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Report of the individual review of the annual submission of Liechtenstein submitted in 2012*

* In the symbol for this document, 2012 refers to the year in which the inventory was submitted, and not to the year of publication.

Contents

I. Introduction and summary

1. This report covers the centralized review of the 2012 annual submission of Liechtenstein, coordinated by the UNFCCC secretariat, in accordance with decision 22/CMP.1. The review took place from 24 to 29 September 2012 in Bonn, Germany, and was conducted by the following team of nominated experts from the UNFCCC roster of experts: generalists – Ms. Yuriko Hayabuchi (Japan) and Mr. Leif Hockstad (United States of America); energy – Mr. Liu Qiang (China), Mr. Anand Sookun (Mauritius) and Ms. Kennie Tsui (New Zealand); industrial processes – Ms. Sohyang Lee (Republic of Korea), Mr. Kakhaberi Mdivani (Georgia) and Ms. Kristina Saarinen (Finland); agriculture – Ms. Britta Maria Hoem (Norway) and Mr. Pa Ousman Jarju (Gambia); land use, land-use change and forestry (LULUCF) – Ms. Cristina Garcia Diaz (Spain), Ms. Rosa Maria Rivas Palma (New Zealand) and Mr. Harry Vreuls (Netherlands); and waste – Mr. Takefumi Oda (Japan) and Ms. Mayra Rocha (Brazil). Ms. Lee and Ms. Saarinen were the lead reviewers. The review was coordinated by Ms. Lisa Hanle and Ms. Astrid Olsson (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 made no comment on it.

3. In 2010, the main greenhouse gas (GHG) in Liechtenstein was carbon dioxide (CO_2), accounting for 85.3 per cent of total GHG emissions[1] expressed in carbon dioxide equivalent (CO_2 eq), followed by methane (CH_4) (6.5 per cent) and nitrous oxide (N_2O) (5.3 per cent). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) collectively accounted for 2.8 per cent of the overall GHG emissions in the country. The energy sector accounted for 86.5 per cent of total GHG emissions, followed by the agriculture sector (9.7 per cent), the industrial processes sector (2.9 per cent), the waste sector (0.7 per cent) and the solvent and other product use sector (0.2 per cent). Total GHG emissions amounted to 233.16 Gg CO_2 eq and increased by 1.1 per cent between the base year[2] and 2010.

4. Tables 1 and 2 show GHG emissions from Annex A sources, emissions and removals from the LULUCF sector under the Convention and emissions and removals from activities under Article 3, paragraph 3, and, if any, Article 3, paragraph 4, of the Kyoto Protocol (KP-LULUCF), by gas and by sector and activity, respectively. In table 1, CO_2, CH_4 and N_2O emissions included in the rows under Annex A sources do not include emissions and removals from the LULUCF sector.

5. Tables 3–5 provide information on the most important emissions and removals and accounting parameters that will be included in the compilation and accounting database.

[1] In this report, the term "total GHG emissions" refers to the aggregated national GHG emissions expressed in terms of CO_2 eq 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

Greenhouse gas emissions from Annex A sources and emissions/removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, by gas, base year to 2010[a]

			Gg CO_2 eq								*Change*
		Greenhouse gas	*Base year[a]*	*1990*	*1995*	*2000*	*2005*	*2008*	*2009*	*2010*	*Base year –2010 (%)*
Annex A sources		CO_2	201.62	201.62	208.37	226.80	239.42	229.38	213.68	198.98	–1.3
		CH_4	16.15	16.15	14.86	14.08	15.77	16.95	16.78	15.12	–6.4
		N_2O	12.87	12.87	12.82	12.22	12.37	12.73	12.55	12.33	–4.2
		HFCs	0.0001	0.0001	0.38	2.32	4.38	5.08	5.33	6.64	6 999 433.1
		PFCs	NA, NO	NA, NO	NA, NO	0.00	0.03	0.06	0.05	0.07	NA
		SF_6	NA, NO	NA, NO	NA, NO	0.09	0.27	0.36	0.14	0.02	NA
KP-LULUCF	Article 3.3[b]	CO_2						0.14	0.22	–0.06	
		CH_4						NO	NO	NO	
		N_2O						NO	NO	NO	
	Article 3.4[c]	CO_2	NA	NA				NA	NA	NA	NA
		CH_4	NA	NA				NA	NA	NA	NA
		N_2O	NA	NA				NA	NA	NA	NA

Abbreviations: KP-LULUCF = land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NA = not applicable, NO = not occurring.

[a] "Base year" for Annex A sources refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol is 1990.

[b] Activities under Article 3, paragraph 3, of the Kyoto Protocol, namely afforestation and reforestation, and deforestation. Only the inventory years of the commitment period must be reported.

[c] Elected activities under Article 3, paragraph 4, of the Kyoto Protocol, including forest management, cropland management, grazing land management and revegetation. For cropland management, grazing land management and revegetation, the base year and the inventory years of the commitment period must be reported.

Table 2
Greenhouse gas emissions by sector and activity, base year[a] to 2010

			Gg CO_2 eq							*Change*
		Sector	*Base year[a]*	*1990*	*1995*	*2000*	*2005*	*2008*	*2009*	*2010*	*Base year –2010 (%)*
Annex A		Energy	203.78	203.78	210.86	229.73	241.88	232.04	216.30	201.63	–1.1
		Industrial processes	0.0001	0.0001	0.38	2.41	4.68	5.50	5.53	6.74	7 102 364.7
		Solvent and other product use	0.55	0.55	0.57	0.51	0.53	0.53	0.54	0.53	–5.0
		Agriculture	24.73	24.73	23.10	21.12	23.23	24.51	24.41	22.55	–8.8
		Waste	1.58	1.58	1.52	1.74	1.92	1.98	1.76	1.72	8.5
		LULUCF	NA	–8.22	–8.36	–3.25	–6.05	–6.12	–6.01	–6.00	NA
		Total (with LULUCF)	**NA**	**222.43**	**228.08**	**252.26**	**266.19**	**258.45**	**242.51**	**227.17**	**NA**
		Total (without LULUCF)	**230.64**	**230.64**	**236.44**	**255.51**	**272.24**	**264.57**	**248.53**	**233.16**	**1.1**
		Other[b]	NO	NO	NO	NO	NO	NO	NO	NO	NO
KP-LULUCF	Article 3.3[c]	Afforestation and reforestation						–0.21	–0.22	–0.2	
		Deforestation						0.36	0.43	0.14	
		Total (3.3)						**0.14**	**0.22**	**–0.06**	
	Article 3.4[d]	Forest management						NA	NA	NA	
		Cropland management	NA	NA				NA	NA	NA	NA
		Grazing land management	NA	NA				NA	NA	NA	NA
		Revegetation	NA	NA				NA	NA	NA	NA
		Total (3.4)	**NA**	**NA**				**NA**	**NA**	**NA**	**NA**

Abbreviations: LULUCF = land use, land-use change and forestry, KP-LULUCF = LULUCF emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NA = not applicable, NO = not occurring.

[a] "Base year" for Annex A sources refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol is 1990.

[b] Emissions/removals reported in the sector other (sector 7) are not included in Annex A to the Kyoto Protocol and are therefore not included in national totals.

[c] Activities under Article 3, paragraph 3, of the Kyoto Protocol, namely afforestation and reforestation, and deforestation. Only the inventory years of the commitment period must be reported.

[d] Elected activities under Article 3, paragraph 4, of the Kyoto Protocol, including forest management, cropland management, grazing land management and revegetation. For cropland management, grazing land management and revegetation, the base year and the inventory years of the commitment period must be reported.

Table 3
Information to be included in the compilation and accounting database in t CO_2 eq for the year 2010, including the commitment period reserve

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Commitment period reserve	950 061			950 061
Annex A emissions for current inventory year				
CO_2	198 981			198 981
CH_4	15 118	15 110		15 110
N_2O	12 331			12 331
HFCs	6 644			6 644
PFCs	73			73
SF_6	25			25
Total Annex A sources	**233 172**	**233 163**		**233 163**
Activities under Article 3, paragraph 3, for current inventory year				
3.3 Afforestation and reforestation on non-harvested land for current year of commitment period as reported	–3 257	–199		–199
3.3 Afforestation and reforestation on harvested land for current year of commitment period as reported	NO			NO
3.3 Deforestation for current year of commitment period as reported	143			143
Activities under Article 3, paragraph 4, for current inventory year[c]				
3.4 Forest management for current year of commitment period				
3.4 Cropland management for current year of commitment period				
3.4 Cropland management for base year				
3.4 Grazing land management for current year of commitment period				
3.4 Grazing land management for base year				
3.4 Revegetation for current year of commitment period				
3.4 Revegetation in base year				

Abbreviation: NO = not occurring.
[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustment(s).
[b] "Final" includes revised estimates, if any, and/or adjustments, if any.
[c] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

Table 4
Information to be included in the compilation and accounting database in t CO_2 eq for the year 2009

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Annex A emissions for 2009				
CO_2	213 678			213 678
CH_4	16 779	16 770		16 770
N_2O	12 552			12 552
HFCs	5 333			5 333
PFCs	51			51
SF_6	142			142
Total Annex A sources	**248 535**	**248 526**		**248 526**
Activities under Article 3, paragraph 3, for 2009				
3.3 Afforestation and reforestation on non-harvested land for 2009 as reported	–3 222	–217		–217
3.3 Afforestation and reforestation on harvested land for 2009 as reported	NO			NO
3.3 Deforestation for 2009 as reported	433			433
Activities under Article 3, paragraph 4, for 2009[c]				
3.4 Forest management for 2009				
3.4 Cropland management for 2009				
3.4 Cropland management for base year				
3.4 Grazing land management for 2009				
3.4 Grazing land management for base year				
3.4 Revegetation for 2009				
3.4 Revegetation in base year				

Abbreviation: NO = not occurring.
[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustment(s).
[b] "Final" includes revised estimates, if any, and/or adjustments, if any.
[c] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

Table 5
Information to be included in the compilation and accounting database in t CO_2 eq for the year 2008

	As reported	*Revised estimates*	*Adjustment*[a]	*Final*[b]
Annex A emissions for 2008				
CO_2	229 382			229 382
CH_4	16 963	16 954		16 954
N_2O	12 730			12 730
HFCs	5 083			5 083
PFCs	56			56
SF_6	363			363
Total Annex A sources	**264 576**	**264 567**		**264 567**
Activities under Article 3, paragraph 3, for 2008				
3.3 Afforestation and reforestation on non-harvested land for 2008 as reported	–3 208	–215		–215
3.3 Afforestation and reforestation on harvested land for 2008 as reported	NO			NO
3.3 Deforestation for 2008 as reported	360			360
Activities under Article 3, paragraph 4, for 2008[c]				
3.4 Forest management for 2008				
3.4 Cropland management for 2008				
3.4 Cropland management for base year				
3.4 Grazing land management for 2008				
3.4 Grazing land management for base year				
3.4 Revegetation for 2008				
3.4 Revegetation in base year				

Abbreviation: NO = not occurring.
[a] "Adjustment" is relevant only for Parties for which the expert review team has calculated one or more adjustment(s).
[b] "Final" includes revised estimates, if any, and/or adjustments, if any.
[c] Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

II. Technical assessment of the annual submission

A. Overview

1. Annual submission and other sources of information

6. The 2012 annual inventory submission was submitted on 13 April 2012; it contains a complete set of common reporting format (CRF) tables for the period 1990–2010 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, paragraphs 3 and 4, of the Kyoto Protocol, accounting of Kyoto Protocol units, changes in the national system and in the national registry, and the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol. The standard electronic format (SEF) tables were submitted on 30 March 2012. The annual submission was submitted in accordance with decision 15/CMP.1.

