG emissions¹ expressed in CO₂ equivalent (eq), followed by methane (CH₄) (6.0 per cent) and nitrous oxide (N₂O), (5.3 per cent). Hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF₆) collectively accounted for 1.9 per cent of the overall GHG emissions in the country. Emissions from perfluorocarbons (PFCs) are not occurring in Liechtenstein. The energy sector accounted for 87.6 per cent of the total GHG emissions, followed by the agriculture sector (9.3 per cent), industrial processes (1.9 per cent), waste (0.8 per cent), and solvent and other product use (0.5 per cent). Total GHG emissions amounted to 243.48 Gg CO₂ eq and increased by 6.1 per cent between the base year² and 2007.

4. Tables 1 and 2 show total GHG emissions by gas and by sector, respectively. Table 1 includes emissions from Annex A sources only and excludes emissions and removals from the LULUCF sector.

¹ In this report, the term “total GHG emissions” refers to the aggregated national GHG emissions expressed in terms of CO₂ equivalent excluding LULUCF, unless otherwise specified.

² “Base year” refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year emissions include emissions from Annex A sources only.

Table 1. Total greenhouse gas emissions by gas, 1990–2007^a

Greenhouse gas	Gg CO ₂ eq							Change base year–2007 (%)
	Base year ^b	1990	1995	2000	2005	2006	2007	
CO ₂	203.06	203.06	209.39	227.53	239.96	241.61	211.28	4.0
CH ₄	13.40	13.40	12.60	12.27	13.97	14.37	14.70	9.7
N ₂ O	13.09	13.09	13.16	12.52	12.63	12.81	12.91	–1.4
HFCs	0.00	0.00	0.38	2.34	4.16	4.16	4.47	53 245 125.0
PFCs	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA
SF ₆	NA, NO	NA, NO	NA, NO	0.02	0.06	0.05	0.12	NA

Abbreviations: NA = not applicable, NO = not occurring.

^a Total greenhouse gas emissions includes emissions from Annex A sources only and excludes emissions/removals from the land use, land-use change and forestry sector.

^b “Base year” refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year emissions include emissions from Annex A sources only.

Table 2. Greenhouse gas emissions by sector, 1990–2007

Sector	Gg CO ₂ eq							Change base year–2007 (%)
	Base year ^a	1990	1995	2000	2005	2006	2007	
Energy	203.48	203.48	210.70	229.49	241.95	243.60	213.35	4.9
Industrial processes	0.00	0.00	0.38	2.36	4.22	4.21	4.59	54 671 012.8
Solvent and other product use	2.00	2.00	1.61	1.28	1.11	1.12	1.11	–44.4
Agriculture	22.52	22.52	21.32	19.83	21.58	22.30	22.58	0.2
LULUCF	NA	–8.32	–8.46	–4.90	–6.50	–6.55	–6.57	NA
Waste	1.55	1.55	1.52	1.72	1.93	1.78	1.85	19.2
Other	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	NA	221.23	227.06	249.77	264.29	266.46	236.91	NA
Total (without LULUCF)	229.55	229.55	235.53	254.67	270.79	273.00	243.48	6.1

Abbreviations: LULUCF = land use, land-use change and forestry, NA = not applicable.

^a “Base year” refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year emissions include emissions from Annex A sources only.

C. Annual submission and other sources of information

5. The 2009 annual inventory was submitted on 2 April 2009; it contains a complete set of common reporting format (CRF) tables for the period 1990–2007, and a national inventory report (NIR). Liechtenstein also submitted information required under Article 7, paragraph 1, of the Kyoto Protocol, including: information on activities under Article 3, paragraph 3, of the Kyoto Protocol, accounting of Kyoto Protocol units and information on changes in the national system and in the national registry. The standard electronic format (SEF) tables were submitted on 24 March 2009. The annual submission was presented in accordance with decision 15/CMP.1. Liechtenstein indicated that the 2009 submission is also its voluntary submission under the Kyoto Protocol.

6. Where necessary, the expert review team (ERT) also used the previous year's submission during the review. In addition, the ERT used the Standard Independent Assessment Report (SIAR), parts I and II, to review information on the accounting of Kyoto Protocol units (including the SEF tables and their comparison report) and on the national registry.³

7. During the review, Liechtenstein provided the ERT with additional information. The documents concerned are not part of the annual submission. The full list of materials used during the review is provided in annex I to this report.

Completeness of inventory

8. The inventory covers almost all sources and sinks categories for the period 1990–2007 and is complete in terms of years and geographical coverage. As indicated above, Liechtenstein has provided a complete set of CRF tables. However, CRF table 8(b) has not been filled in. Actual and potential emissions of HFCs from 1990 onwards and SF₆ from 1996 onwards have been reported in the CRF tables. However, the ERT noted that HFC emissions from foam blowing and fire extinguishers were reported as not occurring (“NO”), as well as PFC emissions from refrigeration and air conditioning. The ERT considers that the notation key not estimated (“NE”) may describe the situation more accurately. After the centralized review, Liechtenstein provided the ERT with additional information, indicating that it will make additional efforts to report emissions from these categories in its next annual inventory submission.

D. Main findings

9. The inventory is generally in line with the Intergovernmental Panel on Climate Change (IPCC) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines), the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF) and is generally reported in accordance with 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” (hereinafter referred to as the

³ The SIAR, parts I and II, is prepared by an independent assessor in line with decision 16/CP.10 (paragraphs 5(a), 6(c) and 6(k)), under the auspices of the international transaction log (ITL) administrator using procedures agreed in the Registry System Administrators Forum. Part I is a completeness check of the submitted information relating to the accounting of Kyoto Protocol units (including the SEF tables and their comparison report) and to national registries. Part II contains a substantive assessment of the submitted information and identifies any potential problem regarding information on the accounting of Kyoto Protocol units and the national registry. The SIAR is not publicly available.

UNFCCC reporting guidelines). However, the ERT identified a need for further improvements in the following areas:

- (a) Use of country-specific emission factors (EFs) and activity data (AD), particularly where proxy data based on the Swiss population are used for emission estimates;
- (b) Reporting of emissions from stationary combustion disaggregated by categories in manufacturing industries and construction, and improving the transparency of the information provided in the NIR on these emissions;
- (c) Developing country-specific uncertainty values for the category consumption of halocarbons and SF₆;
- (d) Correcting inconsistencies between the CRF tables and national statistics regarding livestock population and correcting of distribution of manure from livestock among animal waste management systems (AWMS) in line with changes in agricultural practices over time;
- (e) Providing in the NIR definitions of, and the approach used for distinguishing between, managed and unmanaged land for GHG estimates in the LULUCF sector and ensure that these criteria are compatible with the IPCC good practice guidance for LULUCF;
- (f) Considering the differences in carbon stocks between managed and unproductive forests in the calculation of removals and emissions, and investigating and correcting, if necessary, the use of very high carbon stock change factors used for estimation of emissions and removals associated with changes in land use to grassland, settlements and other land;
- (g) Use of a country-specific value for protein consumption that corresponds to changes of food consumption of the population over the time-series.

10. Liechtenstein has submitted, in part, on voluntary basis supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol in accordance with Part I of the annex to decision 15/CMP.1. The Party did not submit information on minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol on a voluntary basis.

11. Liechtenstein has reported on a voluntary basis information on activities under Article 3, paragraph 3, of the Kyoto Protocol in accordance with section I.D of the annex to decision 15/CMP.1. The Party has not elected any activity under Article 3, paragraph 4, of the Kyoto Protocol.

12. Liechtenstein has reported information on its accounting of Kyoto Protocol units in accordance with section I.E of the annex to decision 15/CMP.1, and used the SEF tables as required by decision 14/CMP.1.

