United Nations

Framework Convention on
Climate Change

FCCC/ARR/2018/LUX

Distr.: General
15 April 2019

English only

Report on the individual review of the annual submission of Luxembourg submitted in 2018*
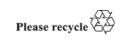
Note by the expert review team

Summary

Each Party included in Annex I to the Convention must submit an annual greenhouse gas inventory covering emissions and removals of greenhouse gas emissions for all years from the base year (or period) to two years before the inventory due date (decision 24/CP.19). Parties included in Annex I to the Convention that are Parties to the Kyoto Protocol are also required to report supplementary information under Article 7, paragraph 1, of the Kyoto Protocol with the inventory submission due under the Convention. This report presents the results of the individual inventory review of the 2018 annual submission of Luxembourg, conducted by an expert review team in accordance with the "Guidelines for review under Article 8 of the Kyoto Protocol". The review took place from 1 to 6 October 2018 in Esch-sur-Alzette, Luxembourg.

---

* In the symbol for this document, 2018 refers to the year in which the inventory was submitted, not to the year of publication.

Contents

Abbreviations and acronyms

2006 IPCC Guidelines	*2006 IPCC Guidelines for National Greenhouse Gas Inventories*
AAU	assigned amount unit
AD	activity data
Annex A sources	source categories included in Annex A to the Kyoto Protocol
AR	afforestation and reforestation
ARR	annual review report
Article 8 review guidelines	"Guidelines for review under Article 8 of the Kyoto Protocol"
BEF	biomass expansion factor
C	carbon
CER	certified emission reduction
CH_4	methane
CM	cropland management
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
CPR	commitment period reserve
CRF	common reporting format
DE	digestibility of feed
DOC	degradable organic carbon
EF	emission factor
ERT	expert review team
ERU	emission reduction unit
ETBE	ethyl tertiary butyl ether
EU	European Union
FAME	fatty acid methyl ester
FAO	Food and Agriculture Organization of the United Nations
F-gas	fluorinated gas
FM	forest management
FMRL	forest management reference level
$F_{NON-CON}$	fraction of non-consumed protein added to wastewater
GHG	greenhouse gas
GM	grazing land management
HFC	hydrofluorocarbon
HWP	harvest wood products
IE	included elsewhere
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
IPPU	industrial processes and product use
KP-LULUCF activities	LULUCF emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol
Kyoto Protocol Supplement	*2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol*
LPIS	Land Parcel Information System
LULUCF	land use, land-use change and forestry
MCF	methane correction factor
N	nitrogen
NA	not applicable
NE	not estimated

Nex	nitrogen excretion
NFI	national forest inventory
NF_3	nitrogen trifluoride
NIR	national inventory report
NMVOC	non-methane volatile organic compound
NO	not occurring
N_2O	nitrous oxide
PFC	perfluorocarbon
QA/QC	quality assurance/quality control
RMU	removal unit
RV	revegetation
SEF	standard electronic format
SF_6	sulfur hexafluoride
SIAR	standard independent assessment report
STATEC	National Institute of Statistics and Economic Studies of the Grand Duchy of Luxembourg
UNFCCC Annex I inventory reporting guidelines	"Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories"
UNFCCC review guidelines	"Guidelines for the technical review of information reported under the Convention related to greenhouse gas inventories, biennial reports and national communications by Parties included in Annex I to the Convention"
WDR	wetland drainage and rewetting
Wetlands Supplement	*2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*
Ym	methane conversion rate

I. Introduction[1]

1. This report covers the review of the 2018 annual submission of Luxembourg organized by the secretariat, in accordance with the Article 8 review guidelines (adopted by decision 22/CMP.1, and revised by decision 4/CMP.11). In accordance with the Article 8 review guidelines, this review process also encompasses the review under the Convention as described in the UNFCCC review guidelines, particularly in part III thereof, namely the "UNFCCC guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention" (decision 13/CP.20). The review took place from 1 to 6 October 2018 in Esch-sur-Alzette, Luxembourg, and was coordinated by Mr. Roman Payo (secretariat). Table 1 provides information on the composition of the ERT that conducted the review of Luxembourg.

Table 1
Composition of the expert review team that conducted the review of Luxembourg

Area of expertise	Name	Party
Generalist	Mr. Mark Hunstone	Australia
Energy	Mr. Michael Smith	New Zealand
IPPU	Mr. Menouer Boughedaoui	Algeria
Agriculture	Mr. Amnat Chidthaisong	Thailand
LULUCF	Ms. Esther Mertens	Belgium
Waste	Ms. Baasansuren Jamsranjav	Mongolia
Lead reviewers	Mr. Boughedaoui	
	Mr. Hunstone	

2. The basis of the findings in this report is the assessment by the ERT of the Party's 2018 annual submission, in accordance with the Article 8 review guidelines. The ERT notes that the individual inventory review of Luxembourg's 2017 annual submission did not take place during 2017 owing to insufficient funding for the review process.

3. The ERT has made recommendations that Luxembourg resolve the findings related to issues,[2] including issues designated as problems.[3] Other findings, and, if applicable, the encouragements of the ERT to Luxembourg to resolve them, are also included.

4. A draft version of this report was communicated to the Government of Luxembourg, which provided comments that were considered and incorporated, as appropriate, into this final version of the report.

5. Annex I shows annual GHG emissions for Luxembourg, including totals excluding and including the LULUCF sector, indirect CO_2 emissions and emissions by gas and by sector. Annex I also contains background data related to emissions and removals from KP-LULUCF activities, if elected, by gas, sector and activity for Luxembourg.

6. Information to be included in the compilation and accounting database can be found in annex II.

---

[1] At the time of publication of this report, Luxembourg had submitted its instrument of ratification of the Doha Amendment; however, the amendment had not yet entered into force. The implementation of the provisions of the Doha Amendment is therefore considered in this report in the context of decision 1/CMP.8, paragraph 6, pending the entry into force of the amendment.

[2] Issues are defined in decision 13/CP.20, annex, paragraph 81.

[3] Problems are defined in decision 22/CMP.1, annex, paragraphs 68 and 69, as revised by decision 4/CMP.11.

II. Summary and general assessment of the 2018 annual submission

7. Table 2 provides the assessment by the ERT of the annual submission with respect to the tasks undertaken during the review. Further information on the issues identified, as well as additional findings, may be found in tables 3 and 5.

Table 2
Summary of review results and general assessment of the inventory of Luxembourg

Assessment				Issue or problem ID#(s) in table 3 and/or 5[a]
Date of submission	Original submission: 5 April 2018 (NIR), 5 April 2018, version 1 (CRF tables), 5 April 2018 (SEF-CP1-2017), 5 April 2018 (SEF-CP2-2017) (SEF tables)			
	Revised submissions: 15 November 2018, version 3 (CRF tables), 29 May 2018 (SEF-CP1-2017), 29 May 2018 (SEF-CP2-2017) (SEF tables)			
	Unless otherwise specified, the values from the latest submission are used in this report			
Review format	In-country			
Application of the requirements of the UNFCCC Annex I inventory reporting guidelines and Wetlands Supplement (if applicable)	1. Have any issues been identified in the following areas:			
		(a) Identification of key categories	Yes	G.2
		(b) Selection and use of methodologies and assumptions	Yes	L.9, W.13, W.21
		(c) Development and selection of EFs	Yes	E.25, I.20, A.11, L.12, W.10
		(d) Collection and selection of AD	Yes	E.24, E.26, I.17, A.6, L.13, L.14, L.18, W.11, W.14, W.19, W.20, KL.7
		(e) Reporting of recalculations	Yes	I.1
		(f) Reporting of a consistent time series	Yes	L.20
		(g) Reporting of uncertainties, including methodologies	Yes	G.11, I.4, I.12, I.14, I.23, A.10, L.9, L.10, L.11
		(h) QA/QC		QA/QC procedures were assessed in the context of the national system (see para. 2 in this table)
		(i) Missing categories/completeness[b]	Yes	I.21, L.21, KL.8
		(j) Application of corrections to the inventory	No	
Significance threshold	For categories reported as insignificant, has the Party provided sufficient information showing that the likely level of emissions meets the criteria in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines?		Yes	
Description of trends	Did the ERT conclude that the description in the NIR of the trends for the different gases and sectors is reasonable?		No	G.4, I.11, I.18, I.19
Supplementary information under	2. Have any issues been identified related to the national system:			

Assessment				Issue or problem ID#(s) in table 3 and/or 5[a]
the Kyoto Protocol		(a) The overall organization of the national system, including the effectiveness and reliability of the institutional, procedural and legal arrangements	No	
		(b) Performance of the national system functions	Yes	G.14
	3. Have any issues been identified related to the national registry:			
		(a) Overall functioning of the national registry	No	
		(b) Performance of the functions of the national registry and the technical standards for data exchange	No	
	4. Have any issues been identified related to reporting of information on ERUs, CERs, AAUs and RMUs and on discrepancies reported in accordance with decision 15/CMP.1, annex, chapter I.E, in conjunction with decision 3/CMP.11, taking into consideration any findings or recommendations contained in the SIAR?		No	
	5. Have any issues been identified in matters related to Article 3, paragraph 14, of the Kyoto Protocol, specifically problems related to the transparency, completeness or timeliness of reporting on the Party's activities related to the priority actions listed in decision 15/CMP.1, annex, paragraph 24, in conjunction with decision 3/CMP.11, including any changes since the previous annual submission?		No	
	6. Have any issues been identified related to the reporting of LULUCF activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, as follows:			
		(a) Reporting requirements in decision 2/CMP.8, annex II, paragraphs 1–5	No	
		(b) Demonstration of methodological consistency between the reference level and reporting on FM in accordance with decision 2/CMP.7, annex, paragraph 14	No	
		(c) Reporting requirements of decision 6/CMP.9	No	
		(d) Country-specific information to support provisions for natural disturbances, in accordance with decision 2/CMP.7, annex, paragraphs 33 and 34	No	
CPR	Was the CPR reported in accordance with the annex to decision 18/CP.7, the annex to decision 11/CMP.1 and decision 1/CMP.8, paragraph 18?		Yes	G.5
Adjustments	Has the ERT applied an adjustment under Article 5, paragraph 2, of the Kyoto Protocol?		No	
	Did the Party submit a revised estimate to replace a previously applied adjustment?		NA	Luxembourg does not have a previously applied adjustment

Assessment		Issue or problem ID#(s) in table 3 and/or 5[a]
Response from the Party during the review	Has the Party provided the ERT with responses to the questions raised, including the data and information necessary for the assessment of conformity with the UNFCCC Annex I inventory reporting guidelines and any further guidance adopted by the Conference of the Parties?	Yes
Recommendation for an exceptional in-country review	On the basis of the issues identified, does the ERT recommend that the next review be conducted as an in-country review?	No
Questions of implementation	Did the ERT list a question of implementation?	No

[a] The ERT identified additional issues and/or problems in all sectors and for KP-LULUCF activities that are not listed in this table but are included in table 3 and/or 5.

[b] Missing categories for which methods are provided in the 2006 IPCC Guidelines may affect completeness and are listed in annex III.

III. Status of implementation of issues and/or problems raised in the previous review report

8. Table 3 compiles all the recommendations made in previous review reports that were included in the previous review report, published on 30 August 2017.[4] For each issue and/or problem, the ERT specified whether it believes the issue and/or problem has been resolved by the conclusion of the review of the 2018 annual submission and provided the rationale for its determination, which takes into consideration the publication date of the previous review report and national circumstances.