7. Liechtenstein officially submitted revised emission estimates on 14 November 2012 in response to questions raised by the expert review team (ERT) during the course of the review. The data in this report are based on the submission of 14 November 2012.

8. The ERT also used the previous years' submissions 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]

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

Completeness of inventory

10. The inventory covers all mandatory[4] source and sink categories for the period 1990-2010 and is generally complete in terms of years and geographical coverage. The ERT notes that CRF table 7 (summary overview of key categories) has not been completed for the years 1990–2003. The ERT reiterates the recommendation in the previous review reports that Liechtenstein complete CRF table 7 for 1990 in its next annual submission. In addition, the ERT has raised questions regarding the use of the notation key "NO" (not occurring) for some categories, particularly in the energy sector (e.g. feedstocks and non-energy use of fuels) and the industrial processes sector (e.g. potential emissions of HFCs, PFCs and SF_6) (see paras. 36 and 50, respectively, below). Further, several subcategories for organic soils are reported as "NE" (not estimated) or "IE" (included

[3] The SIAR, parts I and II, is prepared by an independent assessor in line with decision 16/CP.10 (paras. 5(a) and 6(c) and (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.

[4] Mandatory source and sink categories under the Kyoto Protocol are all source and sink categories for which the Intergovernmental Panel on Climate Change (IPCC) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* 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) provide methodologies and/or emission factors to estimate GHG emissions.

elsewhere), such as forest land remaining forest land, cropland remaining cropland, and land converted to grassland (see para. 69 below). The ERT recommends that the Party evaluate these categories further for its next annual submission.

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

Overview

11. The ERT concluded that the national system continued to perform its required functions.

Inventory planning

12. The NIR described the national system for the preparation of the inventory. The Office of Environmental Protection has overall responsibility for the national inventory. The Office of Economic Affairs, the Office of Agriculture, the Office of Forests, Nature and Land Management and the Office of Land Use Planning directly participate in the compilation of the inventory. Several other administrative and private institutions are also involved in the preparation of the inventory. The inventory group consists of a project manager, a person responsible for quality assurance/quality control (QA/QC) activities and a national inventory compiler, who is represented by the project manager and his assistant. A number of external experts, such as the sectoral specialists, also contribute to the inventory.

13. The NIR does not provide information on the process of final approval of the inventory submission. The ERT recommends that Liechtenstein include this information in the NIR in its next annual submission.

Inventory preparation

Key categories

14. Liechtenstein has reported a key category tier 1 analysis, both level and trend assessment, as part of its 2012 submission. The key category analysis performed by Liechtenstein and that performed by the secretariat[5] produced similar results. Liechtenstein has included the LULUCF sector in its key category analysis, which was performed in accordance with 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) 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).

15. Liechtenstein does not describe in the NIR whether the Party uses the key category analysis to prioritize the development and improvement of the inventory. No key categories were identified using qualitative criteria. The ERT recommends that the Party describe 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 IPCC good practice guidance for LULUCF. 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 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.

its next annual submission how the key category analysis is used to prioritize inventory development.

16. Liechtenstein has identified key categories for activities under Article 3, paragraph 3, of the Kyoto Protocol for both 1990 and 2010.

17. The ERT noted that CRF table 7 is reported for the years 2004–2010 only. A key category analysis is not provided for 1990 in the CRF tables, as required by 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 UNFCCC reporting guidelines); however, key categories for 1990 are presented in the NIR. In response to questions raised by the ERT during the review, Liechtenstein explained that it will report a key category analysis for 1990 in CRF table 7 in its next annual submission. The ERT reiterates the recommendation in the previous review report that Liechtenstein provide such an analysis in its next annual submission and enhance the consistency of the information provided in the NIR and in the CRF tables on the key category analysis (CRF table 7).

Uncertainties

18. Liechtenstein has reported a tier 1 uncertainty analysis for emissions and removals for the level and trend of emissions in its 2012 annual submission both with and without LULUCF. The ERT commends Liechtenstein for having included KP-LULUCF in the uncertainty analysis for the first time, following a recommendation in the previous review report. The tier 1 uncertainty for total national emissions (excluding LULUCF) in 2010 was estimated at ±6.5 per cent and the uncertainty for the emission trend between 1990 and 2010 was estimated at ±8.4 per cent. The uncertainty of total national emissions (including LULUCF) in 2010 was estimated at ±7.2 per cent and the uncertainty of the trend was estimated at ± 8.5 per cent.

19. The uncertainty estimates of activity data (AD) and emission factors (EFs) are largely based on the uncertainty analysis of Switzerland, as well as the use of IPCC good practice guidance default values and expert judgement. The ERT considers that the Swiss uncertainty estimates may not always be applicable to the case of Liechtenstein. For example, as mentioned in the NIR, the uncertainty estimate for the consumption of halocarbons and SF_6 in Liechtenstein is likely to be larger than in Switzerland owing to the application of Swiss data to circumstances in Liechtenstein. The ERT reiterates the recommendation in the previous review reports that the Party further consider the applicability of Swiss uncertainty estimates to the national circumstances of Liechtenstein and that the Party develop national uncertainty estimates, where appropriate, in its next annual submission.

Recalculations and time-series consistency

20. Recalculations have been performed and reported in accordance with the IPCC good practice guidance. The ERT noted that the recalculations reported by Liechtenstein of the time series 1990–2009 have been undertaken to take into account changes made in all sectors. The major changes include the following: recalculations in the energy sector resulting from the adoption of a Swiss model for CH_4 and N_2O emissions from transport (see para. 31 below); recalculations in the industrial processes sector due to correction of a technical error in the AD for HFCs from refrigeration and air conditioning (see para. 46 below); recalculations in the agriculture sector due to a change in the emissions calculation model and an update in young cattle population for enteric fermentation (see paras. 54 and 57 below); recalculations in the LULCUF sector to correct minor technical errors (see para. 67 below); and, for the waste sector, recalculations due to revisions in wastewater handling (see para. 83 below). The magnitude of the impact is an increase in

estimated total GHG emissions in 1990 (0.5 per cent) and in 2009 (0.5 per cent). The rationale for these recalculations is provided in the NIR and in CRF table 8(b).

21. The ERT noted that Liechtenstein has provided the rationale for the recalculations undertaken in chapter 10 of the NIR and in CRF table 8(b), but has not included quantified information on the impact of the recalculations in the NIR as required by the UNFCCC reporting guidelines. The ERT recommends that Liechtenstein provide relevant quantified information of the resulting changes at the key category level for the recalculations in the NIR of its next annual submission.

Verification and quality assurance/quality control approaches

22. Liechtenstein has a QA/QC plan in place in accordance with decision 19/CMP.1 and the IPCC good practice guidance. The QA/QC activities are coordinated by the quality manager of the inventory group and include cross-checks made and documented by sectoral experts and NIR authors. From the checklists the quality manager confirms that the QA/QC activities have been performed. The checklists, including information on the person who carried out the QA/QC activity and when the activities were carried out, are provided in an annex to the NIR. In addition, Liechtenstein documents in the NIR the QA of specific sectors that has been done for certain years. For example, the energy sector and industrial processes sectors were reviewed by a third party in 2006 and the waste sector was reviewed by a peer review group in 2009. In response to questions raised by the ERT during the review about whether QA was conducted for the 2012 annual submission by anyone not directly involved in the inventory compilation, the Party responded that it would investigate this further. The ERT recommends that Liechtenstein review the current QA procedures and document all QA procedures that are undertaken for a given inventory submission, beginning in the next annual submission. In addition, if an external review is not systematically undertaken on the annual inventory submission, the ERT encourages the Party to consider such a third-party review.

23. Liechtenstein did not report on any category-specific tier 2 QC procedures. The ERT encourages Liechtenstein to plan and implement tier 2 QC procedures for key categories in its next annual submission.

Transparency

24. The NIR and CRF tables are generally transparent. However, the ERT reiterates the recommendation in the previous review report that Liechtenstein further improve the transparency of its reporting in the NIR in its next annual submission, in particular in the agriculture sector by providing information on the conversion factors for calculating gross energy intake and on the amount of sewage sludge (see paras. 56 and 61, respectively, below) and in the LULUCF sector. In the LULUCF sector, transparency can be improved broadly by providing information on areas of land use and land-use changes (see para. 68 below), providing pool-specific information for dead wood, litter and soil organic carbon pools (see paras. 71 and 73 below) and providing more information on data sources for selected parameters (see paras. 74, 76 and 78–80 below). The ERT also recommends that Liechtenstein further increase the transparency of its reporting by providing in its next annual submission more detailed justification for the use of EFs, AD and parameters adopted from Switzerland's inventory.

Inventory management

25. Liechtenstein has a centralized archiving system, which includes the archiving of disaggregated EFs and AD and documentation on how these factors and data have been generated and aggregated for the preparation of the inventory. The archived information also includes internal documentation on QA/QC procedures, external and internal reviews,

documentation on annual key categories and key category identification, as well as planned inventory improvements. The back-ups of the information provided by external companies are archived centrally in Liechtenstein's National Bank.