13. The national system continues to perform its required functions as set out in the annex to decision 19/CMP.1.

14. The national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1, and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP).

15. In the course of the review, the ERT formulated a number of recommendations as follows:
- (a) Increase the use of country-specific methods, including the provision in the NIR of more precise descriptions of methodologies that differ from those of the IPCC;
 - (b) Implement specific quality assurance/quality control (QA/QC) procedures for AD obtained from the Swiss energy balance and for AD and EFs in the waste sector;
 - (c) Enhance consistency of the information provided in the NIR and the CRF tables on the comparison between sectoral and reference approaches in the energy sector, the information provided on the key category analysis (CRF table 7), the rationale for recalculations, and the information on stock change in soil organic carbon in the cropland and grassland categories;
 - (d) Make the reporting of supplementary information on activities under Article 3, paragraph 3, of the Kyoto Protocol fully compliant with decision 15/CMP.1.
16. The ERT encourages Liechtenstein to explore the possibility of structuring its reporting, in its next annual submission, following the annotated outline of the NIR, and the guidance contained therein, that can be found on the UNFCCC website.⁴

E. A description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management

1. Overview

17. The ERT concluded that the national system continued to perform its required functions. The NIR described the national system and its institutional arrangements for the preparation of the inventory. The Government of Liechtenstein has overall responsibility for the national inventory and the Office of Environmental Protection (OEP) is the designated single national entity for preparation of the inventory. Following the mandate of Liechtenstein's Emission Trading Act, OEP is in charge of planning, preparing and managing the emission inventories and is therefore also responsible for all aspects concerning the establishing of the national system under the Kyoto Protocol. The Government mandated OEP to coordinate the national system. The head of OEP is the project manager of the inventory group and the National Registry Administrator. The inventory group consists of the project manager, the national inventory compiler, several external experts, sector specialists and the NIR authors. During the inventory preparation and planning, Liechtenstein's OEP cooperates closely with the Swiss Federal Office for the Environment (FOEN), the agency that has the lead within the Swiss federal administration regarding climate policy and its implementation. The NIR, in its annex 10, indicated that there are no changes in the national system in the 2009 submission.

2. Inventory planning

18. The annual cycle for inventory preparation includes several meetings of the inventory group and several meetings of governmental and other data suppliers with OEP. Several governmental and other data suppliers as well as the Swiss FOEN provide the inventory group with data for inventory estimations. The NIR authors check the emission results produced by the sector experts for consistency of cross-cutting parameters, correctness of emissions aggregation, and completeness of the GHG inventory. They also compare the methods used with the recommended methods in the IPCC good practice guidance.

⁴ <http://unfccc.int/files/national_reports/annex_i_ghg_inventories/reporting_requirements/application/pdf/annotated_nir_outline.pdf>.

19. For the majority of the emission categories, EFs are adopted from the Swiss GHG inventory after checking their applicability to Liechtenstein's national circumstances. In those cases when the EFs are applicable, they are reported as country-specific. The applicability of Swiss methodologies to Liechtenstein's GHG inventory is reviewed as well. Due to particular national circumstances, the inventory planning has a strong linkage with Swiss inventory actions and Swiss expertise. The ERT recommends that Liechtenstein continue its efforts to develop national-specific methods and capacities for the inventory planning and preparation.

3. Inventory preparation

Key categories

20. Liechtenstein has reported a key category tier 1 analysis, both level and trend assessments, as part of its 2009 submission. The key category analysis performed by Liechtenstein and that performed by the secretariat⁵ produced similar results, although there are some discrepancies due to differences in the disaggregation level in some categories (e.g. stationary combustion).

21. Liechtenstein has included the LULUCF sector in its key category analysis, which was performed in accordance with the IPCC good practice guidance and the IPCC good practice guidance for LULUCF. The NIR contains the key category analysis including LULUCF, but CRF table 7 (for 1990 and 2007) is not consistent with the information presented in the NIR and does not contain the key categories from the LULUCF sector. The ERT recommends that Liechtenstein correct this inconsistency in its next annual inventory submission.

22. Liechtenstein has provided information on identification of key categories for activities under Article 3, paragraph 3, of the Kyoto Protocol in table NIR 3. However, the ERT noted that this information does not follow the guidance on establishing the relationship between the activities under the Kyoto Protocol and the associated key categories in the inventory reported under the UNFCCC as provided in chapter 5.4.4 of the IPCC good practice guidance for LULUCF. The ERT encourages Liechtenstein to include this information, following the guidance of the IPCC good practice guidance for LULUCF, in its next annual submission under the Kyoto Protocol.

Uncertainties

23. A quantitative uncertainty analysis has been carried out following the tier 1 methodology of the IPCC good practice guidance. This uncertainty analysis was carried out without the LULUCF sector. For key categories, individual uncertainty values are used. For non-key categories, the NIR provides qualitative estimates of uncertainties. The terms used are high, medium and low data quality. In order to extend the quantitative uncertainty analysis to every non-key category, relative quantitative values are linked to these terms and used in the analysis. The global uncertainty in the inventory is determined by the rather high AD uncertainty of liquid fuels. The resulting overall inventory uncertainty in 2007 is estimated to be 5.95 per cent and the trend uncertainty to be 7.68 per cent.

24. For the first time Liechtenstein also carried out a tier 2 uncertainty analysis, using Monte Carlo simulation without the LULUCF sector. The results reveal an overall inventory uncertainty (level) in

⁵ The secretariat identified, for each Party, the categories that 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 for Land Use, Land-Use Change and Forestry. Key categories according to the tier 1 trend assessment were also identified for Parties that provided a full set of CRF tables for the base year or period. Where Liechtenstein performed a key category analysis, the key categories presented in this report follow the Liechtenstein's analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key category assessment conducted by the secretariat.

2007 of 6.05 per cent and a trend uncertainty of 8.85 per cent. The distributions of the overall inventory uncertainty for 2007 and 1990 are almost symmetrical, which is not the case for the trend uncertainty. The level value is slightly higher than the result of the tier 1 uncertainty analysis. However, the trend uncertainty is much greater than in the tier 1 analysis. The ERT commends Liechtenstein for these efforts and recommends that the Party include the LULUCF sector in the uncertainty analysis of its next annual inventory submission.

Recalculations and time-series consistency

25. Recalculations have been performed and reported by Liechtenstein in accordance with the IPCC good practice guidance. The ERT noted that recalculations of the time-series 1990 to 2006 have been undertaken mainly to take into account updated and corrected EFs in the energy and agriculture sectors, as well as improved modelling of HFCs in the industrial processes sectors and updated AD in the solvent and other product use, agriculture and waste sectors. The magnitude of the impact of recalculations is an increase in total GHG emissions of 0.01 per cent in 1990, and a decrease of 0.02 per cent in 2006. The rationale for these recalculations is provided in the NIR but not in CRF table 8(b). The ERT recommends that Liechtenstein include this information in CRF table 8(b) of its next annual inventory submission.

Verification and quality assurance/quality control approaches

26. In its 2009 submission, Liechtenstein provided a description of its QA/QC system. This QA/QC system accounts for the specific circumstances of Liechtenstein. The QA/QC activities are coordinated by the project manager of the inventory group. The QA/QC activities are organized within the inventory group and operational tasks are delegated to the lead author of the NIR, who provides QA/QC checklists to the national inventory compiler, the sectoral experts, the other NIR authors and the project manager. The lists with the QA/QC procedures carried out are then sent back to the project manager, who confirms the performance of the QA/QC activities. The NIR documents such QA/QC checklists in its annex 8. In the 2008 submission, the QC activities had been documented for the first time using these checklists and this procedure has continued for the 2009 submission. During the centralized review, Liechtenstein informed the ERT that further improvements in QA/QC procedures are ongoing and these will be reported in the next annual submission. One example of this is the decision taken in 2009 by OEP, by which a formal inventory development procedure is being introduced under the responsibility of the QA/QC manager, who will no longer be involved in the preparation of the inventory and reporting.