Table 3
Status of implementation of issues and/or problems raised in the previous review report of Luxembourg

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
General			
G.1	Key category analysis – (G.3, 2016) (G.3, 2015) (20, 2014) (18, 2013) Transparency	Include more detailed information on the uncertainty analysis and key category analysis in the NIR.	Resolved. The ERT noted that the previous recommendation is resolved because Luxembourg has provided an additional key category table (NIR, p.74), uncertainty tables consistent with the 2006 IPCC Guidelines and annexes to the NIR.
G.2	Key category analysis – (G.8, 2016), (G.8, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Improve QA/QC in reporting on the key category analysis to ensure consistency with the UNFCCC Annex I inventory reporting guidelines.	Addressing. Luxembourg continues to perform its key category analysis using the IPCC tier 1 method for both the level and trend. The ERT noted that the recommendation has not been fully addressed, because there remain inconsistencies between the NIR and CRF table 7 "Summary overview for key categories". For example, CRF table 7 lists category 4.C.2 land converted to grassland – CO_2 as a key category by trend for 2016 but this category is not listed in NIR table 12. During the review, the Party confirmed that the key category analysis reported in CRF table 7

[4] FCCC/ARR/2016/LUX. The ERT notes that the individual inventory review of Luxembourg's 2017 annual submission did not take place during 2017. As a result, the latest published ARR reflects the findings of the review of the Party's 2016 annual submission.

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
			is correct in relation to the reporting of category 4.C.2 land converted to grassland – CO_2 as a key category. Consequently, table 12 of the NIR is incorrect.
G.3	National registry – (G.10, 2016) (G.10, 2015) Transparency	Report the calculation of the CPR in the NIR.	Resolved. Details of the CPR calculation are provided in the NIR (chapter 12) (see ID# G.5 in table 5).
G.4	Time-series consistency – (G.5, 2016) (G.5, 2015) Transparency	Provide a detailed explanation of the main drivers of the increase in F-gases in the NIR.	Addressing. Although there is some limited discussion of the trend in F-gas emissions between 2015 and 2016, there is no discussion on the trend from 1990, as the previous review report noted. During the review, the Party agreed to include the detailed description that it had provided in response to a question from the previous ERT (see ARR 2016, ID# G.5 in table 5) in its NIR (sections 2.3.4, 2.4.2 and the IPPU chapter).

Energy

ID#	Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale
E.1	1. General (energy sector) – (E.1, 2016), (E.1, 2015), (25, 2014), Transparency	Expand the recalculation sections within each category and subcategory to include recalculated values and the impact of the change, or include a cross reference to the section in the NIR where recalculations are explained.	Resolved. Recalculation sections are included for each category of the NIR energy chapter. Chapter 10 of the NIR has also been extended and comprises several tables detailing the recalculations done in each sector, and provides tables with a quantitative assessment.
E.2	1. General (energy sector) – (E.2, 2016) (E.2, 2015), (28, 2014) (23, 2013), (39, 2012), (47, 2011) Transparency	Report and explain the differences between the reference and sectoral approaches, including the net calorific value used in the inventory and in the energy balance.	Resolved. The differences have been reported in NIR tables 39 and 40, and explanations have been provided in the NIR (section 3.2.1.2). According to the NIR (p.175), unless otherwise specified in the documentation boxes of the CRF tables, the net calorific values used in the reference and sectoral approaches are identical.
E.3	1. General (energy sector) – (E.4, 2016), (E.4, 2015), (30, 2014), (22, 2013) Adherence to the UNFCCC Annex I inventory reporting guidelines	Implement a planned improvement that fuels used in marine activities will be subtracted from the reference approach, where they are still included; enter all fuels used in the country in the reference approach estimates; and improve the QC procedures.	Resolved. In its 2018 annual submission, the Party has reported international marine bunkers (marine gas/diesel oil) in the reference approach (CRF table 1.A(b)) under international bunkers (e.g. 0.04 kt for 2016). Consumption of other fuels, specifically waste and industrial wastes, and their CO_2 emissions have been added to the reference approach. During the review, the Party provided a satisfactory explanation that the QC procedures had been improved, as evidenced by the fact that the improvements were made.
E.4	Fuel combustion – reference approach – all fuels – CO_2 (E.12, 2016) (E.12, 2015) Accuracy	Correct the calculation error detected in the reference approach for solid fuels concerning the double exclusion of carbon from other bituminous coal in iron and steel production.	Resolved. The error has been corrected and other bituminous coal is no longer reported as carbon stored in the reference approach. As a result, compared with the 2016 annual submission, the differences in apparent energy consumption for solid fuels have decreased (e.g. from –1.56 per cent to –1.48 per cent for 2014).
E.5	Fuel combustion – reference	Include data on petroleum coke, other kerosene and other oil (white spirit) in	Not resolved. These fuels are still reported as "NA" and "NO" in the reference approach (CRF

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
	approach – liquid fuels – CO_2 (E.14, 2016), (E.14, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	the reference approach as it is possible to enter fuels in CRF table 1.A(b) that are used for non-energy purposes in CRF table 1.A(d).	table 1.A(b)) and in CRF table 1.A(d) (feedstocks, reductants and other non-energy use of fuels). During the review, the Party explained that this improvement has been scheduled for inclusion in the 2019 annual submission.
E.6	Feedstocks, reductants and other non-energy use of fuels – all fuels – CO_2 (E.15, 2016) (E.15, 2015) Transparency	Replace the notation key "NE" with the notation key "IE" in reporting emissions for use of fuels/solid fuels/anthracite and other bituminous coal in CRF table 1.A(d).	Not resolved. The Party still reports "CO_2 emissions from the NEU reported in the inventory" from these fuels as "NE" in CRF table 1.A(d). During the review, the Party explained that this improvement has been scheduled for inclusion in the 2019 annual submission.
E.7	International navigation – liquid fuels – CO_2 (E.6, 2016), (E.6, 2015), (32, 2014) Transparency	Report fuel consumption in marine bunkers and associated emissions in the CRF tables.	Resolved. The Party reported international marine bunkers (gas/diesel oil) in the reference approach (CRF table 1.A(b)) under international bunkers (e.g. 0.04 kt for 2016).
E.8	1.A. Fuel combustion – sectoral approach – gaseous fuels – CO_2, CH_4 and N_2O (E.16, 2016), (E.16, 2015) Accuracy	Correct the natural gas consumption data in the sectoral approach using the newly revised energy balance in order to avoid underestimates for the period 1995–1999 and overestimates for the period 2000–2014; strengthen QC procedures by ensuring that total natural gas consumption in the sectoral approach is equal to total natural gas consumption from the energy balance or, if this is not the case, provide the rationale for the differences in the NIR.	Resolved. During the review, the Party explained that it had reported a description of the implementation of improvements in its 2017 annual submission (NIR 2017, p.163). As a result of those improvements, the difference in energy consumption for gaseous fuels between the reference approach and the sectoral approach is now low for the period 1990–2016, ranging from –1.8 per cent (for 2000) to 1.1 per cent (for 1993) in the 2018 annual submission, compared with the range reported in the 2016 annual submission (from –8.4 to 6.9 per cent). The difference for 2016 was –0.5 per cent. The documented convergence in the differences between the sectoral and reference approaches for natural gas suggest that QC procedures have been sufficiently strengthened.
E.9	1.A.2.e Food processing, beverages and tobacco – liquid fuels – CO_2, CH_4 and N_2O (E.17, 2016) (E.17, 2015) Transparency	Include the explanations for the inter-annual changes in AD of 1.A.2.e (liquid fuels) in the NIR.	Resolved. Explanations for the inter-annual changes of AD (TJ consumption) identified in the previous review report have been included in the Party's 2018 annual submission (NIR, section 3.2.7.6.1); namely, an increase in gas oil as reported in the national energy balance (1993/1994 (+83.2 per cent) and 2014/2015 (+90.2 per cent)), a switch from residual fuel oil to gas oil (1998/1999 (+93.8 per cent)), and the emptying of gas oil stocks at one facility prior to shutting down (2008/2009 (+158.3 per cent)).
E.10	1.A.2.g Other (manufacturing industries and construction) –	Take into account the biofuel consumption for off-road machinery, allocate it to biomass fuels and correct	Resolved. The quantity of biofuels consumed by off-road machinery and the resulting GHG emissions have been reported separately in the Party's 2018 annual submission (CRF table

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
	liquid fuels – CO_2 (E.18, 2016), (E.18, 2015) Accuracy	the CO_2 overestimation for the years 2004–2014.	1.A(a)s2). For example, the Party reported 81.85 TJ biomass consumption for subcategory 1.A.2.g.vii off-road vehicles and other machinery for 2014 in the 2018 annual submission (it was reported as "NO" in the 2016 annual submission). Regarding the CO_2 overestimation, the Party has reported biofuels separately from fossil fuels, and therefore as a memo item and not included in national totals, to avoid overestimating CO_2 emissions.
E.11	1.A.3.b Road transportation – gasoline – CO_2 (E.19, 2016), (E.19, 2015) Transparency	Explain how the CO_2 EF for gasoline used in road transportation is estimated in the NIR.	Not resolved. The Party has included in the NIR (section 3.2.5.3, pp.188 and 189) a general description of the method used to derive country-specific CO_2 EFs for liquid fuels. However, this methodological description was not updated from the information included in the 2016 NIR, and continued to refer to a CO_2 EF of 72 t CO_2/TJ for the Netherlands and Germany. Further, the description lacks specific details to enable verification and therefore lacks transparency. Also, Luxembourg has not included in the NIR a report on the findings of the analysis commissioned through its fuel quality monitoring system (EU fuel quality directive) of motor gasoline and diesel oil being sold at refuelling stations. During the review, the Party explained that the mix of imported fuels by country of origin would be included in the NIR of its next annual submission.
E.12	1.A.3.b Road transportation – liquid fuels – CO_2, CH_4 and N_2O (E.20, 2016), (E.20, 2015) Comparability	Report the biogenic part of AD and emissions for biofuels in the road transportation sector under the fuel category biomass in order to ensure comparability of the IEF with those of other countries.	Resolved. The Party reported AD and emissions separately under the fuel category biomass in its 2018 annual submission (CRF table 1.A(a)s3). For example, the Party reported 2,839.04 TJ for biomass for 2014 (these emissions were reported as "NO, IE" in the 2016 annual submission).
E.13	1.A.3.b Road transportation – liquid fuels – CO_2, CH_4 and N_2O (E.20, 2016), (E.20, 2015) Transparency	Include detailed information about biofuels in the NIR.	Addressing. Quantities of biogasoline and biodiesel have been reported in the NIR (annex 4); however, information on the source of the data has not been included in the NIR. During the review, the Party explained that this information would be included in the NIR of its next annual submission (see ID# E.18 in table 5).
E.14	1.A.3.d Domestic navigation – liquid fuels – CO_2, CH_4 and N_2O (E.10, 2016) (E.10, 2015), (26, 2014) Transparency	Review the possible double counting of emissions from leisure boats reported under navigation.	Not resolved. The outcome of the discussion with the National Statistics Office, mentioned during the previous review, was not reported in the NIR. During the review, the Party explained that double counting was not occurring, and that this conclusion would be included in the next annual submission.
E.15	1.B.2.b Natural gas – gaseous	Include the explanations about the inter-annual changes of AD for	Resolved. The Party reported explanations about inter-annual changes of AD for the years

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
	fuels – CO_2 and CH_4 (E.21, 2016), (E.21, 2015) Transparency	category 1.B.2.b.4 in section 3.3.2.2.1 of the NIR.	indicated in the previous review report in its 2018 annual submission (NIR, p.272): the significant inter-annual changes in 2001/2002 (+43.0 per cent) and 2012/2013 (–15.3 per cent) are due to the operational start of a new power plant (gas turbine) and its partial shutdown, respectively.