3. Follow-up to previous reviews

26. The ERT noted that Liechtenstein has implemented, or is in the process of implementing, some recommendations made in previous review reports and has provided information on such improvements in chapter 10.1.1 of the NIR. Specifically, the ERT commends Liechtenstein for the internal review performed by the Party to determine the allocation of manure nitrogen (N) to the different animal waste management systems (AWMS) (see para. 63 below). The ERT also welcomes Liechtenstein's efforts to conduct a complete review of the LULUCF sector in 2012, as was mentioned in response to questions raised by the ERT during the review (see para. 69 below).

27. The ERT reiterates the recommendations in the previous review report that have not yet been implemented by Liechtenstein, including:

(a) Enhancing the consistency of the information provided in the NIR and in the CRF tables on the key category analysis (CRF table 7) (see para. 17 above);

(b) Assessing the applicability of Swiss uncertainty estimates to the national circumstances of Liechtenstein and developing national uncertainty estimates, where necessary (see para. 19 above);

(c) Improving the transparency of the information reported in the NIR, in particular in the agriculture sector (regarding conversion factors and AD) and the LULUCF sector (regarding land areas, information on individual carbon pools and data sources) (see para. 24 above);

(d) Improving QA/QC in the agriculture sector (see para. 56 below).

4. Areas for further improvement identified by the expert review team

28. During the review, the ERT identified several issues for improvement. These are listed in table 7 below.

29. Recommended improvements relating to specific categories are presented in the relevant sector chapters of this report and in table 7 below.

B. Energy

1. Sector overview

30. The energy sector is the main sector in the GHG inventory of Liechtenstein. In 2010, emissions from the energy sector amounted to 201.63 Gg CO_2 eq, or 86.5 per cent of total GHG emissions. Since 1990, emissions have decreased by 1.1 per cent. The key driver for the fall in emissions is the reduction of energy consumption in the category other (manufacturing industries and construction). Within the energy sector, 45.2 per cent of the emissions were from the category other sectors, followed by 39.8 per cent from transport, 11.1 per cent from manufacturing industries and construction and 1.7 per cent from other. Energy industries accounted for 1.6 per cent of energy sector emissions and fugitive emissions from fuels accounted for 0.5 per cent.

31. The Party has made recalculations for the energy sector between the 2011 and 2012 submissions. The impact of these recalculations on the energy sector is a decrease in emissions of 0.3 per cent for 2009. The main recalculations, based on a new model adopted

from the Swiss NIR with updated implied emission factors (IEFs) for CH_4 and N_2O, took place in the following categories:

(a) Road transportation;

(b) Other sectors: agriculture/forestry/fisheries;

(c) Other (mobile): off-road vehicles and other machinery.

32. Liechtenstein has adopted an oxidation factor of 1.00 for CO_2 estimation in both the reference and the sectoral approaches. The ERT notes that this is not consistent with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines), which indicate if no specific national information is available, the value of 0.99 and 0.995 should be used for oil and gas fuel, respectively. In response to a question raised by the ERT during the review, Liechtenstein provided two reasons for this factor: (1) technical standards for combustion installations in Switzerland are high and Liechtenstein has followed the approach used in Switzerland's inventory for this category; and (2) a small fraction of originally non-oxidized carbon retained in ash, particulates or soot is very likely to be oxidized later naturally as a result of the degradation process. The ERT recommends that Liechtenstein provide a more detailed justification for the use of this factor in the next annual submission.

2. Reference and sectoral approaches

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

33. Liechtenstein has reported CO_2 emissions from fuel combustion using both the reference and the sectoral approaches for every year in the entire time series (1990–2010). The NIR includes information on the differences in estimates for energy consumption and CO_2 emissions between the two approaches for each year. The differences between the reference and sectoral approaches in the CO_2 emission estimates are very small for the complete time series (0.04 per cent in 2010). The International Energy Agency (IEA) does not collect energy data for Liechtenstein because the country is not a member of the IEA. For this reason, it is not possible to compare the Party's reference approach with international statistics.

34. The NIR indicates that until 2009 the biofuel produced in Liechtenstein stemmed from one single producer. However, in CRF table 1.A(b), the production of liquid biomass has the notation key "NO". In response to a question raised by the ERT during the review, Liechtenstein explained that the information provided in the NIR is incorrect, and that there was one biofuel distributor, but no biofuel producer, between 2007 and 2009. This was not considered to be production of biofuels, which was why the notation key "NO" was used in the CRF table. The ERT recommends that Liechtenstein revise the NIR to be consistent with the CRF table entries in its next annual submission.

International bunker fuels

35. The ERT noted that the only bunker emissions occurring in the country stem from the nation's two helicopter operators. Only a few flights are domestic; most of them are international business flights to Switzerland and Austria. Marine bunker emissions do not occur in the country. Emission estimates in this category are calculated using the tier 1 approach. The information on the share of fuel consumption from international flights is provided by the two companies operating in the country. According to the NIR, the share of fuel consumption for international flights is provided by the two operating companies of the helicopter landing site for 2001 (84.0 per cent) and 2002 (86.0 per cent), while for all other years, the mean value (85.0 per cent) is used. During the review, the ERT noted that, according to CRF table 1.C, Liechtenstein has used 86.0 per cent as the share for the years

between 1990 and 2000, not 85.0 per cent. In response to questions raised by the ERT during the review, Liechtenstein confirmed the observation and indicated that a linear interpolation methodology was used between 1995 and 2002 based on an independent assessment. The ERT recommends that Liechtenstein confirm the appropriate split between domestic and international fuel consumption for the full time series, and ensure that the NIR transparently describes the method used to develop that split, in its next annual submission.

Feedstocks and non-energy use of fuels

36. The ERT noted that Liechtenstein continues to report feedstocks and non-energy use of fuels as "NO" in CRF table 1.A(d) for the complete time series, as has been noted in the previous review reports. According to the NIR, bitumen is imported for road paving; however, use of bitumen does not affect fuel consumption data in Liechtenstein, which are based on the import of secondary fuels. The ERT concludes that Liechtenstein's reporting is not consistent with the Revised 1996 IPCC Guidelines and that these fuels should be reported in CRF tables 1.A(b) and 1.A(d). The ERT, therefore, reiterates the recommendation in the previous review reports that Liechtenstein include the use of lubricants and bitumen in its next annual submission, with a view to ensuring the transparency and completeness of the inventory.

3. Key categories

Stationary combustion: liquid and gaseous fuels – CO_2, CH_4 and N_2O[6]

37. The ERT identified a rapid increase of natural gas consumption for public electricity and heat production between 1990 and 1994. In response to a question raised by the ERT during the review, Liechtenstein provided a graph showing the shares of fuel supplied for electricity generation from the mid-1960s, sourced from Liechtenstein's energy statistics. The graph corroborates the rapid increase of natural gas consumed for electricity generation during the early 1990s. The ERT recommends that Liechtenstein include information on the shares of fuel supplied for electricity generation in its next annual submission.

38. The ERT noted that the NIR shows a considerable decrease in the consumption of natural gas for manufacturing industries and construction between 2008 and 2010. Specifically, there was a 49.5 per cent decrease in consumption from 2008 (390.41 TJ) to 2009 (197.08 TJ), before recovering slightly in 2010 (219.73 TJ). In response to a question raised by the ERT during the review, Liechtenstein explained that natural gas consumption in Liechtenstein (including in the manufacturing industries and construction subcategory) was replaced, in part, by a newly installed district heating facility in 2009, thereby lowering the demand for natural gas and explaining the observed inter-annual variation. This new district heating facility is fuelled by the heat generated in waste incineration. The ERT agrees that this response explains the trend in natural gas consumption; however, the ERT identified a potential discrepancy between the amount of electricity generated by this new district heating facility and the amount of waste used for waste incineration at that facility. In response to the list of potential problems and further questions raised by the ERT during the review week, Liechtenstein explained that the waste incineration plant is situated in Switzerland and Liechtenstein has no waste incineration plants. The ERT recommends that Liechtenstein include a description of the impact of this district heating facility on fuel consumption trends in Liechtenstein in its next annual submission.

[6] Not all emissions related to all gases under this category are key categories, particularly CH_4 and N_2O emissions. However, since the calculation procedures for issues related to this category are discussed as a whole, the individual gases are not assessed in separate sections.

39. The ERT noted that all emissions from liquid and gaseous fuels from the subcategory food processing, beverages and tobacco are reported under the category other (manufacturing industries and construction) in the CRF tables, which is not in line with the Revised 1996 IPCC Guidelines. The ERT recommends that Liechtenstein report these emissions in the appropriate category in its next annual submission in order to improve transparency.

Road transportation: liquid fuels – CO_2

40. The ERT noted that Liechtenstein uses the CO_2 EFs for gasoline and diesel oil from Switzerland's inventory for the entire period 1990–2010 and that these EFs are constant over the whole time period (73.90 t CO_2/TJ for gasoline and 73.60 t CO_2/TJ for diesel oil). The ERT noted that Liechtenstein does not have any refineries and that all gasoline and diesel are imported from Switzerland. The ERT recommends that Liechtenstein justify in more detail in the NIR of its next annual submission why the EFs are constant in the period 1990–2010.

4. Non-key categories

Navigation: other liquid fuels – CO_2, CH_4 and N_2O

41. The ERT identified a discrepancy between the CRF tables and the NIR for the energy consumption of other liquid fuels for navigation. The NIR states that there is no military aviation in Liechtenstein and therefore the notation key "NO" should be adopted. However, the CRF tables show that the notation key "NA" (not applicable) was applied. The ERT recommends that Liechtenstein clarify the use of fuel consumption for military operations and ensure consistency between the CRF tables and the NIR in its next annual submission. Further, the ERT recommends that Liechtenstein report the appropriate notation key for military aviation under the category other (energy), consistent with the IPCC good practice guidance.

Other (energy): liquid fuels – CH_4 and N_2O

42. In the 2012 annual submission, Liechtenstein stated that the IEFs for CH_4 and N_2O emissions for mobile sources reported under other have been updated for the period between 1990 and 2009. During the review, the ERT identified that the IEF for CH_4 for off-road vehicles and other machinery has been updated only between 2007 and 2009 and not for the whole time series. In response to a question raised by the ERT during the review, Liechtenstein explained that a separate model was used to estimate the emissions in this category. The ERT recommends that Liechtenstein provide a detailed explanation on the use of this model in its next annual submission to clarify this issue.