27. During the 2008 review, Liechtenstein provided further information to the ERT on its activities conducted both internally and externally in accordance with the QA/QC plan. However, these activities have not been reflected in the NIR of its 2009 submission. The ERT reiterates the recommendation of the previous review report that Liechtenstein include this information in its next annual inventory submission, particularly a description of the QA/QC activities conducted in connection with AD. During the centralized review, Liechtenstein informed the ERT that further improvements in the QA/QC system are ongoing and will be reported in its next annual inventory submission. The ERT welcomes these efforts.

Transparency

28. The NIR and the CRF tables are in general transparent and sufficiently detailed to assess underlying assumptions and rationale for the choice of data, methods and parameters. Transparency of the NIR with regard to the energy sector has significantly improved, although there remains room for improvement, particularly with regard to assumptions made as well as to observed trends in AD. On the other hand, the transparency for the agriculture sector (e.g. with regard to the applicability of Swiss country-specific methodologies, the estimation of consumption of mineral fertilizers or the AWMS

distribution) and the LULUCF sector (e.g. with regard to distinguishing between managed and unmanaged land and the provision of references and data sources) still needs improvement. The ERT recommends that Liechtenstein continue its efforts to improve the transparency of the information provided in its next annual inventory submission.

4. Inventory management

29. Liechtenstein has a centralized archiving system. OEP keeps the archive and all electronic files are stored at a central server with several backups, particularly the backup system of Liechtenstein's administration.

F. Follow-up to previous reviews

30. The ERT welcomes the progress Liechtenstein has made in its uncertainty estimates, as the Party conducted a tier 2 uncertainty analysis, and provided quantified uncertainty estimates for the non-key categories and the LULUCF sector following recommendations of the previous review reports. Also, Liechtenstein carried out minor corrections in the emission calculations leading to recalculations and some methodological changes (improvement in the modeling of HFC emissions).

G. Areas for further improvement

1. Identified by the Party

31. The NIR of the 2009 submission identifies few areas for improvement. The most important of these are:

- (a) Use of country-specific data for natural gas from Liechtenstein's natural gas utility for the emission estimates for the oil and natural gas category;
- (b) Further analysis and collection of additional information for the calculation of emissions from disposal under domestic refrigeration, mobile air conditioning and transport refrigeration;
- (c) Assessment of the use of uncertainty estimations for AD and carbon factors from Switzerland in the uncertainty analysis.

2. Identified by the expert review team

32. The ERT identifies the following cross-cutting issues for improvement:

- (a) Increasing the use of country-specific methods, including the provision in the NIR of more precise descriptions of methodologies that differ from those of the IPCC;
- (b) Improvement of the transparency of the information provided in the NIR on emissions from stationary combustion in manufacturing industries and construction;
- (c) Implementation of specific QA/QC procedures for AD obtained from the Swiss energy balance and for AD and EFs in the waste sector;
- (d) Enhancing the consistency of the information provided in the NIR and the CRF tables on the following: comparison between sectoral and reference approaches in the energy sector; the information provided on the key category analysis (CRF table 7); the rationale for recalculations; and the information on stock change in soil organic carbon in the cropland and grassland categories;

- (e) Making the reporting of supplementary information on activities under Article 3, paragraph 3, of the Kyoto Protocol fully compliant with decision 15/CMP.1;

33. Recommended improvements relating to specific categories are presented in the relevant sector chapters of this report.

II. Energy

A. Sector overview

34. The energy sector is the main sector in the GHG inventory of Liechtenstein. In 2007, emissions from the energy sector amounted to 215.35 Gg CO₂ eq, or 87.6 per cent of total GHG emissions. Since 1990, emissions have increased by 4.9 per cent. The key driver for the rise in emissions is attributed to increases in road transportation activities. Also, a significant increase of natural gas consumption in cogeneration plants and industries and construction activities was observed. Within the sector, 41.6 per cent of the emissions were from the category other sectors, followed by 40.6 per cent from transport, and 14.5 per cent from manufacturing industry. Other (mobile – off-road vehicles and other machinery (1.A.5.b)) accounted for 1.6 per cent and energy industries accounted for 1.2 per cent. The remaining 0.5 per cent was from fugitive emissions from oil and natural gas.

35. Liechtenstein's CRF tables are complete in terms of gases and categories covered and appropriate notation keys have been used. However, as it was observed by the previous ERT, indirect GHGs (non-methane volatile organic compounds (NMVOC), carbon monoxide, nitrogen oxides and sulphur dioxide) are not reported. During the centralized review, Liechtenstein indicated to the ERT that it is investigating options for reporting these gases. Also, the ERT noted that there were no emissions from military activities reported. Liechtenstein responded by verifying that there are no military activities in Liechtenstein and that this will be explicitly mentioned in its next annual inventory submission. The ERT welcomes this and encourages Liechtenstein to continue with its efforts to improve transparency by adding a paragraph discussing military activities in its next annual inventory submission.

36. Most transparency issues identified in previous review reports have been fixed, although there remains room for improvement, particularly with regard to information on assumptions made as well as observed trends in AD. The time-series of emissions has remained consistent even though Liechtenstein has performed recalculations due to updates on implied emission factors for CH₄ and N₂O in the road transportation, other sectors and other (off-road vehicles and other machinery) categories, as all fuels consumed in Liechtenstein are reported separately from those consumed in Switzerland according to the Swiss energy balance. As also noted by the previous ERT, this connection with the Swiss energy balance has the potential to result in an overestimation or underestimation of fuel consumption in Liechtenstein as a result of a corresponding underestimation or overestimation of fuel consumption in Switzerland. The ERT reiterates the recommendation made in the previous review report that Liechtenstein implement specific QA/QC procedures for AD related to the Swiss energy balance. After the centralized review, Liechtenstein informed the ERT that QC activities for the energy statistics are ongoing and they will be described in more detail in subsequent annual inventory submissions.

B. Reference and sectoral approaches

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

37. Liechtenstein has reported CO₂ emissions from fuel combustion using the reference approach and the sectoral approach for the entire time-series (1990–2007). The differences between the reference and sectoral approaches in the CO₂ emission estimates are very small for the complete time-series (0.03 per cent in 2007), with the largest difference for CO₂ emissions having occurred in 1990

(-0.06 per cent). The ERT noted that the percentage differences reported in the NIR for CO₂ emissions and energy consumption between the two approaches differ from what is reported in the CRF tables and encourages Liechtenstein to improve the consistency between the NIR and the CRF tables in its next annual inventory submission. Data for Liechtenstein are not available in the International Energy Agency (IEA) data bases, as Liechtenstein is not member of the IEA. For this reason a comparison of the Party's reference approach with international statistics is not possible.

2. International bunker fuels

38. The only category contributing to international bunker fuels is CO₂ emissions from jet kerosene for aviation bunkers. As transparently described in the NIR, Liechtenstein has one helicopter base operated by two companies, which supply fuel consumption, flying hours and fleet composition information. This information allows Liechtenstein to separate domestic from bunker fuel use. The share of the fuel consumption in aviation bunkers within the total fuel consumption from aviation in 2007 is 85 per cent.

3. Feedstocks and non-energy use of fuels

39. As also noted in the previous report, Liechtenstein has reported feedstocks and non-energy use of fuels as "NO" in the CRF tables for the complete time-series. During the centralized review as in the previous one, Liechtenstein has informed the ERT that some bitumen (in previous years) and asphalt (in later years) is used for road paving, as is also reported under the road paving with asphalt category. The ERT recommends that Liechtenstein include use of bitumen and other fuels (e.g. lubricants) in its reporting of feedstocks and non-energy use of fuels and provide information on this in the NIR of its next annual inventory submission.