IPPU

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
I.1	2. General (IPPU) – (I.1, 2016), (I.1, 2015), (38, 2014) Transparency	Explain every recalculation such as the emissions from the solvent and other product use sector update of AD and EFs, and state correctly that recalculations have not been implemented in the solvent and other product use sector.	Addressing. The NIR (table 156) reports general information on the revisions made in the 2018 annual submission (NIR, p.335). The ERT noted that the previous recommendation is not resolved because the 2018 annual submission does not provide detailed information on the types of data updated (AD, EF or other parameters), recalculations made or on the impacts on the emission estimates from solvent use. During the review, the Party explained that it will report in the next annual submission more details on recalculations made and how they impact total emissions.
I.2	2. General (IPPU) – HFCs and SF_6 (I.2, 2016) (I.2, 2015), (40, 2014) Consistency	Revise the estimates of HFC emissions from foam blowing and SF_6 emissions from electrical equipment for 1990–1995 to ensure time-series consistency of these categories in accordance with the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*.	Resolved. The ERT noted that the original recommendation in the 2014 ARR (para. 40) to ensure time-series consistency was raised because the Party assumed the HFC emissions from foam blowing and SF_6 emissions from electrical equipment for 1990–1995 as constant. The ERT noted that in the 2016 annual submission these emissions were recalculated and were not constant. The ERT did not identify any problem with the time-series consistency of categories 2.F.2 foam blowing agents or 2.G.1 electrical equipment.
I.3	2. General (IPPU) – CO_2 and HFCs (I.7, 2016), (I.7, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Ensure accuracy and consistency for CO_2 emissions from other solvent use between the NIR and the CRF tables.	Resolved. The Party reported the correct estimates in the NIR (pp.314–316) and CRF table 2(I).A-Hs2, cell G28).
I.4	2.A.3 Glass production – CO_2 (I.8, 2016), (I.8, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Explain the sources of information used to inform the uncertainty of key parameters such as AD and EFs for this category.	Not resolved. The NIR (section 4.2.3.3) reports the uncertainties for the AD and EF but not the source of these values. During the review, the Party explained that only one company produces glass in Luxembourg and that the uncertainties associated with the AD and EF have been determined in collaboration with the manufacturer using the data associated with the entire production process.
I.5	2.F.1 Refrigeration and air conditioning – HFCs	Collect the relevant AD to reflect total stock in operation to provide an	Resolved. The Party collected the relevant AD to reflect the total HFC stock in operation reported for vehicles for refrigerated transport for the

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
	(I.9, 2016), (I.9, 2015) Accuracy	accurate estimate of HFC emissions from transport refrigeration.	whole time series in its 2018 annual submission. The NIR (p.346) explains the estimations.
I.6	2.F.1 Refrigeration and air conditioning – HFCs (I.10, 2015), (I.10, 2016) Transparency	Provide an explanation of emission trends, in particular significant variations across the time series, by providing more information on the drivers influencing HFC emissions from refrigeration and air conditioning, in particular commercial and industrial refrigeration.	Resolved. In its annual submission (NIR, pp.340 and 341), the Party reported more information on the largest inter-annual changes observed (including the increase between 1993 and 1994 and the decrease between 2015 and 2016) in HFC emissions to explain the reasons for the trend for different categories.
I.7	2.F.1 Refrigeration and air conditioning – HFCs (I.11, 2016), (I.11, 2015) Transparency	Describe in the NIR the expert consultation process applied to inform the choice of EF used for estimating emissions from stationary air conditioning during manufacturing.	Resolved. The NIR (p.346) indicates the EFs for manufacturing (0.2 per cent) but does not explain why the lowest EF in the range of IPCC default EFs (2006 IPCC Guidelines, vol. 3, chapter 7, table 7.9) was chosen. However, the ERT noted that footnote 3 to the IPCC table indicates that, for manufacturing, the lower value is for developed countries. The ERT considers that no additional explanations are needed for manufacturing.
I.8	2.F.1 Refrigeration and air conditioning – HFCs (I.11, 2016), (I.11, 2015) Transparency	Describe in the NIR the expert consultation process applied to inform the choice of EF used for estimating emissions from disposal of stationary air-conditioning equipment.	Not resolved. The NIR (p.346) indicates the EF for decommissioning (20.0 per cent) but does not explain why the lowest EF in the range of IPCC default EFs (2006 IPCC Guidelines, vol. 3, chapter 7, table 7.9) was chosen. The ERT considers that the explanations for disposal are still missing. During the review, the Party explained that the choice was made by expert judgment and all decommissioned equipment is exported to neighbouring countries.
I.9	2.F.1 Refrigeration and air conditioning – HFCs (I.12, 2016), (I.12, 2015) Transparency	Provide in the NIR the methods (IPCC tier or country specific), AD and EFs applied to estimate HFC emissions during manufacture, operation, disposal and recovery (occurring during disposal phase) for the reporting of refrigeration and air-conditioning categories, especially commercial refrigeration and stationary air-conditioning categories.	Not resolved. The NIR (pp.344–346) does not include more information on the selection of EFs or on AD used to estimate emissions from disposal for these subcategories. During the review, the Party explained that more information will be included in its next annual submission.
I.10	2.F.6 Other applications (product uses as substitutes for ozone-depleting substances) – SF6 (I.5, 2016) (I.5, 2015), (43, 2014) (41, 2013) Transparency	Provide a more detailed explanation in the NIR of the country-specific methodologies and AD used to estimate SF6 emissions from electrical equipment.	Resolved. Additional details are given in the NIR (section 4.8.2). High voltage electrical equipment is charged with SF_6 on site, and the relevant EF is provided and explained in the NIR. The corresponding AD are given in CRF table 2(II)B-Hs2.

Agriculture

| A.1 | 3. General (agriculture) | Include in the NIR information related to the complete revision that was | Not resolved. During the review, Luxembourg indicated that it would include the summary |

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
	(A.5, 2016), (A.5, 2015) Transparency	undertaken in the agriculture sector, preferably in the sector overview section as well as elaborating as appropriate in the other sections, in order to the enhance the transparency and understanding of issues that are affected by the revision.	information on the revision of the agriculture sector in the next NIR.
A.2	3.B Manure management – CH_4 and N_2O (A.1, 2016), (A.1, 2015), (49, 2014) Transparency	Describe the changes in the estimation of CH_4 emissions from manure management in the NIR.	Resolved. The NIR (p.397) mentions that the shares of animal waste management systems for all animal categories were revised in 2010 based on a survey of agricultural production methods. The shares for the years 2000–2016 were derived from the 2010 survey.
A.3	3.B Manure management – CH_4 (A.6, 2016), (A.6, 2015) Transparency	Report on the values used for the methane conversion factor from the anaerobic digester, particularly in relation to or comparison with the recommendation in the ARR 2014 (para. 49).	Addressing. The NIR (section 5.3.3.1, tables 185 and 186) indicates the sources for these parameters. However, the NIR does not include the specific methane conversion factor values that were used for CH_4 emissions from manure management for anaerobic digesters. The Party provided those values during the review and explained that it will include them in the next annual submission.
A.4	3.B.1 Cattle – N_2O (A.8, 2016), (A.8, 2015) Transparency	Include all the necessary explanations, information and references on the Nex from dairy cows in the NIR.	Addressing. The NIR (p.403) reports the equation used to estimate Nex for dairy cows based on milk production information. However, the NIR does not include the reference used as the basis for the relationship between Nex and milk production and nitrogen content of urea. The Party provided a reference (DLG, 2008) during the review.
A.5	3.D Direct and indirect N_2O emissions from agricultural soils – N_2O (A.3, 2016), (A.3, 2015), (52, 2014) Transparency	Describe the methodology for the revision of the estimation of Nex used for mature dairy cattle in the NIR.	Resolved. The NIR (pp.402–404) explains the estimation of Nex for dairy cattle.
A.6	3.G Liming – CO_2 (A.10, 2016), (A.10, 2015) Accuracy	Include in the NIR refined documentation on the level of use of both dolomite and limestone and indicate this reporting of emissions from agricultural applications of these carbonates in IPPU under other process uses of carbonates.	Addressing. The NIR (p.408) indicates that data on dolomite remain unavailable. AD and emissions from liming with dolomite continue to be reported as "NO" in CRF table 3.G-I. The emission estimates from this category are based on the EF of limestone (0.12 t CO_2/t limestone). The ERT noted that this would result in an underestimate of emissions if the dolomite is also used, because it has a slightly higher EF (0.13 t CO_2/t dolomite). During the review, the Party informed the ERT that the estimates for emissions from liming are not correct, because only dolomite has been used in Luxembourg. The Party also provided provisional estimations, which are slightly higher than the official estimates reported (e.g. for 2016 the preliminary calculations are 341 t CO_2 higher than the emissions reported in the CRF tables). The ERT

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
			noted that the underestimation is below the significance threshold established in the UNFCCC Annex I inventory reporting guidelines (5.01–5.61 kt CO_2 eq for 2013–2016 for the 2018 annual submission).
A.7	3.H Urea application – CO_2 (A.9, 2016), (A.9, 2015) Transparency	Explain how the Party estimated CO_2 emissions from urea application.	Resolved. The Party reported the emissions as "NE" and provided the justification for the use of the notation key "NE" in terms of the significance threshold established in the UNFCCC Annex I inventory reporting guidelines; specifically, the emissions from this category are below the significance threshold established in the UNFCCC Annex I inventory reporting guidelines (5.01–5.61 kt CO_2 eq for 2013–2016 for the 2018 annual submission) (NIR pp.424 and 425 and CRF table 3s2).

LULUCF

ID#	Issue and/or problem classification	Recommendation made in previous review report	ERT assessment and rationale
L.1	4. General (LULUCF) – (L.1, 2016), (L.1, 2015) (58, 2014) (53, 2013) (83, 2012) (99, 2011) (64, 2010) Transparency	Improve the transparency of the reporting by providing references for LULUCF and KP-LULUCF activities in a systematic manner with references for EFs and AD that were provided in earlier reports (e.g. the meaning of "IFL1" in the NIR (2014, p.367); the soil carbon content of various land uses; the country-specific value for carbon stock of forest land biomass before conversion; the annual volume increment of species other than spruce, Douglas fir, beech and oak).	Resolved. The NIR (section 6.2) provides references to below- and above-ground biomass growth rate factors, biomass expansion factors, deadwood and root to shoot ratios reported in the NFI; for non-forest land it refers mostly to default values in the 2006 IPCC Guidelines and for perennial cropland it refers to information from the Agriculture Technical Services Administration. Information on country-specific soil carbon, carbon stocks by soil type and land use is also provided by the Agriculture Technical Services Administration.
L.2	4. General (LULUCF) – (L.2, 2016) (L.2, 2015) (59, 2014) (55, 2013) (86, 2012) (102, 2011) (66, 2010) Adherence to the UNFCCC Annex I inventory reporting guidelines	Improve the QC procedures, in particular regarding references for EFs and AD, and regarding consistency between the NIR and the CRF tables.	Resolved. The references to EFs and AD as identified in the previous review report has been resolved (see ID# L.1 above). The ERT determined that the inconsistency between the NIR and CRF tables initially identified had already been resolved through a previous annual submission.
L.3	4. General (LULUCF) – (L.3, 2016) (L.3, 2015) (60, 2014) Adherence to the UNFCCC Annex I inventory reporting guidelines	Report the uncertainty analysis for LULUCF in accordance with the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* and transparently describe the method used to estimate the uncertainty.	Resolved. Luxembourg included a new section in the NIR (section 6.8) which includes the calculations of uncertainties for biomass EFs (section 6.8.1), areas (section 6.8.2), soil EFs (section 6.8.3) and biomass carbon stocks (section 6.8.4), including uncertainties for land-use categories.
L.4	4. General (LULUCF) – all gases (L.12, 2016)	Report GHG inventory estimates using a tier in accordance with the 2006 IPCC Guidelines.	Resolved. The ERT did not identify any instances where Luxembourg did not use tier levels in accordance with the 2006 IPCC Guidelines.