Oil and natural gas: gaseous fuels – CH_4

43. The previous ERT had strongly recommended that Liechtenstein estimate fugitive emissions associated with natural gas transmission and report these in the next annual submission. In the 2012 annual submission, the notation key "NO" was adopted for AD for this subcategory. In response to a question raised by the ERT during the review, Liechtenstein explained that the emission estimates for natural gas transmission were included in the emission estimates for natural gas distribution. The Party also indicated that it would revise the notation key from "NO" to "IE" in the next annual submission. During the review, the ERT estimated emissions from natural gas transmission using the EFs provided in table 3-33 of the NIR and the AD on the length of natural gas transmission pipelines (steel cath>5 bar) in table 3-34 of the NIR. Based on this analysis, the ERT believed there could be an underestimate of emissions. In response to the list of potential problems and further questions raised by the ERT during the review week, Liechtenstein

submitted revised estimates on 14 November 2012 and agreed to the methodology and allocation proposed by the ERT, which is consistent with the methodology described in the IPCC good practice guidance. The ERT strongly recommends that Liechtenstein transparently explain the estimation of CH_4 emissions associated with natural gas transmission in its next annual submission.

44. The CH_4 IEF adopted by Liechtenstein under the category fugitive emissions from natural gas distribution was 546.29 kg/TJ, with AD reported of 92.70 TJ and estimated CH_4 emissions of 0.05 Gg for 2010. Using AD provided in the NIR, the ERT concluded that the IEF used by Liechtenstein was lower than the default EF provided in both the Revised 1996 IPCC Guidelines (midpoint 102,500 kg/PJ for Western Europe) and the IPCC good practice guidance (midpoint 6.15 E-04 Gg CH_4 per km). From the methodology described in the IPCC good practice guidance, the ERT calculated the amount of CH_4 that would be emitted from natural gas distribution, based on AD on the length of low-pressure natural gas pipelines (HDPE (Polyethylene <100 mbar) and 1-5 bar) shown in table 3-34 of the NIR and the CH_4 EF in table 3-33 of the NIR. Based on this analysis, the ERT believed there could be an underestimate of emissions. In response to the list of potential problems and further questions raised by the ERT during the review week, Liechtenstein submitted revised estimates on 14 November 2012 and agreed to the methodology recommended by the ERT. The ERT strongly recommends that Liechtenstein transparently explain the estimation of CH_4 emissions associated with natural gas distribution in its next annual submission.

C. Industrial processes and solvent and other product use

1. Sector overview

45. In 2010, emissions from the industrial processes sector amounted to 6.74 Gg CO_2 eq, or 2.9 per cent of total GHG emissions, and emissions from the solvent and other product use sector amounted to 0.53 Gg CO_2 eq, or 0.2 per cent of total GHG emissions. Since 1990, emissions have increased by 7,102,364.7 per cent in the industrial processes sector and decreased by 5.0 per cent in the solvent and other product use sector. The key driver for the rise in emissions in the industrial processes sector is the increasing use of refrigeration and air-conditioning equipment containing HFC substances. Within the industrial processes sector, the only emissions reported are under consumption of halocarbons and SF_6. Within this category, 97.9 per cent of the emissions were from the refrigeration and air-conditioning equipment subcategory, followed by 0.9 per cent each from foam blowing and aerosols/metered dose inhalers. The remaining 0.3 per cent of emissions was from electrical equipment.

46. Liechtenstein has made recalculations for the industrial processes sector between the 2011 and 2012 submissions in order to rectify identified errors for 2007, 2008 and 2009. The impact of these recalculations on the industrial processes sector is a 0.2 per cent decrease in emissions for 2009. The main recalculations took place in HFC emissions from refrigeration and air-conditioning equipment.

47. Liechtenstein has also made recalculations for the solvent and other product use sector for the whole time series following changes in AD, primarily population data. The impact of these recalculations on the solvent and other product use sector is a decrease in emissions of 62.8 per cent for 2009. The recalculations took place in the following categories:

(a) Paint application;

(b) Chemical products, manufacture and processing;

(c) Other.

2. Key categories

Consumption of halocarbons and SF_6 – HFCs and PFCs[7]

48. The Party has estimated emissions based on the specific emissions per inhabitant in Switzerland, multiplied by country-specific statistical data, that is, the number of households, number of employees, number of cars, etc. The methodology used by Switzerland is based on a tier 2 bottom-up approach which is used to estimate actual emissions from the category.

49. There is a slight fluctuation of HFCs emission data from 2004 to 2010 in the refrigeration and air-conditioning equipment subcategory. For example, HFC emissions increased 13.4 per cent between 2003 and 2004, then declined for the next two years (by 0.6 per cent and 0.2 per cent) before increasing again by 6.9 per cent between 2006 and 2007. In response to questions raised by the ERT during the review, Liechtenstein explained that it believes that the fluctuations are a result of changes in consumer behaviour and the economy. However, Liechtenstein indicated that an in-depth analysis would be required to really understand the variety of conditions affecting the subcategories of refrigeration and air-conditioning. In order to improve transparency, the ERT recommends that Liechtenstein explain the fluctuation of emissions in the NIR of its next annual submission.

50. Liechtenstein has not provided any information in the NIR or CRF tables regarding potential emissions of HFCs and PFCs from consumption of halocarbons and SF_6. The ERT recommends that Liechtenstein carry out the calculation of potential emissions by using the tier 1b method and provide information on the emissions and the method in its next annual submission.

3. Non-key categories

Consumption of halocarbons and SF_6 – HFCs

51. Emissions from the foam blowing subcategory declined by approximately 27.2 per cent between 2009 and 2010 but there is no explanation provided in the NIR for this decrease. In response to a question raised by the ERT during the review, Liechtenstein indicated that the decline is due to the fact that the only Swiss producer of polyurethane sprays phased out the use of HFCs entirely in 2009 and that there is a small but continuous declining trend of HFC content in imported goods from Germany. The ERT recommends that Liechtenstein provide documentation confirming the decrease in emissions in the NIR in its next annual submission.

Consumption of halocarbons and SF_6 – SF_6

52. The only source of SF_6 in Liechtenstein is the transformers operated by the utility Liechtensteinische Kraftwerke. SF_6 emissions declined by 93.2 per cent between 2008 and 2010 and there were significant fluctuations in emissions in the previous years (e.g. declining by 77.9 per cent between 2005 and 2006 before increasing by 102.4 per cent between 2006 and 2007). In response to a question raised by the ERT during the review, the Party indicated that the decline was within the range of variability since there are few

[7] Not all emissions related to all gases under this category are key categories, particularly PFC emissions. However, since the calculation procedures for issues related to this category are discussed as a whole, the individual gases are not assessed in separate sections.

companies in this category and individual changes in emissions become evident in the total emissions from consumption of halocarbons and SF_6. The ERT finds the response adequate to explain the reduction in SF_6 emissions for 2010. For more transparency, the ERT recommends that Liechtenstein provide the explanation of the downward trend of SF_6 emissions from 2008 to 2010 in its next annual submission.

D. Agriculture

1. Sector overview

53. In 2010, emissions from the agriculture sector amounted to 22.55 Gg CO_2 eq, or 9.7 per cent of total GHG emissions. Since 1990, emissions have decreased by 8.8 per cent. The key driver for the fall in emissions is the decrease in the cattle population since 1990. Within the sector, 46.3 per cent of the emissions were from enteric fermentation, followed by 38.9 per cent from agricultural soils. The remaining 14.8 per cent were from manure management.

54. The Party has made recalculations for the agriculture sector between the 2011 and 2012 submissions in response to the 2011 review report and following changes in AD and EFs. A major recalculation of CH_4 and N_2O emissions from Liechtenstein's agriculture sector has been performed. The impact of these recalculations was an increase of 6.9 per cent in CO_2 eq emissions for 2009. The main recalculations took place in the following categories:

(a) CH_4 emissions from enteric fermentation;

(b) CH_4 and N_2O emissions from manure management;

(c) N_2O emissions from agricultural soils.

55. The ERT found that there are still inconsistencies between the NIR and the CRF tables. For example, it found that the emissions trend information presented in table 2-3, as well as on page 115, and table 6-1 of the NIR for the years 1990–2009 is different from the values in CRF table 10. In addition, the values given in the NIR for the increase in 2009 emissions due to recalculations are different from the values given in CRF table 8(a). The ERT recommends that these inconsistencies between the NIR and the CRF tables be corrected in the next annual submission.

56. In addition to the inconsistencies between the NIR and CRF tables mentioned in paragraph 55 above, several issues were identified during the review that suggest that QA/QC measures could be enhanced. Liechtenstein detected some errors while answering questions raised by the ERT during the review. For example, for manure management, the ERT observed that for 2010 the total quantity of N excreted, calculated as a product of the livestock population number and the N excretion factors, was 9 tonnes higher than the sum of N allocated to different types of alternative AWMS. Liechtenstein agreed that this was an error, but noted that the error was in a background table and did not affect emissions estimates (see para. 62 below). The ERT also observed that a table included in the 2011 annual submission, which provided transparent background information on the conversion factors used to calculate gross energy intake for the different livestock categories, appears to have been inadvertently omitted from the 2012 annual submission. In order to improve transparency, the ERT recommends that Liechtenstein include these conversion factors in the NIR of its next annual submission and, more broadly, reiterates the recommendation in the previous review report that Liechtenstein enhance QA/QC practices in the agriculture sector in its next annual submission.

2. Key categories

Enteric fermentation– CH_4

57. Major recalculations have been performed for this category, including the revision of the gross energy intake for cattle and poultry. The goal of the recalculation, which, according to the NIR, increased emissions by 0.44 Gg CO_2 eq (or 4.2 per cent) for 2009, was to enhance the quality of the background calculation model and to improve time-series consistency of AD. The ERT welcomes these improvements.

58. Liechtenstein uses a tier 2 method for this category for all animal subcategories. The methodology used is in line with the IPCC good practice guidance. For mature dairy cattle and mature non-dairy cattle Liechtenstein calculates the EF by using gross energy intake with the calculations based on country-specific values for lactation period and milk yield. For the other animal categories Liechtenstein uses EFs from Switzerland.