C. Key categories

1. Stationary combustion: liquid and gaseous fuels – CO₂

40. As highlighted in the previous review report, the CO₂ EF for natural gas (55.00 t CO₂/TJ) used by Liechtenstein for its estimates was identified as being lower than the IPCC default value (56.1 t CO₂/TJ). During the centralized review, Liechtenstein indicated to the ERT that it uses an EF obtained from Switzerland since both countries have the same gas providers. Furthermore, it informed the ERT that OEP requested Liechtenstein's gas utility to evaluate the applicability of such an EF. In response to this request, the gas utility confirmed the applicability of this EF based on the results of the latest analysis made in September 2008, which indicated a value of 55.029 t/TJ. The ERT welcomes the effort made by Liechtenstein to test the applicability of the EF it uses for estimates and for the improvement in transparency, and recommends that Liechtenstein include this explanation and results of such an analysis in the NIR of its future annual inventory submissions.

41. Emissions from manufacturing industries and construction are reported in an aggregated manner in the CRF tables under other (1.A.2f). During the centralized review, Liechtenstein informed the ERT that individual reporting of these categories is not possible due to confidentiality of the data. The ERT encourages Liechtenstein to consider the possibility of using other publicly available data (e.g. European Union emissions trading scheme data⁶) for preparation of its next annual inventory submission.

42. Liechtenstein uses expert judgement to split gas oil consumption between the manufacturing industries and construction, commercial/institutional and residential categories. During the centralized review, Liechtenstein informed the ERT that this expert judgement is based on:

⁶ <<http://ec.europa.eu/environment/climat/emission/pdf/vesu2008public.xls>>.

- (a) Consumption of all major installations under manufacturing industries and construction and commercial/institutional categories (>1 MW);
- (b) Emissions of smaller installations under manufacturing industries and construction and commercial/institutional categories (calculated from average consumption and number of installations);
- (c) Analysis of the “Heating Emission Control” database, which is based on annual data collection for every single residential building. The ERT encourages Liechtenstein to include this detailed information in the NIR of its next annual inventory submission to increase transparency.

After the centralized review, Liechtenstein informed the ERT that detailed information on split of gas oil consumption will be included in the NIR of its 2010 annual submission.

2. Road transportation: liquid and gaseous fuels – CO₂

43. A study done by INFRAS (an independent Swiss consulting group) and OEP showed that CO₂ emissions from light and heavy motor vehicles are similar in Liechtenstein and Switzerland. Therefore, for road transportation, Liechtenstein selected, for estimating emissions for the year 2007, the same EFs used for the previous submission, because the EFs for 2007 from the Swiss inventory were still not available at the time of making the 2009 submission. Since the CO₂ EF remains constant over the time-series and the impact in the emission estimates of other gases (CH₄ and N₂O) is small, the ERT does not see any problems with this approach. Nevertheless, the ERT encourages Liechtenstein to explore ways to develop annually its country-specific EFs for road transportation and avoid the dependence on the publication of EFs used in the Swiss inventory.

3. Other (mobile – off-road vehicles and other machinery): liquid fuels – CO₂

44. Emissions from machinery in construction and industry are currently reported as off-road vehicles and other machinery under other (mobile (1.A.5b)), which is not in line with the Revised 1996 IPCC Guidelines. The ERT recommends that Liechtenstein report these emissions under other (manufacturing industries and construction (1.2.Af)) in its next annual inventory submission.

D. Non-key categories

Fugitive emissions from oil and natural gas: gaseous fuels – CH₄

45. CH₄ emissions from distribution of natural gas have increased by 233.5 per cent during the period 1990–2007. During the centralized review, Liechtenstein informed the ERT that the extension of the natural gas distribution network as well as the increased number of household connections explain the strong increase in the CH₄ emissions from distribution of natural gas. The ERT acknowledges this explanation and commends Liechtenstein for the application of a tier 3 methodology for this category and recommends that the Party include such an explanation in the NIR of its next annual inventory submission.

III. Industrial processes and solvent and other product use

A. Sector overview

46. In 2007, emissions from the industrial processes sector amounted to 4.59 Gg CO₂ eq, or 1.9 per cent of total GHG emissions, and those from the solvent and other product use sector amounted to 1.11 Gg CO₂ eq, or 0.5 per cent of total GHG emissions. GHG emissions in the industrial processes sector, which originate only from the consumption of halocarbons and SF₆, were negligible in 1990

(0.0084 t CO₂ eq). In 2007, HFCs contributed 97.4 per cent to the total sectoral emissions, with SF₆ accounting for the remaining 2.6 per cent. PFC emissions are reported as “NO” for the complete time-series. HFC emissions experienced a steep growth between 1992 and 2004 by 44,380.1 per cent, whereas, in recent years, this increase significantly lessened, with a 13.5 per cent increase in emissions between 2003 and 2004, a 0.04 per cent increase between 2004 and 2005, a 0.05 per cent decrease between 2005 and 2006, and a 7.5 per cent increase between 2006 and 2007, owing to the stabilization in the use of HFCs in commercial refrigeration. Information on indirect GHG emissions (CO and NMVOCs) was reported in the NIR for the categories asphalt roofing and road paving with asphalt. GHG emissions from the solvent and other product use sector decreased by 44.4 per cent between 1990 and 2007, due to the control measures introduced to limit NMVOC emissions and to a decline in N₂O consumption (e.g. for anaesthesia and aerosol cans).

47. In general, Liechtenstein estimates emissions in accordance with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. However, the ERT recommends that Liechtenstein implement data gathering following the IPCC good practice guidance, giving priority to key categories, and not basing the estimates on proxy and Swiss data. After the centralized review, Liechtenstein informed the ERT that 86 per cent of the emissions of synthetic gases correspond to the refrigeration and air conditioning equipment category, and that the current estimation method using indicators (inhabitants, number of households, number of cars, etc.) for this category adequately reflects its national circumstances. Liechtenstein also informed the ERT that no further improvements are planned in this sector.

48. No reference to category-specific QC procedures has been made for the industrial processes and solvent and other product use sectors in the NIR. The ERT recommends that Liechtenstein carry out category-specific QC, as described in the IPCC good practice guidance. In its uncertainty analysis, Liechtenstein did not use country-specific values of uncertainties, but used those from Switzerland, although they could be higher due to the conversion of Swiss into Liechtenstein data. The ERT encourages Liechtenstein to estimate its country-specific values of uncertainties, in particular for the consumption of halocarbons and SF₆ key category, in its next annual inventory submission.

49. The emission estimates for the years 1998–2006 for the refrigeration and air conditioning equipment category have been recalculated using the final Swiss EFs. The ERT recommends that Liechtenstein revise the NIR, which states that estimates were recalculated for 1990–2006. A summary table with information on the recalculation was reported in the NIR. The recalculation was based on modelling improvements in commercial refrigeration, air conditioning, heat pumps, general refrigeration and mobile air conditioning. The impact of the recalculations in 2006 is a decrease of HFC emissions in the category consumption of halocarbons and SF₆ of 0.27 per cent. The ERT recommends that Liechtenstein complete CRF table 8(b) with explanatory information on recalculations and improve the consistency of the information provided in the CRF tables and the NIR for its next annual inventory submission.

B. Key categories

Consumption of halocarbons and SF₆ – HFCs

50. An IPCC tier 2a bottom-up approach is used to estimate emissions for this category (refrigeration and air conditioning equipment). AD used for this approach are based on the rule of proportion between the AD reported by Switzerland and specific indicators such as number of households, number of employees or number of cars, assuming that the consumption patterns for industry, services, transport and household sectors of Liechtenstein are very similar to those of Switzerland. In addition, Liechtenstein used the EFs used by Switzerland for its 2009 submission. The IPCC good practice guidance recommends, however, that data be collected on the actual numbers of equipment in the

country, as well as the average charge sizes and leak rates. The ERT recommends that Liechtenstein implement the data gathering as recommended in the IPCC good practice guidance.