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
	(L.12, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines		
L.5	4. General (LULUCF) – CO_2 (L.13, 2016) (L.13, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Report uncertainty estimates for all land categories.	Resolved. Luxembourg included a new section in the NIR (section 6.8), which includes the calculations of uncertainties for all categories (see ID# L.3 above).
L.6	4. General (LULUCF) – all gases (L.14, 2016) (L.14, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Ensure accuracy in the NIR text, tables and figures and consistency between the NIR and CRF tables, and improve its QC procedures.	Addressing. Inconsistencies between the NIR and CRF tables that were identified in the previous review report remain in the 2018 annual submission. Specifically, in table 203 of the NIR (p.428) the trend of LULUCF emissions is a decrease by –1,215.94 per cent and in CRF table 10 it is –1,115.94 per cent.
L.7	4.A.1 Forest land remaining forest land – CO_2 (L.4, 2016) (L.4, 2015) (61, 2014) Accuracy	Reproduce the entire time series of harvest statistics, provide an explanation for the inconsistency between harvesting trends and carbon stock changes in living biomass and investigate the discrepancy between STATEC and FAOSTAT data on harvest.	Resolved. Revised data from the forest agency have been updated in STATEC and are consistent with the data in FAOSTAT and provided for the entire time series. The harvesting trends are reflected in the carbon stock changes in living biomass.
L.8	4.C.2 Land converted to grassland – CO_2 (L.11, 2016) (L.11, 2015) (67, 2014) Adherence to the UNFCCC Annex I inventory reporting guidelines	Correct the NIR to ensure consistency between the NIR and the CRF tables.	Resolved. Luxembourg used a default value of 20 years to correctly distinguish remaining and converted land areas and then corrected changes between cropland and grassland from the land-use change data using expert judgment (1989–2010) and the new LPIS system (2010–2016) to correct for the bias from misinterpretation of the change detection method. This is appropriately explained in the NIR (section 6.4.4.2).
Waste			
W.1	5. General (waste) – CO_2, CH_4 and N_2O (W.5, 2016) (W.5, 2015) Adherence to the UNFCCC Annex I inventory	Ensure the consistency of the information on trends and category codes between the NIR and the CRF tables.	Resolved. The Party corrected the inconsistencies described in the previous review report related to the data trends in the NIR and the CRF tables and references to wastewater treatment.

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
	reporting guidelines		
W.2	5.A Solid waste disposal on land – CH_4 (W.1, 2016) (W.1, 2015) (75, 2014) (70, 2013) (104, 2012) Transparency	Assess whether the assumption of the 90 per cent reduction for the MCF is valid for the Party's national circumstances and provide the results of this assessment.	Resolved. The Party applied MCFs of 0.4, 0.8 and 1.0 to unmanaged shallow, unmanaged deep and managed anaerobic landfills, respectively. The Party applied an MCF of 1 (IPCC default) for managed anaerobic landfills regardless of whether or not waste is pre-treated (in the 2016 annual submission the Party had used an MCF of 0.1 for pre-treated waste). The methodology and parameters used have been explained in the NIR (section 7.2.2.4.1, p.538).
W.3	5.A Solid waste disposal on land – CH_4 (W.6, 2016) (W.6, 2015) Completeness	Estimate the missing CH_4 emissions for 1990–1999 for the industrial solid waste disposal site (Ronnebierg) that was closed in the early 1990s; explain the methodology for estimating the emissions for the Ronnebierg site between 2000 and 2014; if the estimates were based on measurements, justify the representativeness of its monitoring.	Resolved. The Party estimated historical emissions from the industrial solid waste disposal site and provided information in the NIR (sections 7.2.2.1 and 7.2.2.4, p.536). The NIR also explains that the emissions are estimated based on the amount and type of waste deposited and the measurements performed since 2000.
W.4	5.A.1 Managed waste disposal sites – CH_4 (W.7, 2016) (W.7, 2015) Transparency	Explain the choice of MCF and DOC values in the NIR.	Resolved. The Party used 1 for the MCF value for managed anaerobic landfills and provided an explanation in its NIR (section 7.2.2.4.1, p.538). Regarding DOC values, the NIR (p.532) indicates that values for municipal solid waste and bulky waste are based on waste composition. The NIR (table 244) provides additional details on the DOC values.
W.5	5.A.1 Managed waste disposal sites – CH_4 (W.8, 2016) (W.8, 2015) Transparency	Provide appropriate documentation and references so that the reported emission estimates are transparent and steps in their calculation may be retraced.	Resolved. Appropriate documentation and references are provided in the NIR (section 7.2.2.4.1, p.538).
W.6	5.A.1 Managed waste disposal sites – CH_4 (W.9, 2016) (W.9, 2015) Completeness	Include the missing CH_4 emissions for the one industrial solid waste disposal site for the years 2000–2014 in CRF table 5.A.	Resolved. The emissions are reported in the NIR (table 246, p.536) and CRF table 5.A.
W.7	5.B.1 Composting – CH_4 and N_2O (W.10, 2016) (W.10, 2015) Transparency	Include information on whether private composting by households is included in the emission estimates in the NIR.	Resolved. Information is provided in the NIR (section 7.3.2.1.1, pp.546 and 547): the collection scheme for biodegradable waste covers all households and the amounts collected are included in AD for composting.
W.8	5.B.2 Anaerobic digestion at biogas facilities – CH_4 and N_2O (W.11, 2016)	Explain how CH_4 emissions from anaerobic digestion facilities are estimated.	Resolved. Information is provided in the NIR (section 7.3.3, pp.551–555). The Party has estimated these emissions using the default IPCC method (2006 IPCC Guidelines, vol. 5, chapter 5, section 4.1.1). For leakage, the Party assumed 3.1 per cent of the CH_4 produced based on Flesch et

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
	(W.11, 2015) Transparency		al. (2011) and Dumont et al. (2013). That value is within the IPCC default range of 0–10 per cent.
W.9	5.C.2 Open burning of waste – CO_2, CH_4 and N_2O (W.12, 2016) (W.12, 2015) Transparency	Include a paragraph in the NIR with information on the national ban on the open burning of all types of waste in the open air with references to the national legislation.	Resolved. Information is provided in the NIR (section 7.1.5, pp.524 and 525). The NIR indicates that uncontrolled management of waste including open burning of waste is prohibited by national law (Article 42 of the law on waste of 18 December 2015).
W.10	5.D Wastewater treatment and discharge – N_2O (W.2, 2016) (W.2, 2015) (77, 2014) Accuracy	Review the N_2O EF for plants with significant denitrification and use a consistent methodology to estimate these emissions.	Not resolved. During the review, the Party explained that it has tried to validate the country-specific approach and determined that it has limitations. Therefore, Luxembourg will use the tier 1 approach of the 2006 IPCC Guidelines (vol. 5, chapter 6, page 6.25) starting from its 2019 annual submission until new information and data become available to validate the country-specific approach. The ERT believes that future ERTs should consider this issue further to ensure that there is not an underestimate of emissions.
W.11	5.D Wastewater treatment and discharge – N_2O (W.3, 2016) (W.3, 2015) (79, 2014) Accuracy	Take into account the nitrogen removed in the sludge spread on agricultural fields when estimating the N_2O emissions from wastewater in order to avoid double counting; revise the method to estimate N_2O emissions from wastewater handling.	Not resolved. During the review, the Party explained that it has tried to validate the country-specific approach and determined that it has limitations. Therefore, Luxembourg will use the tier 1 approach of the 2006 IPCC Guidelines (vol. 5, chapter 6, page 6.25) starting from its 2019 annual submission until new information and data become available to validate the country-specific approach.
W.12	5.D.1 Domestic wastewater – CH_4, N_2O (W.13, 2016) (W.13, 2015) Accuracy	Use the data from the 2011 census to improve the accuracy of CH_4 and N_2O emissions from this category.	Resolved. The Party, in its NIR (p.562), explained that new census data were used in the emission estimations. NIR figure 7-15 (p.566) shows the time series of population connected to a sewage system and wastewater treatment plant.
W.13	5.D.1 Domestic wastewater – N_2O (W.14, 2016) (W.14, 2015) Accuracy	Implement the results of the study on revising the calculation of emissions from wastewater treatment, taking into account the recommendations of earlier reviews.	Addressing. During the review, the Party explained that it has tried to validate the country-specific approach and determined that it has limitations. Therefore, Luxembourg will use the tier 1 approach of the 2006 IPCC Guidelines (vol. 5, chapter 6, p.6.25) starting from its 2019 annual submission until new information and data become available to validate the country-specific approach.
W.14	5.D.3 Other (wastewater treatment and discharge) – N_2O (W.4, 2016) (W.4, 2015) (78, 2014) Accuracy	Review the estimates from all discharges of wastewater, including those from wastewater plants, to confirm there are no underestimates, and that all N_2O emissions are estimated and nitrogen removal at these plants should be considered in the estimates.	Addressing. During the review, the Party explained that the country-specific approach has limitations. Therefore, Luxembourg will use the tier 1 approach of the 2006 IPCC Guidelines (vol. 5, chapter 6, p.6.25) starting from its 2019 annual submission until new information and data become available to validate the country-specific approach. The ERT believes that future

ID#	Issue and/or problem classification[a,b]	Recommendation made in previous review report[b]	ERT assessment and rationale
			ERTs should consider this issue further to ensure that there is not an underestimate of emissions.

KP-LULUCF

KL.1	General (KP-LULUCF) (KL.6, 2016) (KL.6, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Estimate and report uncertainty for each KP-LULUCF activity.	Resolved. The NIR (section 11.3.1.5, figures 11-10 to 11-12) presents the uncertainties for each KP-LULUCF activity.
KL.2	AR – CO$_2$ (KL.7, 2016) (KL.7, 2015) Adherence to the UNFCCC Annex I inventory reporting guidelines	Ensure consistency of the information on carbon stock change for above-ground biomass between CRF tables and NIR data.	Addressing. CRF table (4KP-I) A.1 still reports a carbon stock change of 3.11 t C for above-ground biomass. The NIR (table 280) provides above-ground biomass gain values for different conversions to forest land, ranging from 0.07 to 3.12 t C/ha per year (0 to 20 years) and from 0.11 to 4.66 t C/ha per year (20 to 40 years). However, there is a lack of transparency between the numbers reported in the NIR and the CRF table, so the ERT was unable to verify the consistency of the data. The Party reports that the AR gains are calculated in the same manner as the gains under forest land in LULUCF reporting.
KL.3	AR – CO$_2$ (KL.7, 2016) (KL.7, 2015) Transparency	Provide information and references for biomass growth rates used for AR areas.	Addressing. Table 11.7 of the 2016 NIR had the wrong units (tdm/ha/year instead of t C/ha/year), which has been corrected in table 280 of the 2018 NIR. However, in the current table (table 280) the growth rates for areas, other than annual cropland converted to forest land, are wrong and should be constant: 3.12 t C/ha (0–20 years) and 4.66 t C/ha (20–40 years). References for growth rates have been provided in the NIR (section 11.3.1.1). Section 11.3.1.1 of the NIR, on AR, refers to the LULUCF chapter of the NIR for references to the EFs. The ERT noted that section 6.2.4.1.1 of the NIR, on carbon stock changes in living biomass for forest land remaining forest land, indicates that the calculation of gains in living biomass is mainly based on the results from the two forest inventories carried out in 2000 and 2010.
KL.4	AR – CO$_2$ (KL.8, 2016) (KL.8, 2015) Accuracy	Generate biomass growth rates separately for the conversion of different land categories to forest land.	Resolved. The NIR (p.456) explains that the NFI provides only 50 points for afforestation; correlation with other factors (soil maps, etc.) is not possible. Also, the NFI does not distinguish between cropland and grassland. Therefore, Luxembourg assumes that the growth rate does not vary by previous land use. The ERT agrees with this assumption.