59. For 2010, AD for breeding cattle are reported in the CRF tables as "NA" under the livestock category other, but for the other years a value is reported. In response to a question raised by the ERT during the review, Liechtenstein indicated that all breeding cattle are included under young cattle in the CRF tables since they are not yet considered as adult. The ERT recommends that this inconsistency in the time series in the reporting be corrected in the next annual submission and that all breeding cattle be included under young cattle for the years 1990–2009.

Agricultural soils – N_2O

60. Liechtenstein has estimated emissions from agricultural soils by using the tier 1b methodology from the IPCC good practice guidance and IPCC default EFs. Both N excretion factors and volatilization losses are based on Swiss values from the ammonium model AGRAMMON. In addition, the fractions used for the calculation of the N input for biological fixation and crop residues are based on Swiss factors. The ERT agrees with the justification provided in the NIR of the use of Swiss values, which is based on similar agricultural situations in the two countries.

61. In response to recommendations in the previous review reports, Liechtenstein has, in the 2012 annual submission, reported values in the additional information table of CRF table 4.D for $Frac_{GASF}$, $Frac_{GASM}$, $Frac_{GRAZ}$, $Frac_R$ and $Frac_{NCRBF}$. Also in response to recommendations in the previous review reports, AD of synthetic fertilizer use, compost and sewage sludge application and a description of how AD are collected are now presented separately in the NIR. Emissions from compost and sewage sludge are reported under the category other direct emissions in CRF table 4.D. In response to a question raised by the ERT during the review, Liechtenstein provided the ERT with information on the source of the amount of sewage sludge used in the calculations for 1990–2003. The ERT commends Liechtenstein for these improvements, and, in order to further improve transparency, recommends that the Party include such additional information in its next annual submission.

62. In response to questions raised by the ERT during the review, Liechtenstein indicated that the value reported for N input from manure applied to soils in CRF table 4.D was too high owing to a transcription error that had occurred when data were transferred from the background sheets to the CRF Reporter. The ERT recommends that this error be corrected in the next annual submission.

3. Non-key categories

Manure management – CH_4 and N_2O

63. Based on recommendations in previous review reports, an internal review has been performed by Liechtenstein of the allocation of manure N to the different AWMS. The internal review led to recalculations in the 2012 annual submission as the total quantity of N was incorrectly allocated to the different AWMS. In response to questions raised by the ERT during the review regarding whether the same distribution was used for the calculation of both CH_4 and N_2O emissions, Liechtenstein confirmed that the same distribution was used. The ERT welcomes the improvements made in the allocation among AWMS.

64. In the course of the review, the Party informed the ERT that an error was detected in the additional information in CRF table 4.B(a) due to the transformation process of background data into the CRF tables. The ERT recommends that the additional information reported in this table be corrected in the next annual submission.

65. For 2010, the total quantity of N excreted, calculated as a product of the livestock population number and the N excretion factors, is higher than the sum of N allocated to different types of AWMS. In 2009 it is lower. In response to a question raised by the ERT during the review, the Party explained that a calculation error occurred for mature non-dairy cattle and young cattle (liquid system), since values for the first should be higher by a factor of 10. There were also further errors discovered that Liechtenstein believes to have occurred when data were transferred from the background sheets to the CRF Reporter. As these errors are related to background information, and do not affect the quantity of emissions reported, the ERT recommends that they be corrected for the next annual submission.

E. Land use, land-use change and forestry

1. Sector overview

66. In 2010, net removals from the LULUCF sector amounted to 6.00 Gg CO_2 eq. Since 1990, net removals have decreased by 27.0 per cent. The key driver for the fall in removals is the use of updated land-use statistics, which resulted in a change in the attribution of areas to the respective land-use categories. During the period 1997–2002, the removals were lower owing to a higher rate of conversion from forest land to grassland during this period. Within the sector, removals are reported only for forest land (18.55 Gg CO_2 eq in 2010), while emissions are reported from cropland (4.54 Gg CO_2 eq), grassland (3.39 Gg CO_2 eq), settlements (3.33 Gg CO_2), other land (1.15 Gg CO_2 eq) and wetlands (0.13 Gg CO_2 eq).

67. The Party has made recalculations for the LULUCF sector between the 2011 and 2012 annual submissions in order to rectify identified errors. These recalculations took place in all LULUCF categories. The impact of these recalculations on the LULUCF sector is a decrease in removals of 2.1 per cent for 2009. However, the reporting of the recalculations in the NIR is not transparent and Liechtenstein has not included sufficient information on the impacts of these recalculations. Therefore, the ERT reiterates the recommendation in the previous review reports that Liechtenstein provide further information on the impacts of its recalculations on the LULUCF sector in its next annual submission.

68. Liechtenstein has provided information on land use and land-use changes. This information includes a national classification and definition of different land uses and their allocation to UNFCCC categories. Liechtenstein has included in its NIR table 7-6 the

statistics on the areas maintaining their land use from 1990 to 2010 as well as information about the change between 1990 and 2010 in each category. Table 7-7 represents the land-use change matrix between 2008 and 2010. The ERT reiterates the recommendation in the previous review report to improve the transparency of reporting of land use and land-use change areas. For example, the ERT encourages the Party to provide in its next annual submission a summary table on the national areas of different land uses and land-use changes from 1990 to the last year reported, using the approaches for consistent land representation and land-use matrices of the IPCC good practice guidance for LULUCF.

69. Liechtenstein has used notation keys "NE" and "IE" for organic soils in several subcategories, such as forest land remaining forest land, cropland remaining cropland and land converted to grassland. In addition, Liechtenstein uses a 12-year interval for calculating annual carbon stock changes in soils due to land-use conversion; this is not consistent with the IPCC good practice guidance for LULUCF, which recommends using a 20-year interval for conversions. These issues have also been raised in recommendations in the previous review reports. In response to a question raised by the ERT during the review, Liechtenstein explained that the LULUCF sector is undergoing a complete review during 2012, and that the issues identified by the ERT with respect to soils have been recognized and the Party is working to solve them. The ERT strongly recommends that Liechtenstein include these modifications, including the use of a 20-year conversion interval or an explanation for the 12-year conversion interval, in its next annual submission.

2. Key categories

Forest land remaining forest land – CO_2

70. Liechtenstein uses data for growing stock, gross growth, cut (harvesting) and mortality, derived from the first and second Swiss national forest inventories (NFIs). Liechtenstein classifies its forest land remaining forest land depending on the altitude of the forests, the tree species (coniferous and deciduous) and the soil type (organic or mineral). Liechtenstein also uses other Swiss parameters (e.g. biomass expansion factors) to estimate carbon stocks and carbon stock changes in this category. The ERT encourages Liechtenstein to consider also using data for growing stock, gross growth, cut (harvesting) and mortality derived from the third Swiss NFI.

71. The ERT noted the division between managed forests, unproductive forests (inaccessible forests and brush forests) and afforestation in the forest land remaining forest land category. Liechtenstein provided information on growing stock, gross growth and cut and mortality, dead wood and soil carbon for managed forests, and information on carbon stock in living biomass and soil carbon for unproductive forests and afforestation. Nevertheless, there is no information available on dead wood and litter pools for unproductive forests or afforestation, or on litter in the case of managed forests. In response to a question raised by the ERT during the review, the Party explained that no specific data on these pools are available; therefore, they have not been estimated separately and are included in growing stock. Liechtenstein informed the ERT that the issue will be discussed for the next annual submission. The ERT recommends that Liechtenstein provide separate information on these pools in its next annual submission.

Cropland remaining cropland – CO_2

72. As with forest land remaining forest land, methods and parameters used are derived from the Swiss national inventory data (e.g. carbon stocks and carbon stock changes).

73. According to the NIR, changes in carbon stocks in mineral soils are due to a loss of 9.52 Mt C/ha/year. However, there is no transparent information presented on how this loss has been calculated or the source of this parameter. In response to a question raised by the

ERT during the review, Liechtenstein indicated that the value is taken from the Swiss inventory. Although Liechtenstein noted that this is already documented in table 7-8 of the NIR, it indicated that it intends to include the reference in the accompanying text in its next annual submission. The ERT recommends that Liechtenstein, in its next annual submission, improve the transparency of the information on the soil organic carbon pool in cropland remaining cropland, providing detailed information on all the parameters used and their applicability to Liechtenstein cropland.

Land converted to settlements – CO_2

74. According to the NIR, between 1990 and 2010, 361 hectares were converted to settlements, increasing by 26.4 per cent the total area of this category. The ERT considers that the information provided in the NIR on emissions associated with land-use changes to settlements is not sufficient to evaluate the quality of the estimations. The ERT recommends that Liechtenstein provide detailed information on the methods, data and parameters used for the estimations associated with each subcategory of this category in its next annual submission.

3. Non-key categories

Grassland remaining grassland – CO_2

75. According to the NIR, Liechtenstein uses national AD and data based on experiments, field studies, literature and expert estimates from Switzerland. The approach used is in line with the IPCC good practice guidance for LULUCF.

76. The NIR does not provide sufficient and transparent information on the source of the data included in tables 7-8 and 7-28 and used for the estimation of emissions and removals associated with this category. The ERT recommends that Liechtenstein include more information about how these parameters have been obtained, and their applicability to Liechtenstein, in its next annual submission.

Land converted to grassland – CO_2

77. Conversion to grassland occurs mainly from cropland to grassland and from forest land to grassland. For the estimation of emissions and removals associated with this category, the Party uses national AD as well as experimental data field studies, literature and Swiss expert estimates.

78. For the determination of the changes in carbon stocks of land converted to grassland, Liechtenstein used the carbon stock factors as contained in tables 7-8 and 7-28 of its NIR which, according to the Party, were taken from Switzerland's 2008 annual submission, and which are applied to and combined with the land-use changes included in the land-use change matrix in tables 7-6 and 7-7 of the NIR. Liechtenstein has not provided detailed information on the source of the data included in tables 7-8 and 7-28 for this category. The ERT recommends that Liechtenstein include in its next annual submission more information about how these parameters have been obtained and their applicability to Liechtenstein.

Land converted to wetlands – CO_2

79. According to the NIR, the parameters used for the calculation of emissions associated with land converted to wetlands are based on expert estimates or default values. The ERT noted that the NIR does not provide sufficient information that justifies the election of parameters and methods for the estimation of emissions and removals associated

with these land-use changes. The ERT recommends that Liechtenstein provide detailed information on this category in its next annual submission.