51. Also, the ERT recommends that Liechtenstein take into consideration in its future improvement plans the development of its own AD to avoid using Swiss data, and include further explanations about specific assumptions made in the NIR of its next annual inventory submission, to enhance the transparency and completeness of the information provided. This recommendation is made acknowledging the difficulties that may arise from the fact that Liechtenstein and Switzerland form a customs and monetary union governed by a customs treaty, as indicated by the Party after the centralized review.

52. The ERT noted that Liechtenstein has reported HFC emissions from foam blowing and fire extinguishers and PFCs from refrigeration and air conditioning as “NO”. HFC emissions may be released from foam blowing applications (e.g. for insulating, cushioning and packaging). HFCs are used as replacements for chlorofluorocarbons and hydrochlorofluorocarbons. The ERT encourages Liechtenstein to consider producing an estimate for HFC emissions on the basis of the data reported by neighbouring countries, in its next annual inventory submission. After the centralized review, Liechtenstein informed the ERT that for soft foams, it will check whether in the Swiss inventory a distinction between soft foams and hard foams can be accomplished. If this is possible, for soft foams the notation key “NO” will be confirmed as no production is occurring in the country. If a distinction is not possible, then for hard foams, recalculations will be performed and the corresponding correction of used notation keys made, because even though emissions are not occurring from production, as there is none, emissions from stock and disposal can be estimated based on the Swiss inventory and will be implemented for the 2010 submission.

53. Regarding fire extinguishers, Liechtenstein informed the ERT that it will contact the Swiss inventory team suggesting expanding the NIR for this category, and an estimation of emissions could be provided for Liechtenstein as of 2011 using the rule of proportion. In addition, estimations of PFC emissions from refrigeration and air conditioning can be provided as of 2010 also using the rules of proportion based on Swiss inventory data.

C. Non-key categories

Electrical equipment – SF₆

54. The sum of potential SF₆ emissions reported by Liechtenstein for 1996–2007 is about 20.42 tonnes. The sum of actual emission for the same period is about 0.019 tonnes. This implies that the quantity of gas stocked in equipment is about 3.085 tonnes. During the review, Liechtenstein informed the ERT that there are three major electrical installations and some smaller transformer stations in the country. Given such a small equipment base, the ERT encourages Liechtenstein to check with the Liechtensteinische Kraftwerke (LKW), the utility that operates the electrical equipment, whether this is a reasonable result. The ERT also recommends that Liechtenstein report the result of this check in the NIR of its next annual inventory submission. After the centralized review, Liechtenstein informed the ERT that the reported data have been analysed by LKW on installation level and in this process the data were reconfirmed.

IV. Agriculture

A. Sector overview

55. In 2007, emissions from the agriculture sector amounted to 22.58 Gg CO₂ eq, or 9.3 per cent of total GHG emissions. Since 1990, emissions have increased by 0.2 per cent. The key drivers for this trend are a 5.9 per cent increase in livestock emissions and a slightly lower (5.1 per cent) fall in the N₂O

emissions from agricultural soils, primarily due to a reduced consumption of mineral fertilizers. Within the sector, 46.0 per cent of the emissions were from enteric fermentation, followed by 39.1 per cent from agricultural soils and 14.9 per cent from manure management. CH₄ accounted for 53.7 per cent of total sectoral emissions, and N₂O accounted for 46.3 per cent.

56. The ERT reiterates the finding from the previous review report that the NIR is not sufficiently transparent and has not been improved with respect to the previous submission. In addition, the ERT noted that the recommendation from the previous review report that Liechtenstein provide in the NIR proper justification for the applicability of Swiss country-specific methodologies and EFs to its national circumstances has not been yet implemented. This includes statistics on annual milk production per dairy cow, average nitrogen excretion rates, mineral fertilizer consumption, annual ammonia emission, and nitrogen leaching. Furthermore, no justification has been provided for the reported non-applicability of savanna burning, even though the ERT considers that this activity may not occur in the country.

57. The methodologies and EFs used by Liechtenstein are heavily dependent on those used by Switzerland, and Liechtenstein has not reported any plans to make improvements to them. There are no differences between the 2007, 2008 and 2009 submissions in terms of methodologies and the transparency of the NIR. For the 2009 submission there has been a small recalculation for the inventory year 2006 due to updated EFs received from Switzerland (0.1 per cent decrease in sectoral emissions).

58. The number of animals reported in the inventory is not entirely consistent with the official agricultural statistics of Liechtenstein. For example, the cattle population in 2007 has been reported in the CRF tables as 6,088 head of cattle, whereas the national agricultural statistics report 6,029. In the CRF tables, Liechtenstein has classified 951 animals as “breeding cattle” under other, which is not logical, therefore the ERT recommends that Liechtenstein remove these animals from this subcategory and include them in the relevant cattle group. For other major animal groups, the numbers are consistent except for horses and poultry. During the centralized review, Liechtenstein has explained to the ERT that this is due to different sampling techniques and that by 2011 at the latest full consistency between the numbers in the inventory and the agricultural statistics will be achieved. This will partly be done on the cattle registration in the Tierverkehrsdatenbank (Animals Dealing Database). The ERT recommends that Liechtenstein perform this update of the AD, if possible for its next annual inventory submission.

B. Key categories

1. Enteric fermentation – CH₄

59. Liechtenstein used the tier 2 Swiss methodology for its emission estimates in this category for all livestock species, which is consistent with the IPCC tier 2 methodology and in line with the IPCC good practice guidance. The EFs used are a mixture of IPCC default factors and Swiss country-specific factors. The ERT recommends that Liechtenstein provide an explanation in the NIR of its next annual inventory submission, reflecting its national circumstances, of the applicability of Swiss country-specific methodologies and EFs for its estimates.

60. AD for the estimates are obtained from the Office of Food Inspection and Veterinary Affairs in cooperation with the Office for Agriculture. Since 2002, Liechtenstein has adopted a livestock data collection system which generates much more accurate data. The livestock data are well disaggregated and the data have been applied across all appropriate categories, which is in line with the IPCC good practice guidance.

2. Direct soil emissions – N₂O

61. Direct N₂O soil emissions have decreased slightly since 1990 (1.6 per cent), mainly as a result of the reduced input of mineral fertilizer. Emissions have been calculated using the IPCC tier 1b

methodology and a combination of Swiss country-specific EFs and IPCC default EFs. The estimation of the consumption of mineral fertilizer is unclear, and assumptions made have not been documented in the NIR. The ERT noted that Liechtenstein has not followed the recommendations from previous review reports to provide in the NIR a justification of the applicability of Swiss country-specific methodologies and EFs to its national circumstances. The ERT reiterates the recommendation that Liechtenstein provide all this missing information in the NIR of its next annual inventory submission.

3. Indirect emissions – N₂O

62. Indirect N₂O soil emissions have also decreased since 1990 (8.0 per cent), mainly as a result of the reduced input of synthetic fertilizer. In order to calculate these emissions, a combination of Swiss country-specific and IPCC tier 1b methodologies and IPCC default EFs were used. The ERT noted that Liechtenstein has not followed the recommendations from previous review reports to provide in the NIR a justification of the applicability of Swiss country-specific methodologies to its national circumstances. The ERT reiterates the recommendations given in paragraph 61 above.