[a] References in parentheses are to the paragraph(s) and the year(s) of the previous review report(s) where the issue and/or problem was raised. Issues are identified in accordance with paragraphs 80–83 of the UNFCCC review guidelines and classified as per paragraph 81 of the same guidelines. Problems are identified and classified as problems of transparency, accuracy, consistency,

19

completeness or comparability in accordance with paragraph 69 of the Article 8 review guidelines, in conjunction with decision 4/CMP.11.

[b] The review of the 2017 annual submission of Luxembourg did not take place during 2017 and, as such, the 2017 ARR was not available at the time of this review. Therefore, the recommendations reflected in table 3 are taken from the 2016 ARR. For the same reason, the year 2017 is excluded from the list of years in which the issue has been identified.

IV. Issues identified in three successive reviews and not addressed by the Party

9. In accordance with paragraph 83 of the UNFCCC review guidelines, the ERT noted that the issues included in table 4 have been identified in three successive reviews, including the review of the 2018 annual submission of Luxembourg, and have not been addressed by the Party.

Table 4
Issues identified in three successive reviews and not addressed by Luxembourg

ID#	Previous recommendation for the issue identified	Number of successive reviews issue not addressed[a]
General		
	No such general issues were identified	
Energy		
E.14	Review the possible double counting of emissions from leisure boats reported under navigation	3 (2014–2018)
IPPU		
I.1	Explain every recalculation such as the emissions from the solvent and other product use sector update of AD and EFs, and state correctly that recalculations have not been implemented in the solvent and other product use sector	3 (2014–2018)
Agriculture		
	No such issues for the agriculture sector were identified	
LULUCF		
	No such issues for the LULUCF sector were identified	
Waste		
W.10	Review the N_2O EF for plants with significant denitrification and use a consistent methodology to estimate these emissions	3 (2014–2018)
W.11	Take into account the nitrogen removed in the sludge spread on agricultural fields when estimating the N_2O emissions from wastewater in order to avoid double counting; revise the method to estimate N_2O emissions from wastewater handling	3 (2014–2018)
W.14	Review the estimates from all discharges of wastewater, including those from wastewater plants, to confirm there are no underestimates, and that all N_2O emissions are estimated and nitrogen removal at these plants should be considered in the estimates	3 (2014–2018)
KP-LULUCF		
	No such issues for KP-LULUCF activities were identified	

[a] The review of the 2017 annual submission of Luxembourg did not take place during 2017. Therefore, the year 2017 is not taken into account when counting the number of successive years in table 4. In addition, as the reviews of

the 2015 and 2016 annual submissions were held in conjunction with each other, they are not considered "successive" years and 2015/2016 is considered as one year.

V. Additional findings made during the individual review of the 2018 annual submission

10.   Table 5 contains findings made by the ERT during the individual review of the 2018 annual submission of Luxembourg that are additional to those identified in table 3.

Table 5
Additional findings made during the individual review of the 2018 annual submission of Luxembourg

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
General			
G.5	CPR	Luxembourg explained the calculation of the CPR in its NIR (pp.634 and 635). The ERT noted that the CPR reported is correct and it is 90 per cent of the assigned amount. However, to select the CPR, the Party compared 90 per cent of the assigned amount with 8 times the 2015 total emissions. The ERT noted that Luxembourg should have compared 90 per cent of the assigned amount with 8 times the latest inventory year reported (2016 in the 2018 annual submission).	Yes. Adherence to reporting guidelines under Article 7, paragraph 1, of the Kyoto Protocol
		The ERT recommends that the Party select its CPR as the lower value between 90 per cent of the assigned amount and the value of 8 times the latest inventory year reported in the annual submission.	
G.6	Follow-up to previous reviews	Luxembourg reported revisions since the previous annual submission in the NIR (chapter 10, table 264) and planned improvements including those in response to the review process (table 273). During the review, Luxembourg provided the ERT with a detailed inventory improvement plan, which tracks inventory improvement tasks and includes specific references to inventory improvements already implemented in the NIR and CRF tables. The NIR tables do not currently provide this level of detail.	Not an issue/problem
		The ERT encourages Luxembourg to include its inventory improvement plan in the NIR, especially details of where in the NIR and CRF tables the improvements have been implemented, to assist future ERTs in assessing progress on recommendations.	
G.7	National system	Luxembourg outlines plans to develop a centralized database system (Seven2One) to perform the key functions of inventory compilation and to improve integration between the national inventory system and the CRF Reporter system in the NIR (p.62). During the review, Luxembourg identified resource constraints as the main impediment to the introduction of this system. The ERT welcomes this plan as it will represent a significant improvement to the national system by providing standardized GHG estimation, QC, metadata and archiving functionality.	Not an issue/problem
		The ERT encourages Luxembourg to allocate sufficient financial and human resources to this task and to consider an incremental introduction of database functionality sector by sector.	
G.8	National system	In the NIR (p.54) Luxembourg reports the introduction in 24 April 2017 of a new Grand Ducal Regulation defining the key elements of the national system. Key changes introduced by this new regulation include the designation of the Minister for the Environment as the single national entity, and the definition and allocation of specific responsibilities for the preparation of GHG inventories within the single national entity and other administrations and entities involved in the preparation of the inventory.	Yes. Adherence to reporting guidelines under Article 7, paragraph 1, of the Kyoto Protocol

ID#	Finding classification	Description of the finding with recommendation or encouragement	*Is finding an issue and/or a problem?[a] If yes, classify by type*
		The ERT considers these changes to be important improvements to the national system and recommends that Luxembourg detail the key changes introduced by the Grand Ducal Regulation of 24 April 2017 in the NIR, chapter 13 (information on changes in the national system).	
G.9	National system	During the review, Luxembourg provided details of human resources allocated to the delivery of the inventory submission on an annual basis. Recent personnel changes in the agricultural compilation function have highlighted a potential vulnerability of the national system to losses of knowledge due to changes in human and other resources. The ERT recognizes that the revised and very detailed QA checklist provided during the review includes an annual system audit function that will help to identify resourcing issues affecting the preparation of the inventory early in the process, and encourages Luxembourg to implement this new audit functionality for its next inventory preparation cycle and to ensure that adequate human resources are provided to minimize the potential vulnerability of the national system due to the unexpected loss of knowledge. The ERT further encourages Luxembourg to develop inventory technical preparation manuals for each sector as a way of ensuring continuity in the inventory compilation process in the event of personnel changes.	Not an issue/problem
G.10	NIR	The previous ERT encouraged the Party to provide information on key categories, uncertainty analyses, methodology descriptions and the energy balance in the annexes to its NIR (ARR 2016, ID# G.4 in table 5). Although annexes are included in the NIR, in the case of the key category analysis and uncertainty, these mostly refer back to the main sections of the NIR that contain discussions of these inventory elements (sections 1.5 and 1.7, respectively). The ERT therefore reiterates the encouragement for the Party to follow the outline and general structure of the NIR contained in the UNFCCC Annex I inventory reporting guidelines. Specifically, the ERT encourages the Party, in these annexes, to expand on discussions of key categories and uncertainty methods used, levels of disaggregation and tables, as specified in the NIR outline.	Not an issue/problem
G.11	Uncertainty analysis	Luxembourg reported a tier 1 uncertainty analysis in its NIR (p.84). The ERT noted the following inconsistencies in emissions and uncertainty values reported in table 14 of the NIR: (a) Emissions of N_2O from liquid fuels consumed in navigation include N_2O emissions from biomass; (b) Uncertainty values for the combined uncertainty for CH_4 and N_2O for agriculture (4 per cent and 121 per cent, respectively) are inconsistent with those reported in table 202 of the sectoral chapter for agriculture (3.4 per cent and 125.9 per cent, respectively); (c) Uncertainty values for CH_4 and N_2O for categories 1.A.3.c and 1.A.3.d liquid fuels have not been updated from previous values as identified by the Party during the review (e.g. 1.A.3.c liquid fuels CH_4 – 150 per cent, N_2O – 200 per cent should both be 20 per cent and 1.A.3.d liquid fuels CH_4 – 50 per cent, N_2O – 140 per cent should both be 20 per cent).	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
		Although the ERT considers these inconsistencies to be minor and easily corrected, they do impact the final total uncertainty values which become 4.75 per cent (level including LULUCF) and 5.49 per cent (trend including LULUCF) when these issues are corrected, compared with 4.68 per cent (level) and 5.41 per cent (trend) as reported in the NIR.	
		The ERT recommends that the Party correct the inconsistencies in the uncertainty analysis regarding emissions of N_2O from liquid fuels consumed in navigation to exclude biomass, the combined uncertainty values for CH_4 and N_2O for agriculture, and the outdated uncertainty values for CH_4 and N_2O for categories 1.A.3.c and 1.A.3.d liquid fuels, and improve its QC processes for reporting on uncertainty by including a check of total emissions from the uncertainty table against the total emissions in the CRF tables to identify any differences and to ensure input uncertainties are updated each year.	
G.12	Uncertainty analysis	Luxembourg indicated in its NIR (p.84) that a tier 2 uncertainty analysis will only be carried out if important methodological changes have occurred. The Party also indicated in the NIR that the last tier 2 analysis was carried out in 2011. During the review, the Party explained that, in particular, a new tier 2 uncertainty analysis will be undertaken when some major methodology changes in the waste and agriculture sectors are completed, and that the Party plans to perform a tier 2 analysis for the 2019 annual submission.	Not an issue/problem
		The ERT encourages Luxembourg to implement a new tier 2 uncertainty analysis across all sectors. Furthermore, the ERT encourages Luxembourg to use this updated uncertainty analysis to also complete a tier 2 key category analysis.	
G.13	QA/QC and verification	The Party reported in its NIR (p.83) that it currently outsources its QA/QC management functions but has plans to internalize its QA/QC functionality during 2018. During the review, the Party explained that resource constraints had been an impediment to the realization of this aim for the 2018 annual submission.	Not an issue/problem
		The ERT commends the Party for this planned improvement to the national system and encourages Luxembourg to ensure adequate human and financial resources to be able to complete this process in time for the 2019 annual submission, noting that the Party shall ensure this change to its national system is adequately documented (in the NIR, section 1.6 and in chapter 13 – information on changes to the national system).	
G.14	QA/QC and verification	In the NIR (section 1.6.6.1), the Party documented the QC procedures undertaken as part of the inventory compilation process, including checklists for data validation to be completed by sectoral experts. During the review, the ERT was able to review a sample of hard copies of completed checklists but was not able to verify that these checklists had been saved to the Party's archives prior to submission for all sectors. The ERT also noted that not all checklists had been archived electronically.	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines
		The ERT recommends that Luxembourg ensure that data validation checklists are completed prior to submission for every sector, for each annual submission, and stored on the Party's central archiving system in electronic format.	