Land converted to other land – CO_2

80. Emissions from land converted to other land increased by 162.7 per cent in relation to 1990. At the same time, according to the NIR, the area of land categorized as other land has remained fairly stable (–0.5 per cent). The ERT noted that there is no transparent information provided on the methods, parameters and factors used for the estimation of emissions associated with this land-use change that would help to explain this trend. In response to questions raised by the ERT during the review, Liechtenstein noted that some changes could be attributed to changing land use statistics. The ERT concludes that the NIR does not include sufficient information to ensure time-series consistency for this category and recommends that Liechtenstein improve transparency and include in its next annual submission detailed information on how the emissions associated with this land-use change have been calculated and the rationale for the considerable increase in these emissions.

Emissions from disturbance associated with land-use conversion to cropland – N_2O

81. The N_2O-N emissions per area converted declined by 88.2 per cent between 1995 (20.02 kg N_2O-N/ha) and 2010 (2.37 kg N_2O-N/ha). Emissions were reported as "NO" in 1990–1994, but, according to the CRF tables, there are areas reported under other land uses converted to cropland during this period. In response to a question raised by the ERT during the review, the Party explained that where negative emissions occur, they are set to zero and "NO" is reported in the CRF table (e.g. for the year 2008), and asserted that this is a conservative assumption, as only absorptions are not reported. This is the case for emissions in the period 1990–1994. The ERT recalls that, in reporting under the Convention, there should not be underestimation or overestimation of emissions and removals as far as can be judged. Therefore, the ERT recommends that Liechtenstein provide information on this specific issue for the complete time series in its next annual submission.

F. Waste

1. Sector overview

82. In 2010, emissions from the waste sector amounted to 1.72 Gg CO_2 eq, or 0.7 per cent of total GHG emissions. Since 1990, emissions have increased by 8.5 per cent. The key drivers for the rise in emissions are: an increase in population leading to higher emissions from wastewater treatment; and an increase in composting activities, which more than offset the decrease in emissions from the category solid waste disposal on land. Within the sector, 58.4 per cent of the emissions were from wastewater handling, followed by 40.0 per cent from other (composting), 0.8 per cent from waste incineration and 0.8 per cent from solid waste disposal on land.

83. Liechtenstein has made a recalculation for CH_4 and N_2O emissions from wastewater handling resulting from an update in the EF for the percentage of biogas leakage and an update in protein consumption, between the 2011 and 2012 annual submissions. The recalculation is explained transparently in the NIR. The impact of this recalculation on the waste sector is an increase in total GHG emissions of 3.0 per cent for 2009.

2. Non-key categories

Solid waste disposal on land – CH_4

84. Using the tier 2 method (IPCC first-order decay method) from the IPCC good practice guidance, Liechtenstein reported emission estimates of CH_4 from solid waste disposal on land which amounted to 0.01 Gg CO_2 eq in 2010. Historically there were only unmanaged landfills in Liechtenstein; therefore, the Party has reported emissions from managed waste disposal on land as "NO" for the entire time series.

85. The NIR states that all unmanaged solid waste disposal sites in Liechtenstein have been closed since 1974, and all municipal solid waste is exported to Switzerland for incineration. To enhance the transparency of the inventory, the ERT recommends that Liechtenstein provide additional background information (e.g. political measures for waste management, evidence of waste trade, etc.) in its next annual submission.

86. Liechtenstein reported the waste generation ratio, CH_4 oxidation factor and CH_4 generation rate constant (k) as "NA" in the CRF tables although these values are uniquely identified in the NIR. To ensure comparability among Parties, the ERT recommends that Liechtenstein report actual figures for these items in the CRF tables in its next annual submission.

Wastewater handling – CH_4 and N_2O

87. Liechtenstein has reported CH_4 and N_2O emission estimates from wastewater treatment. In the NIR, it is stated that industrial wastewater in Liechtenstein is treated in the municipal wastewater treatment plants to produce biogas from the sludge; therefore, the accounting of CH_4 emissions from sludge in the category domestic and commercial wastewater includes all emissions from handling of liquid wastes and sludge from housing, commercial and industrial sources. In order to ensure completeness of the CH_4 emission estimates, the ERT recommends that Liechtenstein provide additional information on wastewater handling circumstances (e.g. the adoption ratio of the municipal sewage system connected to the plants) in the NIR of its next annual submission.

88. Liechtenstein has made recalculations for the whole time series for CH_4 and N_2O emissions. CH_4 emissions have been recalculated using a new EF owing to a revision of the biogas leakage ratio in Liechtenstein's country-specific methodology. N_2O emissions have been recalculated using updated year-specific values for protein consumption according to the numbers provided by the Swiss Farmers' Union. The ERT commends the updating of AD and EFs to improve the accuracy of the emissions estimates.

Waste incineration – CO_2, CH_4 and N_2O

89. There are no waste incineration plants in Liechtenstein. However, Liechtenstein has reported CO_2, CH_4 and N_2O emission estimates from illegal waste incineration by using a country-specific tier 2 method.

90. Liechtenstein has applied the CO_2 EF used in the Swiss inventory to estimate emissions from waste incineration (203.2 kg/t). Consistent with the planned improvements documented in the 2011 NIR, and in response to a recommendation in the previous review report, Liechtenstein has further analysed the Swiss CO_2 EF and provided a transparent assessment of the factor in the 2012 annual submission. The ERT commends Liechtenstein's effort to improve the EF and documentation. It encourages the Party to investigate further to assess the suitability of Swiss EFs for Liechtenstein, as outlined in the planned improvements of the 2012 NIR, and to provide information on the results in its next annual submission.

Other (waste) – CH_4 and N_2O

91. Liechtenstein has reported CH_4 and N_2O emission estimates from composting of organic waste under this category. Emission estimates are based on the Swiss country-specific method and EFs. Liechtenstein does not provide specific information in the NIR regarding whether the Swiss factors are representative of conditions in Liechtenstein. In order to demonstrate the appropriateness of adopting the Swiss methodology, the ERT recommends that Liechtenstein transparently describe the national circumstances surrounding composting in its next annual submission.

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

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

Overview

92. In its 2012 annual submission, Liechtenstein has provided the requested supplementary information on KP-LULUCF in the NIR and in the KP-LULUCF CRF tables. Liechtenstein did not elect any activity under Article 3, paragraph 4, of the Kyoto Protocol. The Party elected annual accounting for its activities under Article 3, paragraph 3, of the Kyoto Protocol. The information provided on these activities is generally in line with the reporting requirements included in paragraphs 5 to 9 of the annex to decision 15/CMP.1. However, the information provided in the KP-LULUCF section of the NIR is brief and in many cases only a reference is made to another section in the NIR where issues are not necessarily clearly described. Reiterating the recommendation in the previous review report that Liechtenstein improve the transparency of its reporting of the KP-LULUCF supplementary information under Article 7, paragraph 1, of the Kyoto Protocol, the ERT strongly recommends that, in its next annual submission, Liechtenstein more transparently describe all the methods, parameters and factors used in estimating emissions and removals in each Article 3, paragraph 3, activity in Chapter 11 of the NIR, as required by the annex to decision 15/CMP.1.

93. The Party has made recalculations for the KP-LULUCF activities between the 2011 and 2012 submissions in order to rectify identified errors. The impact of these recalculations on afforestation and reforestation for 2009 was a reduction in removals of 3.01 Gg CO_2 eq.

Activities under Article 3, paragraph 3, of the Kyoto Protocol

Afforestation and reforestation – CO_2

94. Liechtenstein has provided information on estimates of carbon stock changes for above-ground biomass and soil organic carbon under these activities. The methods and parameters used were the same as those used in the inventory to calculate emissions from the LULUCF sector for reporting under the Convention. Therefore, the recommendations related to these methods and parameters are also applicable here (see paras. 70 and 71 above (forest land remaining forest land)). The ERT noted that Liechtenstein continues to report below-ground biomass as "IE" and reiterates its encouragement to the Party to report the estimations for below-ground biomass separately and include additional information on this pool in its next annual submission.

95. In the NIR (section 11.1.1.2), Liechtenstein affirms that the area where afforestation has taken place is equal to the area reported for land-use changes to forests in the LULUCF sector. However, during the review the ERT found that there are some inconsistencies

between those areas. The Party confirmed that the LULUCF and KP-LULUCF sectors are undergoing an internal review that has identified several errors in the KP-LULUCF CRF tables submitted in April 2012. In response to questions raised by the ERT during the review, Liechtenstein provided the corrected areas for these activities and stated that it expects the final results of the internal review by the end of 2012. The ERT recommends that the Party improve the land-use change determination and provide accurate information on the areas where afforestation has taken place in its next annual submission.

96. Liechtenstein has not reported the dead wood and litter pools in afforestation activities, and has explained that it used the IPCC tier 1 approach, which assumes these pools to be in balance. Based on decision 15/CMP.1, in cases where Parties decide not to report a pool, verifiable information needs to be presented in the NIR to justify that the pool is not a net source. During the review, the ERT requested more information on a Swiss study (Perruchoud et al., 1999[8]), referenced in previous review reports, which verifies that these pools are not a net source in Liechtenstein. In response to the questions raised by the ERT during the review, the Party stated that the methodology was chosen in accordance with the Swiss study and no further investigations into the applicability of the study in Liechtenstein have been carried out. The ERT recommends that Liechtenstein undertake any necessary investigations to guarantee the applicability of the Swiss methodology to Liechtenstein and document the results in the next annual submission.

Deforestation – CO_2

97. Recommendations in the previous review report included that Liechtenstein provide more transparent and complete documentation of the methods or models and assumptions used for the estimations related to deforestation in the 2012 annual submission. However, the ERT has not found any new information on this issue in the NIR. The ERT recommends that Liechtenstein include a more detailed description of the methods and assumptions used for the estimation of emissions from deforestation in its next annual submission. The ERT encourages the Party to disaggregate the estimations of emissions from deforestation, taking into account the final use of the area deforested.

98. Liechtenstein continues to report carbon stock changes for below-ground biomass as "IE", "NE". Previous review reports have identified a lack of transparency and recommended that Liechtenstein provide separate estimates for above-ground and below-ground biomass, or provide additional information regarding the approach used and the justification for using this approach. None of these options has been implemented in the 2012 NIR; therefore, the ERT reiterates the recommendation in previous review reports that Liechtenstein, in its next annual submission, provide either separate estimates for above-ground and below-ground biomass, or comprehensive additional information justifying the use of the elected approach that does not result in the disaggregation of these pools.