C. Non-key categories

Manure management – CH₄ and N₂O

63. Country-specific methodologies and default EFs were used to estimate N₂O emissions from manure management in AWMS, based on the Swiss data. No information is given in the NIR on the AWMS distribution adopted by Liechtenstein, which was assumed to be the same as for Switzerland for all years from 1990 to 2007, regardless of the changes in practices during this period. The ERT recommends that Liechtenstein collect and verify information on the distribution of livestock in different AWMS and, if necessary, update the EFs used in its estimates for its next annual inventory submission.

V. Land use, land-use change and forestry

A. Sector overview

64. In 2007, net removals from the LULUCF sector amounted to 6.57 Gg CO₂ eq. Since 1990, net removals have decreased by 21.1 per cent. The key driver for the fall in removals is the increase in emissions in other land-use categories. CH₄ and N₂O emissions for all categories are reported as “NO”. Forest land is the only category with reported net CO₂ removals, which in 2007 amounted to 19.13 Gg. Total CO₂ emissions from cropland, grassland, wetlands, settlements and other land in 2007 were 12.56 Gg. From these total emissions, 36.3 per cent were from cropland, followed by 28.1 per cent from settlements, 21.2 per cent from grassland, 8.3 per cent from other land and 6.1 per cent from wetlands. The carbon removal of this sector only offset 2.7 per cent of the total GHG emissions in the country.

65. The inventory of the LULUCF sector is complete. The CRF tables include estimates of CO₂ emissions and removals for all six land-use categories in the sector. Carbon stock changes in living biomass, dead organic matter (DOM) and soils have been reported under the relevant categories. Liechtenstein has applied tier 2 methods and used country-specific emission/removal factors.

66. Liechtenstein has represented all land-use areas in the CRF tables, with a total extension of 16,050 ha for all inventory years. The total land area reported in the NIR (between 16.10 and 16.11 kha, depending on the year) is consistent with that in the CRF (16,050 ha in every year). However, the ERT found that the areas reported in table 91 of the NIR for each land-use category correspond to land-use categories remaining in the same land-use categories, while areas of land converted to other land-use categories seem to have been excluded. While land-use changes are of very small magnitude, the ERT encourages Liechtenstein to improve the consistency of representation of land use between the NIR and CRF tables, and to include land-use change categories in the areas reported in the NIR.

67. In previous review stages a number of significant inter-annual changes in net carbon stock changes in living biomass, DOM and soils per area have been identified for most categories between 1996 and 1997 and between 2002 and 2003. In its response, Liechtenstein explained that this is due to a change in interpolation parameters between these two groups of years, as Liechtenstein used three land-use data sets (aerial photographs for 1984, 1996 and 2002) for its estimations in the LULUCF sector. The ERT noted that a periodical inconsistency between the time-series data sets exists, that is, between 1990–1996, 1997–2002 and 2003–2007. The ERT recommends that Liechtenstein revisit and refine the interpolation and extrapolation method used in order to have more consistent data series in its next annual inventory submission.

68. In the previous review report it was noted that the use of a 12-year interval in calculating annual carbon stock change in soils due to land-use conversion is not consistent with the IPCC good practice guidance for LULUCF and it was recommended that Liechtenstein explore the availability of country-specific data or use the IPCC default transition time of 20 years. In the 2009 submission Liechtenstein still uses the 12-year interval, and therefore the ERT reiterates the above recommendation to be implemented in its next annual inventory submission.

69. Liechtenstein divided lands into managed and unmanaged for its emission/removals estimates. However, Liechtenstein did not provide in the NIR detailed definitions and the national approach to distinguishing between unmanaged and managed land in transparent manner as suggested by the IPCC good practice guidance for LULUCF. After the centralized review Liechtenstein explained to the ERT that it applies the definitions of forest management as provided in the IPCC good practice guidance for LULUCF for distinguishing its managed forest. The ERT recommends that Liechtenstein improve the descriptions in the NIR of its next annual inventory submission on how it distinguishes between managed and unmanaged land and the related definitions applied and how it ensures that land areas once accounted as managed land continue to be tracked as managed land in the accounting system.

70. Liechtenstein provided most of the AD and emission/removal factors in the NIR. However, some data have no references. Liechtenstein explained that country-specific AD were taken from aerial photographs, while emission and removal factors were adopted from Switzerland's inventory. Liechtenstein informed the ERT during the centralized review that it will indicate the source of all data used in its future annual inventory submissions.

B. Key categories

1. Forest land remaining forest land – CO₂

71. The annual net CO₂ removals from forest land remaining forest land in 2007 amounted to 19.03 Gg, a 2.1 per cent increase as compared to the value in 1990. In the calculation of removals and emissions, Liechtenstein ignored the loss of living biomass due to changes between two so called combination categories, from managed forest (CC12) to unproductive forest (CC13). Since both types of forest differ significantly in their levels of carbon stock, this assumption may lead to an underestimation of emissions in 2007, or to overestimations in other years, depending on the extent of land areas of each category being converted. During the centralized review, Liechtenstein informed the ERT that it will improve the specification of the conditions of the managed and unproductive forest in its next annual inventory submission.

2. Cropland remaining cropland – CO₂

72. Cropland remaining cropland accounted for a net source of 4.45 Gg CO₂ in 2007. Since 1990, emissions from this category tended to increase at a rate of 0.26 per cent per year. In the CRF tables, these emissions are reported as occurring from mineral soils. The ERT noted an inconsistency between the CRF tables and the NIR, regarding the reported emissions from cropland remaining cropland due to

the loss of carbon stock in mineral soils. While Liechtenstein reported emissions from this category in the CRF tables, it reported zero emissions in the NIR. Liechtenstein informed the ERT during the centralized review that it will correct this inconsistency in its next annual inventory submission.

3. Grassland remaining grassland – CO₂

73. Grassland remaining grassland accounted for a net source of 1.80 Gg CO₂ in 2007. Since 1990, emissions from this category tended to decrease at a rate of 1.0 per cent per year. In the CRF tables, these emissions are reported as occurring from mineral soils. In the 2009 NIR, Liechtenstein reported zero emissions from this category. Liechtenstein informed the ERT during the centralized review that it will correct this inconsistency in its next annual inventory submission.

4. Land converted to grassland – CO₂

74. Land converted to grassland accounted for a net source of 0.87 Gg CO₂ in 2007. Before 1997, these activities resulted in a net sink, and then turned into a net source until 2007. Liechtenstein informed the ERT that the conversion of land to grassland that resulted in a net sink occurred when the conversion took place in surface water which has no carbon stock. In the case of wetlands converted to grassland, Liechtenstein reported that the conversion caused a remarkable increase of 68 Mg carbon per hectare in soil carbon. This value is out of the IPCC default values range. The ERT recommends that Liechtenstein revisit and check the data used and the calculations made for this category in its next annual inventory submission.

5. Land converted to settlements – CO₂

75. Land converted to settlements accounted for a net source of 3.47 Gg CO₂ in 2007. Since 1990, the emissions from this category tended to increase at a rate of 0.51 per cent per year. The increase in emissions was mainly due to a slight increase in forest land converted to settlements.

76. The assumed rate of loss of soil carbon during the conversion of forest land, cropland and grassland to settlements is between 19 and 44 Mg C/ha. These values are out of the IPCC default values range. The ERT recommends that Liechtenstein revisit and check the data used and the calculations made for this category in its next annual inventory submission.

C. Non-key categories

Land converted to other land – CO₂

77. Among the non-key categories of the LULUCF sector, conversion of land to other land gave the highest emissions, that is, 1.04 Gg CO₂ in 2007. On average, the emissions from this category tended to increase at a rate of 5.1 per cent per year. The increase in emissions was mainly due to a slight increase in forest land converted to settlements. The assumed rate of loss of soil carbon during the conversion of forest land, grassland and settlements to other land is between 50 and 93 Mg C/ha. These values are out of the IPCC default values range. The ERT recommends that Liechtenstein revisit and check the data used and the calculations made for this category in its next annual inventory submission.