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
Energy			
E.16	Fuel combustion – reference approach – liquid fuels – CO_2	Since the year 2000, the reference approach has consistently been reporting a higher level of emissions from liquid fuels compared with the sectoral approach (e.g. 0.2 per cent for 2015 and 0.4 per cent for 2016). The trend across years is increasing and the difference for 2016 is 26.8 kt CO_2 (0.4 per cent). Most of this difference is due to the use of bitumen and lubricants, which are included in the reference approach but not the sectoral approach. The ERT noted that, after taking non-energy use into account, the difference mostly disappears except for 2016, where the apparent energy consumption is still 180 TJ higher (0.2 per cent) than fuel consumption reported under the sectoral approach. During the review, the Party reported that the difference can be attributed to an error which occurred in the reference approach for jet kerosene. In 2016, 4.41 kt (190.05 TJ) of jet kerosene were exported according to the energy balance. This was the first year such an export took place. However, this was not reflected in the reference approach, and the 190.05 TJ were reported as apparent consumption instead (see CRF table 1.A(b) for 2016, cell M12). As a consequence, the consumption of liquid fuels reported in the sectoral approach is 10 TJ higher than the reference approach. The ERT recommends that the Party correct the reference approach to include the 190.05 TJ of jet kerosene exported in 2016 to ensure comparability with the sectoral approach.	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines
E.17	Fuel combustion – reference approach – liquid fuels – CO_2	The ERT noted that there are discrepancies between CRF tables 1.D and 1.A(b) for jet kerosene (international aviation bunkers) for the years 1990 to 1999 and 2010. The largest difference is in 1998, with 11,853 TJ reported in CRF table 1.A(b) (275.00 kt times 43.105 TJ/kt) versus 12,492.22 TJ in CRF table 1.D. During the review, the Party explained that there seems to be an error in the estimates reported in CRF table 1.A(b) because the values in CRF table 1.D are correct, and that further investigation is needed on the source of the error in CRF table 1.A(b). The ERT recommends that the Party identify the sources of error and correct all discrepancies in jet kerosene for international aviation between CRF table 1.D and CRF table 1.A(b) for all years.	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines
E.18	1.A. Fuel combustion – sectoral approach – liquid fuels – CO_2	Luxembourg imports liquid fuels pre-blended with biofuels, including gasoline containing biogasoline and gas/diesel oil containing biodiesel. The ERT noted that liquid biofuel supply chains can extend through multiple countries and without strict certification practices along the way the authenticity of the delivered product can be uncertain. The ERT has identified a number of international reports of inaccurate blending practices or fraud occurring, where the actual biofuel fraction is lower than the advertised composition (e.g. Reddy et al., 2008) and provided the references to the Party during the review. During the review, the Party explained that the fuel importers provide certificates to the Party to assure the biofuel content of the fuel blends. The Party also explained that it has access to an online registry where a number of European countries can track parts of the biofuel supply chain. However, the ERT did not view this registry and an audit of it is beyond the scope of this review. The ERT recommends that the Party provide in the NIR information on the biofuel import certificates and the registry system. The ERT encourages the Party to investigate the possibility of testing fuel, using carbon 14 dating or a similar suitable method, to verify the biofuel fraction of fuel sold in Luxembourg.	Yes. Transparency

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
E.19	1.A. Fuel combustion – sectoral approach – liquid fuels – CO_2, CH_4 and N_2O	The ERT noted that Luxembourg imports liquid fuels pre-blended with biofuels from other countries, including gas/diesel oil containing biodiesel (FAME). The ERT also noted that Luxembourg reported CO_2, CH_4 and N_2O emissions from biomass used in road transportation in CRF table 1.A(a)s3 for the period 2004–2016. For "other fossil fuels" and for "other liquid fuels" the Party reported AD and emissions as "NO" in the same table. The Party reported in the NIR (p.244) that "For biogasoline (ethanol, ETBE) and biodiesel (FAME, HVH, HVP), European CO_2 IEFs for gasoline and diesel oil, respectively, were used as EFs". (HVH and HVP refer to types of vegetable oil). During the review, the Party clarified that no ETBE has been used as biofuel, and confirmed that FAME is sold in Luxembourg and that no CO_2 emissions from FAME have been considered fossil emissions; therefore all emissions were reported as biomass. The ERT noted that the 2006 IPCC Guidelines (vol. 2, chapter 3, p.3.17, section "CO_2 emissions from biofuels",) state that "to avoid double counting, over or under-reporting of CO_2 emissions, it is important to assess the biofuel origin so as to identify and separate fossil from biogenic feedstocks" and, in a footnote on the same page, that FAME biodiesel produced using methanol as a feedstock will contain fossil carbon if the methanol is produced from a fossil fuel (e.g. natural gas). The ERT also noted that "worldwide, almost all methanol is made by way of steam reforming of natural gas" (2006 IPCC Guidelines, vol. 3, chapter 3, p.3.58, section "Methanol"). The ERT further noted that measurements based on radiocarbon analysis performed on a range of pure (B100) FAME biodiesels found that 5.4 per cent of the carbon was of fossil origin (Reddy et al., 2008: table 2).	Yes. Transparency
		The ERT included this issue in the list of potential problems and further questions raised by the ERT during the review. In response to this list, the Party submitted revised estimates on 15 November 2018. That submission included revised estimates for emissions of CO_2 (as well as very small revisions for CH_4 and N_2O) from the use of the fossil fraction of biodiesel for categories 1.A.2.g.vii (off-road vehicles and other machinery), 1.A.3 (transport), reported under a new category (other fossil fuels – biodiesel (fossil component)) for cars, light- and heavy-duty trucks, railways and domestic navigation, 1.A.4.c (agriculture/forestry/fishing) and 1.A.5.b (mobile). That submission also included revised estimates for emissions of CO_2 (as well as very small revisions for CH_4 and N_2O) from the use of the biogenic fraction of biodiesel for all categories where the activity was occurring. These estimates assumed that the default composition of FAME is constant throughout the years and equal to the detailed composition of the FAME mixture sold in Luxembourg in 2017 (no detailed information was available for earlier years), which indicated that 5.4 per cent of the carbon atoms in the biodiesel were of fossil origin. For example, for 2016, the results of these changes were that, for category 1.A.2.g.vii, CO_2 emissions from biomass increased by 0.45 kt CO_2 , for category 1.A.3, CO_2 emissions increased by 12.95 kt CO_2 (12.93, 0.02 and 0.003 kt CO_2 from road transportation, railways and domestic navigation, respectively), for category 1.A.4.c, CO_2 emissions increased by 0.07 kt CO_2 and, for category 1.A.5.b, CO_2 emissions increased by 0.0003 kt CO_2. Regarding CH_4 emissions, for 2016 the revisions increased CH_4 emissions for category 1.A.4.c by 1×10^{-14} kt and decreased CH_4 emissions for category 1.A.5.b by 1×10^{-14} kt. Regarding N_2O emissions, for 2016 the revisions increased N_2O emissions for categories 1.A.2.g and 1.A.5.b (by 1×10^{-14} kt in both cases) and decreased N_2O emissions from road transportation (by 1×10^{-14} kt). As a result, the revised estimates increased national totals by 13.46 kt CO_2 eq, or 13.4 per cent, for 2016. The ERT agrees with the estimates and considers that the potential issue has been resolved.	

		The ERT recommends that the Party include in the NIR details of the method and data used to estimate CO_2, CH_4 and N_2O emissions from the fossil fraction of biodiesel.	
E.20	1.A.3.b Road transportation – liquid fuels – CH_4	In 2016, the CH_4 IEFs for gasoline and diesel cars (2.15 and 0.14 kg/TJ, respectively) are among the lowest from reporting Parties (ranging from 1.79 to 33.0 kg/TJ for gasoline cars and 0.08 to 4.82 kg/TJ for diesel cars). Furthermore, the CH_4 IEF for diesel light-duty trucks (0.08 kg/TJ) and heavy-duty trucks (0.07 kg/TJ) are the lowest among reporting Parties (ranging from 0.08 to 8.04 kg/TJ for light-duty trucks and 0.07 to 12.35 kg/TJ for heavy-duty trucks). During the review, the Party explained that CH_4 EFs for road transportation originate from the HBEFA 3.3 database (available at http://www.hbefa.net/e/index.html) and emissions were determined by the NEMO model, and that the reason for the relatively low CH_4 IEFs is that both the national and the transiting fleet (all vehicle types, i.e. passenger cars for commuters and heavy-duty vehicles) are very modern and thus equipped with more efficient combustion and emission control systems than in most other countries. The Party reported in its NIR (p.243) that it assumes that the composition of the trans-border fleet is identical to the domestic fleet, although supporting evidence has not been provided to justify this assumption. The ERT considers that the composition of the trans-border fleet may be somewhat different to the domestic fleet, in which case different CH_4 EFs would be applicable. The ERT believes that future ERTs should consider this issue further to ensure that there is not an underestimate of emissions.

The ERT recommends that the Party provide justification of the applicability of domestic fleet CH_4 EFs to the trans-border fleet, or adopt an alternative approach, such as using default CH_4 EFs for the trans-border fleet. | Yes. Transparency |
| E.21 | 1.A.3.b Road transportation – liquid fuels (diesel) – CH_4 and N_2O | The Party reported in its NIR (p.243) that the shares of gasoline- and diesel-fuelled cars in the trans-border fleet are used to determine the amount of diesel used by cars in the trans-border fleet. The remainder of trans-border diesel use is allocated to heavy-duty vehicles. During the review, the Party clarified that the shares of gasoline- and diesel-fuelled cars in the trans-border fleet are assumed to be the same as the shares for the cars in the domestic fleet, and that specific data on the composition of the trans-border fleet are not currently available. The ERT considers that this assumption could lead to a potential misallocation of diesel use between cars and heavy-duty vehicles which have quite different emission profiles for CH_4 and N_2O. The ERT believes that future ERTs should consider this issue further to ensure that there is not an underestimate of emissions.

The ERT recommends that the Party justify the assumptions underlying the estimation of the diesel used by trans-border cars and heavy-duty vehicles, including the assumptions on the shares of the gasoline- and diesel-fuelled cars in the trans-border fleet, or use an alternative approach to avoid a possible underestimation of CH_4 and N_2O emissions. | Yes. Transparency |
| E.22 | 1.A.3.b Road transportation – liquid fuels – CO_2 | The Party reported in its NIR (p.188) that country-specific CO_2 EFs for liquid fuels are derived from the EFs reported in the NIRs of the corresponding source countries (primarily Belgium, the Netherlands and Germany) relative to the annual quantities imported. During the review, the Party explained that it has been participating in a multilateral study to more accurately characterize liquid transport fuels. A survey (and testing) of various fuels sold in Luxembourg found that there was significant variation in the carbon content between companies. The Party acknowledged that it may be possible to obtain refinery-specific EFs for some imports, which would be more | Not an issue/problem |

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
		accurate than using a national average EF of the source countries (primarily from Belgium, the Netherlands and Germany), especially for the case of a large country such as Germany which may have significant regional variation. However, the Party also informed the ERT that refineries will likely not be forthcoming in providing such data. The ERT encourages the Party to acquire refinery-specific CO_2 EFs for fuel imports from those refineries from which Luxembourg imports most of its liquid fuels, and report on the outcome in the NIR.	
E.23	1.A.4.a Commercial/ institutional – biomass – CO_2, CH_4 and N_2O	The Party reported in table 107 of its NIR (p.257) that IPCC default EFs (for CO_2, CH_4 and N_2O) are used to estimate emissions for biogas (no other biomass is listed); however, the ERT noted that NIR table 108 (p.258) gives the IEFs for biomass which show significant differences across the whole time series. During the review, the Party explained that since 2000, in addition to biogas, wood and wood waste are also used for heat production, and that the annually changing fuel mix explains the variation of the IEFs. For wood and wood waste the following IPCC default EFs from the 2006 IPCC Guidelines (vol. 2, chapter 2, p.2.20, table 2.4) were used: CO_2, 112,000 kg/TJ; CH_4, 300 kg/TJ; N_2O, 4 kg/TJ. The ERT recommends that the Party update the NIR text with the description of biomass fuel types and choice of EFs, and correct the entries in NIR table 107.	Yes. Transparency
E.24	1.A.4.b Residential – liquid fuels – CH_4 and N_2O	The Party reported in its NIR (p.249) that mobile residential gasoline consumption was allocated to household and gardening use by assuming an average of 0.57 motorized gardening tools per household. However, the ERT noted that this estimate will only capture residential gasoline use in Luxembourg, and does not take into account trans-border commuters who may also purchase fuel in Luxembourg for off-road use. During the review, the Party informed the ERT that it was possible that small quantities (e.g. jerrycans) of fuel sold to trans-border commuters at petrol stations could be used for non-transport purposes, but that the unauthorized transport of larger quantities (e.g. mini tankers) of fuel across the border was prohibited. The ERT believes that future ERTs should consider this issue further to ensure that there is not an underestimate of emissions. The ERT recommends that the Party gather more information on potential off-road fuel use by commuters (e.g. export in jerrycans for household and gardening use) to estimate the quantity of fuel sold to trans-border commuters and likely used for non-transport purposes such as motorized gardening equipment and off-road vehicles, estimating the associated emissions, revising the emissions for road transportation accordingly and describing the estimations in the NIR.	Yes. Accuracy
E.25	1.A.4.b Residential – liquid fuels – CH_4	In table 110 of the NIR (p.261), Luxembourg reported the use of a country-specific CH_4 EF for gasoline in 2016 of 26.90 kg/TJ. This also aligns with the CH_4 IEF reported in CRF table1.A(a)s4 for liquid fuels in off-road vehicles and other machinery (26.9 kg/TJ). The ERT noted that the IPCC default CH_4 EF for household 2-stroke gasoline engines is 180 kg/TJ (2006 IPCC Guidelines, vol. 2, p.3.36, table 3.3.1), significantly higher than the EF used by the Party. During the review, the Party explained that its CH_4 EF was based on EFs from the 1999 core inventory of air emissions (CORINAIR) and that it plans to update these to EFs from the *EMEP/EEA Air Pollutant Emission Inventory Guidebook* (available at https://www.eea.europa.eu/themes/air/emep-eea-air-pollutant-emission-inventory-	Yes. Accuracy