2. Information on Kyoto Protocol units

Standard electronic format and reports from the national registry

99. 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 included in the SIAR on the SEF tables and the SEF comparison

[8] Perruchoud et al. 1999, Perruchoud, D., Kienast, F., Kaufmann, E., Bräker, O.U 1999: 20th Century Carbon Budget of Forest Soils in the Alps. Ecosystems 2: 320-337. <http://dx.doi.org/10.1007/s100219900083>.

report.[9] The SIAR was forwarded to the ERT prior to the review, pursuant to decision 16/CP.10. The ERT reiterated the main findings contained in the SIAR.

100. Information on the accounting of Kyoto Protocol units has been prepared and reported in accordance with decision 15/CMP.1, annex, chapter I.E, 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 referred to in decision 22/CMP.1, annex, paragraph 88(a–j). 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.

Accounting of activities under Article 3, paragraph 3, of the Kyoto Protocol

101. Liechtenstein has reported information on its accounting of KP-LULUCF in the accounting table, as included in the annex to decision 6/CMP.3. Information on the accounting of KP-LULUCF has been prepared and reported in accordance with decisions 16/CMP.1 and 6/CMP.3.

102. Table 6 shows the accounting quantities for KP-LULUCF as reported by the Party and the final values after the review.

103. Based on the information provided in table 6 for the activity afforestation/reforestation, Liechtenstein shall cancel 5,800 assigned amount units (AAUs), emission reduction units (ERUs), certified emission reduction units (CERs) and/or removal units (RMUs) in its national registry.

104. Based on the information provided in table 6 for the activity deforestation, Liechtenstein shall cancel 143 AAUs, ERUs, CERs and/or RMUs.

National registry

105. 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, data safeguard and disaster recovery measures in place and its operational performance is adequate.

Calculation of the commitment period reserve

106. Liechtenstein has reported its commitment period reserve in its 2012 annual submission. The Party reported that its commitment period reserve has not changed since the initial report review (950,061 t CO_2 eq), as it is based on the assigned amount and not on the most recently reviewed inventory. The ERT agrees with this figure.

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

Table 6
Accounting quantities for activities under Article 3, paragraph 3, and, if any, activities under Article 3, paragraph 4, of the Kyoto Protocol, in t CO_2 eq

	2012 submission[a]			*2010 and 2011 submissions*[b]	*"Net" accounting quantity*[c]
	As reported	*Revised estimates*	*Final*	*Final*	
Afforestation and reforestation	–9 688	–631	–631	–6 431	5 800
Deforestation	936	936	936	792	143
Forest management	NA	NA	NA	NA	NA
Article 3.3 offset[d]	NA	NA	NA	NA	NA
Forest management cap[e]	NA	NA	NA	NA	NA
Cropland management	NA	NA	NA	NA	NA
Grazing land management	NA	NA	NA	NA	NA
Revegetation	NA	NA	NA	NA	NA

Abbreviations: CRF = common reporting format, KP-LULUCF = land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NA = not applicable.

[a] The values included under the 2012 submission are the cumulative accounting values for 2008, 2009 and 2010 as reported in the accounting table of the KP-LULUCF CRF tables for the inventory year 2010.

[b] The values included under the 2010 and 2011 submissions are the final accounting values as a result of the 2010 and 2011 reviews and are included in table 4 of the 2011 annual review report (FCCC/ARR/2011/LIE, page 25) in the column "2011 submission", "Final".

[c] The "net" accounting quantity is the quantity of Kyoto Protocol units that the Party shall issue or cancel under each activity under Article 3, paragraph 3, and paragraph 4, if relevant, based on the final accounting quantity in the 2011 submission and where the quantities issued or cancelled based on the 2010 review have been subtracted ("net" accounting quantity = final 2012 – final 2010 and 2011).

[d] Article 3.3 offset*:* for the first commitment period, a Party included in Annex I to the Convention that incurs a net source of emissions under the provisions of Article 3, paragraph 3, of the Kyoto Protocol may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under forest management under Article 3, paragraph 4, up to a level that is equal to the net source of emissions under the provisions of Article 3, paragraph 3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3, paragraph 3.

[e] In accordance with decision 16/CMP.1, annex, paragraph 11, for the first commitment period only, additions to and subtractions from the assigned amount of a Party resulting from forest management under Article 3, paragraph 4, of the Kyoto Protocol after the application of decision 16/CMP.1, annex, paragraph 10, and resulting from forest management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.

3. Changes to the national system

107. Liechtenstein has reported that there are no changes in its national system since the previous annual submission. The ERT concluded that the Party's national system continues to be in accordance with the requirements of national systems outlined in decision 19/CMP.1.

4. Changes to the national registry

108. Liechtenstein reported a change in its national registry since the previous annual submission. The Party described the change in the description of technical standards for data exchange in its NIR. The ERT concluded that, taking into account the confirmed change in the national registry, 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 relevant decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP).

5. Minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol

109. Liechtenstein reported that there is no change in its reporting of the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol since the previous annual submission. The ERT concluded that the information provided is transparent but not complete.

110. The following information has not been provided: there were recommendations in previous review reports that Liechtenstein report on how it gives priority in implementing its commitments mentioned in Article 3, paragraph 1, of the Kyoto Protocol, to the actions listed in paragraph 24 of the annex to decision 15/CMP.1; however, no additional information is provided in the current annual submission. Therefore, the ERT reiterates the above-mentioned recommendation.

111. Liechtenstein's reporting of activities to minimize the adverse impacts of response measures includes the following:

(a) Policies and measures developed are compatible and consistent with those of the European Union in order to avoid trade distortion, non-tariff barriers to trade and to set similar incentives. In accordance with international law, this approach strives at ensuring that Liechtenstein is implementing those climate change response measures, which are least trade distortive and do not create unnecessary barriers to trade;

(b) Tax exemption in Switzerland and consequently also Liechtenstein for biofuels is limited to fuels that meet ecological and social criteria. The conditions are set out in such a way that biofuels do not compete with food production and are not causing degradation of rainforests or other valuable ecosystems;

(c) Initiation of a project by the Swiss Academies of Arts and Sciences to assess possible conflicts and synergies between the expansion of renewable energy production and land management. The project takes into account that large-scale use of areas for energy production has to be planned taking into consideration the maintenance of ecosystem services, the protection of biodiversity and the natural landscapes, which are important for tourism.

III. Conclusions and recommendations

A. Conclusions

112. Liechtenstein made its annual submission on 13 April 2012. 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, Kyoto Protocol units, changes to the national registry, and minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol). This is in line with decision 15/CMP.1.

113. 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 generally complete and the Party has submitted CRF tables for the years 1990–2010 and an NIR; these are complete in terms of geographical coverage and sectors, and in terms of categories and gases, but not for all years. CRF table 7 is not completed for 1990–1993 and the ERT has raised questions regarding the use of the notation key "NO"

for some of the categories, particularly in the energy sector (e.g. feedstocks and non-energy use of fuels) and the industrial processes sector (e.g. potential emissions of HFCs, PFCs and SF_6) (see paras. 36 and 50, respectively, above). In addition, several subcategories for organic soils are reported as "NE" or "IE", such as forest land remaining forest land, cropland remaining cropland and land converted to grassland (see para. 69 above).

114. The submission of information required under Article 7, paragraph 1, of the Kyoto Protocol has been prepared and reported in accordance with decision 15/CMP.1.

115. Liechtenstein's inventory is generally in line with the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and the IPCC good practice guidance for LULUCF. The ERT has observed that the Party often uses EFs adopted from the inventory of Switzerland without sufficient justification (see paras. 19, 24, 32, 40, 73, 91, and 96 above). Further, transparency, in particular related to the LULUCF sector (see paras. 68, 71, 73, 74, 76, and 78–80 above) and for KP-LULUCF activities (see paras. 92 and 98 above) could be improved.

116. The Party has made recalculations for the inventory between the 2011 and 2012 annual submissions following changes in AD and EFs and in order to rectify identified errors. The impact of these recalculations on the national totals is an increase in emissions of 0.5 per cent for 2009. The main recalculations took place in the following sectors/categories:

(a) Energy: CH_4 and N_2O emissions from road transportation; other sectors: agriculture/forestry/fisheries; and other: mobile: off-road vehicles and other machinery (see para. 31 above);

(b) Industrial processes: HFC emissions from refrigeration and air-conditioning equipment (see para. 46 above);

(c) Agriculture: CH_4 emissions from enteric fermentation, CH_4 and N_2O emissions from manure management and N_2O emissions from agricultural soils (see para. 54 above);

(d) LULUCF: across all categories to correct identified errors (see para. 67 above);

(e) Waste: CH_4 and N_2O emissions from wastewater handling (see para. 83 above).

117. Liechtenstein has reported afforestation and deforestation activities under Article 3, paragraph 3, of the Kyoto Protocol for 2008, 2009 and 2010 (the Party has reported that reforestation does not occur in the country). Liechtenstein has not elected any activities under Article 3, paragraph 4, of the Kyoto Protocol. In response to the list of potential problems and further questions raised by the ERT during the review week, Liechtenstein has submitted revised estimates for afforestation for 2008–2010. The revised estimates considerably reduced the net removals from afforestation reported for 2008–2010, leading to a net cancellation of units in 2010.

118. The Party has made recalculations for the KP-LULUCF activities between the 2011 and 2012 submissions following changes in AD and EFs. The impact of the recalculation for 2009 is a decrease in afforestation and reforestation net removals of 93.2 per cent.

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

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

121. 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.

122. Liechtenstein has reported information under decision 15/CMP.1, annex, chapter I.H, "Minimization of adverse impacts in accordance with Article 3, paragraph 14", as part of its 2012 annual submission. The information was provided on 13 April 2012. The ERT concluded that the information provided is transparent but not complete.

B. Recommendations

123. The ERT identifies issues for improvement as listed in table 7. Recommendations are for the next annual submission unless otherwise specified.