VI. Waste

A. Sector overview

78. In 2007 emissions from the waste sector amounted to 1.85 Gg CO₂ eq and contributed 0.8 per cent to total GHG emissions. Since 1990, emissions have increased by 19.2 per cent, mostly due to the increase of 63.0 per cent in composting activities and of 22.6 per cent in wastewater handling. In 2007, within the sector, 55.2 per cent of the emissions were from wastewater handling, followed by

43.0 per cent from other (waste composting). The emissions from solid waste disposal on land and waste incineration contributed 1.1 per cent and 0.8 per cent, respectively, to total GHG emissions of the sector.

79. There are no managed landfills in Liechtenstein, as all municipal solid waste is exported to Switzerland for incineration. In response to the recommendation from a previous review report, Liechtenstein included estimates from an unmanaged landfill, which was closed in 1974.

80. A preliminary uncertainty analysis of the GHG emissions from the waste sector has been performed based on expert judgment. Category-specific QA/QC procedures have not been implemented yet. Liechtenstein is encouraged to develop category-specific QA/QC procedures for the most important categories in its next annual inventory submission.

81. According to the key category analysis, there are no key categories in the waste sector.

B. Non-key categories

1. Solid waste disposal on land – CH₄

82. CH₄ emissions from solid waste disposal on land amounted to 0.02 Gg CO₂ eq in 2007. The IPCC first order decay method was used for estimating CH₄ from solid waste disposal in unmanaged landfills.

83. Liechtenstein used Switzerland's EFs, for example for waste composition, to calculate the value for degradable organic carbon, on the assumption that these data are roughly representative of the situation in Liechtenstein. The ERT encourages Liechtenstein to explore the possibility of developing and using country-specific parameters, where possible, in its future annual inventory submissions.

2. Wastewater handling – CH₄ and N₂O

84. In Liechtenstein wastewater treatment plants are equipped with digesters, and biogas is used for cogeneration of heat and power on-site. A country-specific method, which is based on Swiss EFs was used for estimating CH₄ emissions from domestic and commercial wastewater handling. The ERT encourages Liechtenstein to develop and use country-specific parameters, where possible, in its future annual inventory submissions.

85. Liechtenstein used the IPCC default methodology to estimate N₂O emissions from human sewage, based on a constant value of 36 kg/person/year for protein consumption for the entire time-series. The ERT recommends Liechtenstein to use annual country-specific values or data on protein consumption for the neighbouring countries from the Food and Agriculture Organization of the United Nations Statistical Database (FAOSTAT) in order to improve accuracy in its future annual inventory submissions.

3. Waste incineration – CO₂

86. The CO₂ emissions from illegal waste incinerations are estimated based on the assumption that waste incinerated illegally represents 0.5 per cent of waste generated in the country, which resulted in an emission of 0.01 Gg CO₂ eq in 2007. A country-specific tier 2 method and Switzerland's EFs are used for estimating GHG emissions. The ERT commends the Party for these efforts and encourages Liechtenstein to develop and use country-specific parameters, where possible, in its future annual inventory submissions.

4. Other – CH₄ and CO₂

87. Liechtenstein has reported CH₄ and CO₂ emissions from waste composting, which amounted to 0.80 Gg CO₂ eq, or 0.3 per cent of total GHG emissions in the country. A country-specific method,

based on the Swiss parameters, is used for emissions estimation, and covers the emissions from the centralized composting plants and small composting sites in backyards. Based on expert judgement, it is assumed that small compost sites represent from 8 to 5 per cent of total composted waste during the period 1990–2007. The ERT commends the Party for these efforts and encourages Liechtenstein to provide relevant explanations on this assumption in the NIR and to use country-specific parameters for its estimates, where possible, in its future annual inventory submissions.

VII. Supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

A. Information on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol

88. Liechtenstein has included a section in the NIR of its 2009 submission with information provided on a voluntary basis of activities under Article 3, paragraph 3, of the Kyoto Protocol, as well as complete Kyoto Protocol CRF tables for 2007. Liechtenstein has not elected any activities under Article 3, paragraph 4, of the Kyoto Protocol. The information in the NIR only provides general information.

89. The ERT noted that Liechtenstein has not provided the following information: how it ensures that units of land and areas of land are identifiable; verifiable information that demonstrates that carbon pools that are not accounted for are not sources; how removals from elevated concentrations of CO₂ from indirect nitrogen deposition and from the dynamics of age–class structure are factored out; how it distinguishes afforestation from deforestation and transient situations like harvesting or forest disturbance; and information that demonstrates that the starting date for activities under Article 3, paragraph 3, of the Kyoto Protocol is after 1 January 1990 and of the fact that these are human induced. The ERT recommends that Liechtenstein include all these mandatory information items in its next annual submission under the Kyoto Protocol, following the annotated outline of the NIR, and the guidance contained therein, that can be found on the UNFCCC website.⁷

90. Activities under Article 3, paragraph 3, have been reported as a net source of 5 Gg CO₂ eq in 2007. In estimating the emissions and removals from afforestation, Liechtenstein used the tier 1 method of the IPCC good practice guidance, and reported no changes in the litter, dead wood and soil carbon pools, thus only changes in living biomass are reported. For deforestation, Liechtenstein accounted for losses of carbon in living biomass, litter, dead wood and soil. Assumed loss of soil carbon from deforestation is about 46 Mg C/ha, which are out of the IPCC default values range. The ERT recommends that Liechtenstein revisit and check the data used and calculations made for this category in its next annual submission.

B. Information on Kyoto Protocol units

1. Standard electronic format and reports from the national registry

91. Liechtenstein has reported information on its accounting of Kyoto Protocol units in the required SEF tables, as required by decisions 15/CMP.1 and 14/CMP.1. The ERT took note of the findings and recommendations included in the SIAR on the SEF tables and their comparison report.⁸ The SIAR was forwarded to the ERT prior to the review, pursuant to decision 16/CP.10.

⁷ <http://unfccc.int/files/national_reports/annex_i_ghg_inventories/reporting_requirements/application/pdf/annotated_nir_outline.pdf>.

⁸ The SEF tables comparison report is prepared by the ITL administrator and provides information on the outcome of the comparison of data contained in the Liechtenstein's SEF tables with corresponding records contained in the ITL.

92. Information on the accounting of Kyoto Protocol units has been prepared and reported in accordance with section I.E of the annex to decision 15/CMP.1, and reported in accordance with decision 14/CMP.1 using the SEF tables. This information is consistent with that contained in the national registry and with the records of the international transaction log (ITL) and the clean development mechanism registry and meets the requirements set out in paragraph 88 (a) to (j) of the annex to decision 22/CMP.1. The transactions of Kyoto Protocol units initiated by the national registry are in accordance with the requirements of the annex to decision 5/CMP.1 and the annex to decision 13/CMP.1. No discrepancy has been identified by the ITL and no non-replacement has occurred. The national registry has adequate procedures in place to minimize discrepancies.

2. National registry

93. The ERT took note of the SIAR and its finding that the reported information on the national registry is complete and has been submitted in accordance with the annex to decision 15/CMP.1. The ERT further noted from the SIAR and its finding that the national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1, and continues to adhere to the technical standards for data exchange between registry systems in accordance with decisions 16/CP.10 and 12/CMP.1. The national registry also has adequate security measures in place and its operational performance is adequate.

94. The ERT reiterates the recommendations contained in the SIAR that Liechtenstein should provide, in its next annual submission, more detailed information with regard to paragraph 32 (d), (i) and (j) of the annex to decision 15/CMP.1 on changes made to the conformance of the registry to the technical standards for data exchange and measures taken to safeguard, maintain and recover data in order to ensure the integrity of data storage and recovery of national registry services in the event of a disaster, including the relevant test plans and procedures and test reports available, with the aim of testing the performance, procedures and security measures of the national registry.