		guidebook/emep) in its 2019 annual submission. The ERT believes that future ERTs should consider this issue further to ensure that there is not an underestimate of emissions.	
		The ERT recommends that the Party revise the CH_4 EF for residential use of gasoline, and if the Party chooses a non-IPCC default EF, include in the NIR a justification of its applicability to Luxembourg.	
E.26	1.B.2.b Natural gas – CO_2 and CH_4	The Party reported in its NIR (p.274) the use of the IPCC default EFs for natural gas transmission, namely 8.8×10^{-7} Gg $CO_2/10^6$ m^3 marketable gas and 2.7×10^{-4} Gg $CH_4/10^6$ m^3, which are for gas transmission – fugitives (2006 IPCC Guidelines, vol. 2, p.4.49, table 4.2.4). During the review, the ERT asked the Party to confirm that venting (such as blowdown, purging and emergency relief events) from transmission pipelines and associated infrastructure was not occurring in Luxembourg. The Party explained that it contacted the transmission network operator which informed the Party that such venting does occur from time to time during maintenance work, and that some recent records do exist of these venting occurrences but that the amount of venting is quite small. The Party also indicated to the ERT that it may be able to obtain a historical time series of venting. The ERT believes that future ERTs should consider this issue further to ensure that there is not an underestimate of emissions.	Yes. Accuracy
		The ERT recommends that the Party include emissions and AD estimates for venting from natural gas transmission, and include in the NIR a description of the estimation methodology.	
IPPU			
I.11	2.D.2 Paraffin wax use – CO_2	The Party reported in its NIR (p.312) AD and CO_2 emissions from paraffin wax use. The ERT noted that AD increased by 921.4 per cent between 2009 and 2010, by 298.5 per cent between 2012 and 2013 and by 1,154.5 per cent between 1990 and 2016. During the review, Luxembourg explained that paraffin wax is used for the nail polish production industry in Luxembourg, which increased significantly during the past decade.	Yes. Transparency
		The ERT recommends that the Party explain the trend of AD and CO_2 emissions and the significant inter-annual changes between 2009 and 2010 and between 2012 and 2013 in the NIR.	
I.12	2.D.2 Paraffin wax use – CO_2	The NIR (section 4.5.2.3) indicates that the uncertainties of AD and EFs for paraffin wax use are 5 per cent and 100 per cent, respectively, but the sources of these values are not reported.	Yes. Transparency
		The ERT recommends that the Party include in the NIR the source of the values of the uncertainty reported for AD and EFs for paraffin wax use.	
I.13	2.D.3 Other (non-energy products from fuels and solvent use) – CO_2	The Party reported in its NIR (pp.325–327, tables 151 and 152) the AD and IEFs for road paving with asphalt and for asphalt roofing as "IE". The NIR (section 4.2.7, p.293 and section 4.5.3.3, p.336) states that the categories road paving with asphalt and asphalt roofing do not exist in Luxembourg. During the review, the Party clarified that asphalt roofing does not occur in Luxembourg but road paving occurs and that NMVOC emissions are estimated and reported in the CRF tables, and that the information on road paving in the NIR is incorrect. The ERT noted that NMVOC emissions estimated for the whole time series by Luxembourg are not reported in the NIR and the notation	Yes. Transparency

ID#	Finding classification	Description of the finding with recommendation or encouragement	*Is finding an issue and/or a problem?[a] If yes, classify by type*
		key used is inappropriate, because "NO" should be used instead of "IE" for asphalt roofing. Also, AD for road paving with asphalt should be reported in the respective columns for AD and IEFs to ensure consistency between the NIR and the CRF tables.	
		The ERT recommends that the Party revise the information on road paving with asphalt in the NIR to clarify that these emissions are occurring and reported in Luxembourg and include the AD and IEFs in tables 151 and 152, and revise the notation key used for asphalt roofing, so that the information is consistent with the CRF tables.	
I.14	2.F. Product uses as substitutes for ozone-depleting substances – HFCs, PFCs and SF$_6$	The Party reported in its NIR (p.352) the assumed uncertainties for category 2.F (30 and 20 per cent for the AD and EFs, respectively) but the ERT noted that the methodology used to assess this uncertainty is not described and the uncertainties for each subcategory under 2.F are not estimated.	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines
		The ERT recommends that Luxembourg estimate and report the uncertainty for each subcategory under 2.F and explain in the NIR how it estimates those uncertainties.	
I.15	2.F. Product uses as substitutes for ozone-depleting substances – HFCs	The Party reported in its NIR (p.342, table 158) emissions for the entire time series from product uses as substitutes for ozone-depleting substances. The ERT noted that emissions reported for category 2.F and subcategory 2.F.1 in the NIR are not consistent with the values reported in CRF table 2(I)s2. For example, for 2016, the NIR reports 58.35 and 54.09 kt CO$_2$ eq for 2.F and 2.F.1, respectively, but the CRF table reports 63.75 and 59.48 kt CO$_2$ eq, respectively. Similar inconsistencies occur for all other years in the time series. During the review, the Party explained that a mistake had been made while importing the data files used for the NIR.	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines
		The ERT recommends that the Party revise NIR table 158 so that the HFC emissions from 2.F and 2.F.1 reported for all years in the time series are consistent with the emissions reported in CRF table 2(I)s2.	
I.16	2.F.1 Refrigeration and air conditioning – HFCs	The Party reported in its NIR (p.344) on the sole plant producing refrigerators in Luxembourg. The NIR indicates that in 2006, emissions from manufacture of refrigerators were calculated to be 2 kg of F-gas R134a (HFC-134a) and that this value is assumed for the entire time series of emission estimations. However, the ERT noted that this is not consistent with the amount of HFC-134a filled into new manufactured products reported in CRF table 2(II)B-Hs2 (reported as "NO" for 1990–1998 and 0.62–2.29 t HFC for 1999–2016).	Yes. Transparency
		The ERT recommends that the Party correct the description in the NIR of the estimations of HFC emissions from manufacture of refrigeration equipment.	
I.17	2.F.1 Refrigeration and air conditioning – HFCs	The Party reported in its NIR (p.344) on the sole plant producing refrigerators in Luxembourg (see ID# I.16 above). This plant exports 99.5 per cent of its production. During the review, Luxembourg provided the ERT with a report by Econotec in 2010 that includes all details of the study conducted in 2006 and the methodology used to generate the EF and data of all other types of F-gases used by the plant in the whole process. The ERT noted that the survey report did not estimate or refer to the uncertainty of the emissions. The report also indicates the number of accidents and unplanned releases, which fluctuates from one to five times a year and may release between 3 and 5 kg of HFCs. These emissions in case of accident are not considered in the estimations. During the review, the Party explained	Yes. Accuracy

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
		that the company has improved the process of filling the fridges, which now takes place in an isolated chamber where any F-gas leak is collected and recovered. The ERT believes that future ERTs should consider this issue further to ensure that there is not an underestimate of emissions. The ERT recommends that Luxembourg reassess with the company the AD, EFs and emissions from manufacturing of refrigerators, including the emissions from accidental releases, and, if necessary, revise the time series of HFC emission estimates to include these accidental releases. The ERT also recommends that the Party explain in the NIR the methodology used to estimate all emissions, planned and unplanned (e.g. from accidental and other unplanned releases) from this activity, including a description of any recovery system. The ERT further recommends that Luxembourg make efforts to estimate the uncertainty of the AD and EFs from this category and encourages the Party to develop category-specific QA/QC procedures for the AD and EFs.	
I.18	2.F.1.a Commercial refrigeration – HFCs	The ERT noted significant inter-annual decreases in emissions between 2014 and 2016 (14.7 per cent and 35.3 per cent between 2014 and 2015 and between 2015 and 2016, respectively). The ERT did not identify any information on this trend in the NIR. The ERT believes that future ERTs should consider this issue further to ensure that there is not an underestimate of emissions. The ERT recommends that the Party explain in the NIR the decrease in HFC emissions from 2.F.1.a (commercial refrigeration) between 2014 and 2015 (14.7 per cent) and 2015 and 2016 (35.3 per cent).	Yes. Transparency
I.19	2.F.1.f Stationary air conditioning – HFCs	The ERT noted two significant inter-annual decreases in emissions between 2012 and 2013 (HFC emissions decreased by 27.4 per cent) and 2015 and 2016 (by 11.8 per cent). The ERT did not identify any information on this trend in the NIR. During the review, Luxembourg explained that the decrease between 2015 and 2016 was due to new EU F-gas regulation, adopted in 2014, that phased out the usage of various F-gases (R134a, R143a, R32 and R125) in stationary refrigeration and air conditioning, which entered into force on 1 January 2015. However, the ERT noted that the drop should probably have happened between 2014 and 2015 too, and not just between 2015 and 2016. The ERT recommends that the Party explain in the NIR the decrease in HFC emissions from 2.F.1.f (stationary air conditioning) between 2012 and 2013 and between 2015 and 2016, including the impact of the EU regulation phasing out various HFCs.	Yes. Transparency
I.20	2.F.2 Foam blowing agents – HFCs	The Party reported in its NIR (p.351) that the per capita ratio for Belgium is used to estimate emissions for the whole time series because of lack of data on foam blowing in Luxembourg. The ERT noted that Belgium uses an average value of EU member States which might not be representative of the national context of Luxembourg and suggested that the Party use an average proxy from the neighbouring countries, which could be more representative for Luxembourg. During the review, the Party acknowledged that the ratio for Belgium may not be the most representative value for the circumstances of Luxembourg and that it would use an average from the neighbouring countries in its next annual submission. The ERT believes that future ERTs should consider this issue further to ensure that there is not an underestimate of emissions.	Yes. Accuracy