Table 7
Recommendations identified by the expert review team

Sector	*Category*	*Recommendation*	*Paragraph reference*
General	Completeness of inventory	Complete CRF table 7 for 1990	10, 27
		Evaluate the use of the notation keys for feedstocks, non-energy use of fuels, potential emissions of HFCs, PFCs and SF_6, and organic soils subcategories forest land remaining forest land, cropland remaining cropland and land converted to grassland	10
	Inventory planning	Include information on the process of final approval of the inventory submission	13
		Describe how the key category analysis is used to prioritize inventory development	15
		Provide the key category analysis for 1990 in the CRF tables and enhance the consistency of the information provided in the NIR and the CRF tables on the key category analysis (CRF table 7)	17, 27
		Further consider the applicability of Swiss uncertainty estimates to the national circumstances of Liechtenstein and develop national uncertainty estimates, where appropriate	19, 27
		Provide relevant quantified information of the resulting changes at the key category level for recalculations in the NIR	21
		Plan and implement tier 2 QC procedures for key categories	23
		Further improve the transparency of reporting, in particular in the agriculture and LULUCF sectors, and by more detailed justification for the use of EFs, AD and parameters adopted from Switzerland's inventory	24, 27
	Follow up to previous reviews	Enhance QA/QC practices in the agriculture sector	27, 55, 56
Energy	Sector overview	Provide a more detailed justification for the selected oxidation factor	32

Sector	*Category*	*Recommendation*	*Paragraph reference*
	International bunker fuels	Confirm the appropriate split between domestic and international fuel consumption for the full time series, and ensure that the NIR transparently describes the method used to develop that split	35
	Feedstocks and non-energy use of fuels	Include the use of lubricants and bitumen in the assessment of feedstocks and non-energy use of fuels	36
	Stationary combustion: liquid and gaseous fuels – CO_2, CH_4 and N_2O	Include information on the shares of fuel supplied for electricity generation	37
		Include a description of the impact of the district heating facility on fuel consumption trends in Liechtenstein	38
		Report emissions from liquid and gaseous fuels from the category food processing, beverages and tobacco in the appropriate category	39
	Road transportation: liquid fuels – CO_2	Justify in more detail in the NIR why the EFs are constant in the period 1990–2010	40
	Navigation: other liquid fuels – CO_2, CH_4 and N_2O	Clarify the use of the notation key for fuel consumption for military operations and ensure consistency between the CRF tables and the NIR	41
		Report the appropriate notation key for military aviation under the category mobile (other)	41
	Other: liquid fuels – CH_4, N_2O	Provide a detailed explanation of the use of the model used to estimate emissions	42
	Oil and natural gas: gaseous fuels – CH_4	Transparently explain the estimation of CH_4 emissions associated with natural gas transmission	43
		Transparently explain the estimation of CH_4 emissions associated with natural gas distribution	44
Industrial processes and solvent and other product use	Consumption of halocarbons and SF_6 – HFCs and PFCs	Explain the fluctuation of emissions from refrigeration and air-conditioning equipment between 2004 and 2010	49
		Carry out the calculation of potential emissions by using the tier 1b method and present information on the emissions and the method	50
	Consumption of halocarbons and SF_6 – HFCs	Provide documentation confirming the decrease in emissions from the foam-blowing subcategory between 2009 and 2010	51
	Consumption of halocarbons and SF_6 – SF_6	Provide an explanation of the downward trend of SF_6 emissions from 2008 to 2010	52
Agriculture	Sector overview	Correct inconsistencies between the NIR and the CRF tables	55
		Include conversion factors used to calculate gross energy intake in the NIR and, more broadly, enhance QA/QC	56

Sector	*Category*	*Recommendation*	*Paragraph reference*
		practices in the agriculture sector	
	Enteric fermentation – CH_4	Correct the inconsistency in the time series for the reporting of all breeding cattle for the period 1990–2009	59
	Agricultural soils – N_2O	Include additional information on the source of the amount of sewage sludge used in the calculations for 1990–2003	61
		Correct the value reported in CRF table 4.D for nitrogen input from manure applied to soils	62
	Manure management – CH_4 and N_2O	Correct the additional information reported in CRF table 4.B(a)	64
		Correct errors identified by Liechtenstein that were believed to have occurred when data were transferred from the background sheets to the CRF Reporter, as well as the calculation error for mature non-dairy cattle and young cattle (liquid system)	65
LULUCF	Sector overview	Provide further information on the impacts of recalculations on the LULUCF sector	67
		Improve the transparency of reporting of land use and land-use change areas	68
		Provide values instead of notation keys for organic soils in several subcategories (forest land remaining forest land, cropland remaining cropland and land converted to grassland) and use a 20–year conversion interval or explain use of the current 12–year interval	69
	Forest land remaining forest land – CO_2	Provide information on dead wood and litter pools for unproductive forests or afforestation, and for litter in the case of managed forests	71
	Cropland remaining cropland – CO_2	Improve the transparency of the information on the soil organic carbon pool in cropland remaining cropland, providing detailed information on all the parameters used and their applicability to Liechtenstein cropland	73
	Land converted to settlements – CO_2	Provide detailed information on methods, data and parameters used for the estimations associated with each subcategory of this category	74
	Grassland remaining grassland – CO_2	Include more information on the source of the data included in NIR tables 7–8 and 7–28 used for the estimation of emissions and removals associated with this category, including how these parameters have been obtained and their applicability to Liechtenstein	76
	Land converted to grassland – CO_2	Include detailed information on the source of the data included in NIR tables 7–8 and 7–28, including how these parameters have been obtained and their applicability to Liechtenstein	78
	Land converted to wetlands – CO_2	Provide detailed information to justify the election of parameters and methods for the estimation of emissions and removals associated with these land-use changes	79
	Land converted to other land – CO_2	Improve transparency and include detailed information on how the emissions associated with this land-use change have been calculated and the rationale for the considerable increase in these emissions	80

Sector	*Category*	*Recommendation*	*Paragraph reference*
	Emissions from disturbance associated with land-use conversion to cropland – N_2O	Clarify the use of the notation key "NO" (not occurring) for only certain years in the time series	81
Waste	Solid waste disposal on land – CH_4	Provide additional background information (e.g. political measures for waste management, evidence of waste trade, etc.)	85
		Report in the CRF tables actual figures for waste generation ratio, CH_4 oxidation factor and CH_4 generation rate constant (k)	86
	Wastewater handling – CH_4 and N_2O	Provide additional information of wastewater handling circumstances (e.g. the adoption ratio of municipal sewerage system connected to the plants)	87
	Other – CH_4 and N_2O	Transparently describe the national circumstances surrounding composting	91
Supplementary information	Sector overview	Improve the completeness and transparency of the information provided in the KP-LULUCF section of the NIR	92
	Activities under Article 3, paragraph 3, of the Kyoto Protocol: Afforestation and reforestation – CO_2	Improve the land-use change determination and provide accurate information on the areas where afforestation has taken place	95
		Undertake any necessary investigations to guarantee the applicability of the Swiss methodology for Liechtenstein and document the results	96
	Activities under Article 3, paragraph 3, of the Kyoto Protocol: Deforestation – CO_2	Include a more detailed description of the methods and assumptions used for the estimation of emissions	97
		Provide either separate estimates for above-ground and below-ground biomass, or comprehensive additional information justifying the use of the elected approach that does not result in the disaggregation of these pools	98
	Minimization of adverse impacts	Improve its reporting on how the Party gives priority in implementing its commitments under Article 3, paragraph 14, of the Kyoto Protocol to the actions listed in paragraph 24 of the annex to decision 15/CMP.1	110

Abbreviations: AD = activity data, CRF = common reporting format, EF = emission factor, ERT = expert review team, KP-LULUCF = LULUCF emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, LULUCF = land use land-use change and forestry, NIR = national inventory report, QA/QC = quality assurance/quality control.

IV. Questions of implementation

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

Annex I

Documents and information used during the review

A. Reference documents

Intergovernmental Panel on Climate Change. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html>.

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"Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol". Decision 19/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf# page=14>.

"Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol". Decision 15/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf#page=54>.

"Guidelines for review under Article 8 of the Kyoto Protocol". Decision 22/CMP.1. Available at <http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=51>.

Status report for Liechtenstein 2012. Available at <http://unfccc.int/resource/docs/2012/asr/lie.pdf>.

Synthesis and assessment report on the greenhouse gas inventories submitted in 2012. Available at <http://unfccc.int/resource/webdocs/sai/2012.pdf>.

FCCC/ARR/2011/LIE. Report of the individual review of the annual submission of Liechtenstein submitted in 2011. Available at <http://unfccc.int/resource/docs/2011/arr/lie.pdf>.

UNFCCC. *Standard Independent Assessment Report*, parts I and II. Available at <http://unfccc.int/kyoto_protocol/registry_systems/independent_assessment_reports/items/4061.php>.

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.

The following documents[1] were also provided by Liechtenstein:

Abwasserzweckverband der Gemeinden Liechtensteins. *Scheme Waste Water Treatment Plant Bendern.pdf*. General information may be found on the web at <http://www.azv.li/abwasserzweckverband-azv/chronik.html>.

Bretscher, Daniel and Thomas Kupper. April 2012. *Categorization of livestock animals in Switzerland.* Zurich: Federal Department of Economic Affairs, Agroscope Reckenholz Tänikon Research Station (ART). Internal Report.

[1] Reproduced as received from the Party.

Annex II

Acronyms and abbreviations

AAU	assigned amount unit
AD	activity data
AWMS	animal waste management systems
CER	certified emission reduction unit
CH_4	methane
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
CRF	common reporting format
EF	emission factor
ERT	expert review team
ERU	emission reduction unit
Gg	gigagrams
GHG	greenhouse gas; unless indicated otherwise, GHG emissions are the sum of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 without GHG emissions and removals from LULUCF
HFCs	hydrofluorocarbons
IE	included elsewhere
IEA	International Energy Agency
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
ITL	international transaction log
kg	kilogram (1 kg = 1,000 grams)
KP-LULUCF	land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol
LULUCF	land use, land-use change and forestry
Mt	million tonnes
N	nitrogen
N_2O	nitrous oxide
NA	not applicable
NE	not estimated
NIR	national inventory report
NO	not occurring
PFCs	perfluorocarbons
QA/QC	quality assurance/quality control
SEF	standard electronic format
SF_6	sulphur hexafluoride
SIAR	standard independent assessment report
TJ	terajoule (1 TJ = 10^{12} joule)
UNFCCC	United Nations Framework Convention on Climate Change