95. The registry of Liechtenstein provides practically all the public information referred to in paragraphs 44 to 48 of the annex to decision 13/CMP.1 on its website,⁹ as included in annex 10.9 of the NIR. Nevertheless, the ERT considers that Liechtenstein should enhance, the availability of public information referred to in paragraph 47 of the annex to decision 13/CMP.1, and report, in its next annual submission, on any changes to that public information. In addition, reporting of Article 6 projects information could be strengthened by indicating clearly that no such projects exist instead of providing no information through the user interface of the registry.

3. Calculation of commitment period reserve

96. Liechtenstein has reported its commitment period reserve in its 2009 annual submission. Liechtenstein reported that its commitment period reserve has not changed since the initial report review (950,061 t CO₂ eq), as it is based on the assigned amount and not the most recently reviewed inventory. The ERT agrees with this figure.

C. **Changes to the national system**

97. Liechtenstein reported no change in its national system as compared to the previous annual submission. The ERT concluded that Liechtenstein's national system continues to be in accordance with the requirements of national systems outlined in decision 19/CMP.1.

⁹ <<https://www.national-registry.li>>.

D. Changes to the national registry

98. Liechtenstein reported a minor change (change of postal address of the registry and increase of the registry staff) in its national registry, as compared to the previous annual submission. The ERT concluded that Liechtenstein's national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1, and continues to adhere to the technical standards for data exchange between registry systems in accordance with decisions 16/CP.10 and 12/CMP.1.

VIII. Conclusions and recommendations

99. Liechtenstein made its annual submission on 2 April 2009. Liechtenstein indicated that the 2009 annual submission is a voluntary submission under the Kyoto Protocol. The annual submission contains the GHG inventory (comprising CRF tables and an NIR) and supplementary information under Article 7, paragraph 1, of the Kyoto Protocol (information on activities under Article 3, paragraph 3, of the Kyoto Protocol, information on Kyoto Protocol units, and changes to the national system and the national registry). This is in line with decision 15/CMP.1.

100. The ERT concludes that the inventory submission of Liechtenstein has been prepared and reported in accordance with the UNFCCC reporting guidelines. The inventory submission is complete and Liechtenstein has submitted a complete set of CRF tables for the years 1990–2007 and an NIR; these are complete in terms of geographical coverage, years and sectors, as well as generally complete in terms of categories and gases. The ERT noted that HFC emissions from foam blowing and fire extinguishers, as well as PFC emissions from refrigeration and air conditioning currently reported as “NO” may occur in the country and that the notation key “NE” may describe the situation more accurately.

101. The submission on a voluntary basis of information required under Article 7, paragraph 1, of the Kyoto Protocol has been prepared and reported in accordance with decision 15/CMP.1. Liechtenstein did not submit information on minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol on a voluntary basis.

102. Liechtenstein's inventory is generally in line with the UNFCCC reporting guidelines, the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and the IPCC good practice guidance for LULUCF. The ERT encourages Liechtenstein to make efforts to improve the general accuracy of GHG estimates for a number of categories by thoroughly assessing the applicability of Switzerland's EFs and AD and, where suitable, develop its own parameters.

103. Liechtenstein provided information on activities under Article 3, paragraph 3, of the Kyoto Protocol, generally in accordance with the guidelines for the preparation of information required under Article 7 of the Kyoto Protocol. The ERT noted that the information provided only covers some mandatory items and recommends that Liechtenstein include all the mandatory information required in paragraphs 6 to 8 of the annex to decision 15/CMP.1 in its next annual submission.

104. Liechtenstein has reported information on its accounting of Kyoto Protocol units in accordance with section I.E of the annex to decision 15/CMP.1, and used the required reporting format tables as required by decision 14/CMP.1.

105. The national system continues to perform its required functions as set out in the annex to decision 19/CMP.1.

106. The national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1, and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant CMP decisions.

Nevertheless, the ERT considers that Liechtenstein should enhance the availability of public information referred to in paragraph 47 of the annex to decision 13/CMP.1.

107. In the course of the review, the ERT formulated a number of recommendations¹⁰ relating to the transparency of emission estimates in the energy sector, consistency between CRF tables and the NIR and implementation of specific QA/QC procedures, particularly for AD related to the Swiss energy balance. The key recommendations are that Liechtenstein:

- (a) Increase the use of country-specific EFs, AD and methods, particularly for those categories for which national circumstances differ from those of Switzerland, and include in the NIR more precise descriptions of methodologies that differ from those of the IPCC;
- (b) Improve the transparency of estimates of emissions from stationary combustion in manufacturing industries and construction;
- (c) Report supplementary information for activities under Article 3, paragraph 3, of the Kyoto Protocol, fully in line with provisions in the annex to decision 15/CMP.1;
- (d) Adopt criteria compatible with the IPCC good practice guidance for LULUCF regarding the classification of land between managed and unmanaged;
- (e) Enhance consistency of the information provided in the NIR and the CRF tables, for example on the comparison between sectoral and reference approaches in the energy sector, the information provided on the key category analysis, the rationale for recalculations, and the information on stock change in soil organic carbon in the cropland and grassland categories.

IX. Questions of implementation

108. No questions of implementation were identified by the ERT during the review.

¹⁰ For a complete list of recommendations, the relevant chapters of this report should be consulted.

Annex I

Documents and information used during the review

A. Reference documents

Intergovernmental Panel on Climate Change. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at <<http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>>.

Intergovernmental Panel on Climate Change. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. Available at <<http://www.ipcc-nggip.iges.or.jp/public/gp/english/>>.

Intergovernmental Panel on Climate Change. *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. Available at <<http://www.ipcc-nggip.iges.or.jp/public/gp/landuse/gp/landuse.htm>>.

“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/2006/9. Available at <<http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf>>.

“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>>.

Status report for Liechtenstein 2009. Available at <<http://unfccc.int/resource/docs/2009/asr/lie.pdf>>.

Synthesis and assessment report on the greenhouse gas inventories submitted in 2009. Available at <<http://unfccc.int/resource/webdocs/sai/2009.pdf>>.

FCCC/ARR/2008/LIE. Report of the individual review of the greenhouse gas inventory of Party submitted in 2008. Available at <<http://unfccc.int/resource/docs/2009/arr/lie.pdf>>.

B. Additional information provided by the Party

Responses to questions during the review were received from Mr. Patrick Insinna (Office of Environmental Protection), including additional material on the methodology and assumptions used.

Annex II**Acronyms and abbreviations**

AD	activity data	ITL	international transaction log
AWMS	animal waste management system	kg	kilogram (1 kg = 1 thousand grams)
CH ₄	methane	LULUCF	land use, land-use change and forestry
CO ₂	carbon dioxide	Mg	megagram (1 Mg = 1 tonne)
CO ₂ eq	carbon dioxide equivalent	NA	not applicable
CRF	common reporting format	NO	not occurring
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol	N ₂ O	nitrous oxide
DOM	dead organic matter	NIR	national inventory report
EF	emission factor	NMVOG	non-methane volatile organic compounds
ERT	expert review team	PFCs	perfluorocarbons
GHG	greenhouse gas; unless indicated otherwise, GHG emissions are the sum of CO ₂ , CH ₄ , N ₂ O, HFCs, PFCs and SF ₆ without GHG emissions and removals from LULUCF	QA/QC	quality assurance/quality control
HFCs	hydrofluorocarbons	SEF	standard electronic format
IPCC	Intergovernmental Panel on Climate Change	SF ₆	sulphur hexafluoride
		SIAR	Standard independent assessment report
		TJ	terajoule (1 TJ = 10 ¹² joule)
		UNFCCC	United Nations Framework Convention on Climate Change