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
		The ERT recommends that the Party estimate these emissions using country-specific data or, if this is not possible, estimate these emissions using a proxy (e.g. using per capita emissions from other neighbouring Parties) and justify the applicability of the used value to the circumstances of Luxembourg.	
I.21	2.G.2 SF_6 and PFCs from other product use – SF_6	Luxembourg did not report SF_6 emissions from medical use in radiotherapy and/or from research institutes' particle accelerators (the CRF tables include SF_6 emissions from 2.G.2 but only from soundproof windows). The ERT noted that in accordance with the 2006 IPCC Guidelines (vol. 3, chapter 8, p.8.29) it is good practice to report on these sources. The ERT noted that there are medical centres equipped with radiotherapy devices using SF_6 and accelerator research equipment in research laboratories in the country. During the review, the Party confirmed that there are two public hospitals and other research institutes using small amounts of SF_6 to which the reporting regulations do not apply and consequently these are not included in the F-gas database used in the estimations. The ERT noted that preliminary estimates based on proxy data from Denmark (NIR Denmark, 2018 annual submission, p.334, figure 4.8.3) using a per capita ratio indicate that these emissions could be approximately 7.7 kt CO_2 eq, which is beyond the significance threshold (5.01–5.61 kt CO_2 eq) for the 2018 annual submission from Luxembourg. The ERT believes that future ERTs should consider this underestimation of emissions further.	Yes. Completeness
		The ERT recommends that the Party estimate and report SF_6 emissions from medical use and from particle accelerators and explain in the NIR how the estimations were made, including information on the number of medical devices and particle accelerators using SF_6 and the SF_6 amount used to fill and refill equipment.	
I.22	2.G.3 N_2O from product uses – N_2O	The Party improved its estimate of N_2O emissions from medical applications for anaesthesia by collecting country-specific data directly from the hospital association named "Federation des Hopitaux Luxembourgeois" covering all hospitals in Luxembourg, instead of the previous methodology which was based on data from Germany. The ERT commends Luxembourg for this improvement. The ERT noted that N_2O may also be used in veterinary applications. During the review, the Party initiated a survey to assess the use of N_2O in those applications. The preliminary results indicate that N_2O is not used in veterinary applications in the country.	Yes. Transparency
		The ERT recommends that the Party either confirm that N_2O is not used in veterinary applications and include this information in the NIR or, if N_2O is used, estimate and report N_2O emissions and describe the methodology in the NIR.	
I.23	2.G.4 Other (other product manufacture and use)	The Party reported in its NIR (p.363) the assumed uncertainties for category 2.G.4 (30 and 20 per cent, for the AD and EFs, respectively) but the bases for these assumptions are not described. The NIR (section 4.8.4.3) indicates that the emissions reported under this category correspond to a single manufacturer, which provides AD directly to the inventory team.	Yes. Transparency
		The ERT recommends that Luxembourg explain in its NIR how it estimates the uncertainties reported for the AD and EFs.	
I.24	2.H Other (industrial	The Party reported in its NIR (p.364) that this category does not exist in Luxembourg and the notation key "NO" is used in CRF table 2(I)s2. The ERT noted that there are many beverage and food industry businesses occurring in	Yes. Transparency

ID#	Finding classification	Description of the finding with recommendation or encouragement	*Is finding an issue and/or a problem?[a] If yes, classify by type*
	processes and product use) – N_2O	Luxembourg which might use N_2O. During the review, the Party explained that this type of activity does exist, for example producing beer and meat products, but without using N_2O in the processes. The ERT recommends that Luxembourg describe the beverage and food industry in the country and confirm that N_2O is not used in these processes.	

Agriculture

ID#	Finding classification	Description of the finding with recommendation or encouragement	Issue/problem
A.8	3.A Enteric fermentation – CH_4	Table 164 of the NIR reports the emission trends from enteric fermentation by gas (in CO_2 eq) and the total for the category. Only CH_4 emissions are estimated for this category, because CO_2 and N_2O emissions are reported as "NA". The ERT noted that the total for the category should be the same as the total CH_4 emissions. However, the total emissions from this category for 1990–2013 reported in the table are higher (by 700 to 1,000 Gg CO_2 eq) than the total CH_4 emissions reported in the same table. During the review, the Party indicated that the NIR table had not been updated and provided a revised table with consistent values. The ERT recommends that the Party revise NIR table 164 and report consistent total and CH_4 emissions for all years.	Yes. Transparency
A.9	3. General (agriculture) – CH_4 and N_2O	On the basis of expert judgment, the Party chose values for DE from the range of values provided in table 10.2 of the 2006 IPCC Guidelines (vol. 4, chapter 10); 70 per cent for cattle, goats and horses, and 80–90 per cent for pigs for enteric CH_4 emission estimates, as indicated in table 172 of the NIR. The ERT noted that these values are in the upper range of values provided in the IPCC table 10.2. As DE is one of the most important parameters that affect CH_4 and N_2O emissions under categories 3.A and 3.B, the ERT requested the Party to provide the documentation on feeding situation and feed characteristics to confirm that these DE values are suitable under Luxembourg's circumstances. During the review, the Party explained that for cattle, the range proposed in IPCC table 10.2 for livestock category "cattle and other ruminants" is between 45 and 85 per cent. To account for pasture grazing during summer months (class "Pasture fed animals", for which a digestibility of 55–75 per cent is proposed), Luxembourg decided to reduce the higher value of 75 per cent to 70 per cent. The DE for swine used by Luxembourg is at the higher end of the range because the feeding processes as well as diets are highly optimized. The Party also provided an expert judgment document on feeding situation, feed composition and the selection of DE for all animal categories, which explains that there are three main forage sources used in Luxembourg for cattle and other ruminants, namely fresh grass, grass silage and corn silage (whole plant) with average DE values of 68.6 per cent (range: 62.4–73.1 per cent), 71.1 per cent (range: 68.2–73.2 per cent) and 74.7 per cent (range: 73.9–76.5 per cent), respectively. Given the high digestibility of the three main forage sources, and the fact that the cattle diet is supplemented with concentrated feed, both the animal expert at Service d'Economie Rurale (Mr. Roger Barthelmy; personal communication) and Ms. Christelle Schmit (ASTA, Ettelbruck) suggested to use 70 per cent for feed digestibility for cattle, goats and horses. The ERT considers that the information provided by the Party is acceptable. The ERT recommends that Luxembourg provide in the NIR the information supporting the assumptions on the values for DE for cattle, goats and horses, and for pigs, including information on the consideration of pasture	Yes. Transparency

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
		grazing during summer and the three main forage sources and feed concentrates used in the country for cattle and other ruminants.	
A.10	3.A Enteric fermentation – CH_4 and N_2O	An uncertainty analysis was not performed by the Party on the DE values for cattle, goats, horses and pigs (see ID# A.9 above) and a tier 1 uncertainty level (30 per cent) was provided instead. The ERT notes that DE is one of the most important parameters that affect CH_4 and N_2O emissions under categories 3.A and 3.B. The ERT recommends that the Party estimate the country-specific uncertainty of the DE values used in the estimates.	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines
A.11	3.A.2 Sheep – CH_4	The value of Ym used for sheep as indicated in CRF table 3.As1 is 5.50 per cent, and NIR table 172 mentions that this value is from table 10.13 of the 2006 IPCC Guidelines (vol. 4, chapter 10). However, the ERT noted that the values in IPCC table 10.13 are 4.5 per cent ±1.0 per cent for lambs (<1 year old) and 6.5 per cent ±1.0 per cent for mature sheep. During the review, the Party indicated that, as there are no detailed data in the country on age structure of sheep, an average Ym value has been used to estimate emissions assuming that half of the sheep fall under the "lamb" category and half under "mature sheep"; hence $(0.045 + 0.065)/2 = 0.055 = 5.50$ per cent. The ERT noted that this assumption may result in an over- or underestimation of CH_4 emissions from sheep. However, the ERT also noted that CH_4 emissions from this category are well below the significance threshold so any potential underestimation from using an inappropriate Ym would be below the significance threshold (e.g. for 2016, CH_4 emissions from 3.A.2 were 0.09 kt CH_4, or 2.19 kt CO_2 eq, and the ERT noted that this underestimation is below the significance threshold established in the UNFCCC Annex I inventory reporting guidelines (5.01–5.61 kt CO_2 eq for 2013–2016 for the 2018 annual submission). The ERT recommends that the Party improve the accuracy of the estimate by collecting data on age structure for sheep, and revise the estimate by using the appropriate Ym values for each age in accordance with the 2006 IPCC Guidelines.	Yes. Accuracy
A.12	3.B Manure management – N_2O	The amounts of Nex are provided in table 188 of the NIR. The methodology for estimating Nex of dairy cattle is described in the NIR and additional information for deriving Nex from milk production and N content of urea was also provided during the review. However, a description for Nex from other animals is still missing. During the review, the Party informed the ERT that the methodology for deriving Nex is embedded in the programme code of the software used by the sector expert that performed the estimates, and that the expert has left the inventory team. The Party could not find out, during the review week, how Nex from other animals has been estimated. The ERT performed a preliminary assessment based on live weight of each animal subcategory, the feeding situation and the feed characteristics. This preliminary assessment indicates that the Nex factors used by the Party do not seem to be disproportionate and are in similar ranges to those reported by other countries with similar climate and feeding conditions. The ERT recommends that the Party provide in the NIR the detailed information on the methodology used or the reference document on Nex estimates of animals other than dairy cattle.	Yes. Transparency

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
A.13	3.B.1 Cattle – N$_2$O	The ERT noted that CRF table 3.B(b) reports Nex ranging from 85.00 to 102.00 kg N/head/year for dairy cows for 1990–2016. However, the NIR (section 5.3.7) indicates that those values are incorrect and that the correct values are reported in NIR table 188 (values reported in the NIR range from to 116.02 to 125.54 kg N/head/year). The NIR also indicates that the N$_2$O emissions reported in CRF table 3.B(b) are correct. During the review, the Party confirmed that the Nex values reported in table 188 in the NIR are correct, the Nex values for dairy cows reported in CRF table 3.B(b) are incorrect, and the N$_2$O emissions reported in the CRF table 3.B(b) are correct. The ERT recommends that the Party report the correct values of Nex for dairy cows in CRF table 3.B(b) for all years in the time series and that those values be consistent with the values reported in the NIR.	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines
A.14	3.D Direct and indirect N$_2$O emissions from agricultural soils – N$_2$O	The Party estimated and reported N$_2$O emissions, EFs and the amount of N under the subcategory "mineralization/immobilization associated with loss/gain of soil organic matter" in CRF table 3.D. The EF indicated in CRF table 3.D (2.00 kg N$_2$O-N/kg N) is higher than the IPCC default values for both direct emissions (0.01 kg N$_2$O-N/kg N indicated in the 2006 IPCC Guidelines, vol. 4, chapter 11, table 11.1) and N leaching and run-off (0.0075 kg N$_2$O-N/kg N indicated in the 2006 IPCC Guidelines, vol. 4, chapter 11, table 11.3). The NIR does not include information on the methodology, data source and selection of EFs. During the review, the Party confirmed that the emission estimates reported in CRF table 3.D are correct, but both the amount of N and the EFs are not correct. The description of the calculation method for direct N$_2$O emissions from mineralization/immobilization associated with loss/gain of soil organic matter as well as indirect N$_2$O emissions from the conversion of land to cropland is provided in the LULUCF chapter of the NIR (section 6.3.4.2.3). N in mineral soils that is mineralized in association with loss of soil carbon should be 3,577.70 kg N/year, instead of 17.89 kg N/year indicated in CRF table 3.D. During the review, the Party provided the spreadsheet that shows the detail of estimates for N inputs from mineral soils. The ERT could not identify any problem with the calculations. The ERT recommends that Luxembourg include a reference, in the agriculture chapter of the NIR, to the section in the LULUCF chapter where the methodology to estimate N$_2$O emissions from the conversion of land to cropland is described. The ERT also recommends that the Party correct the values for N inputs and EFs reported in CRF table 3.D.	Yes. Transparency
A.15	3.D Direct and indirect N$_2$O emissions from agricultural soils– N$_2$O	The amount of N and the EFs for the estimation of N$_2$O emissions under subcategory 3.D.a.2.c "other organic fertilizers applied to soils" were provided in CRF table 3.D. However, no information on the methodology and data sources used is provided in the NIR. During the review, the Party indicated that "other organic fertilizers applied to soils" under category 3.D.a.2.c is compost. The amount of compost applied to soils was derived according to equation 11.3 in the 2006 IPCC Guidelines (vol. 4, chapter 11) and is reported annually by the Environment Agency. For 2016, the amount applied was 6,949 tonnes of compost, based on the N content for compost of 1.74 per cent (https://data.public.lu/en/datasets/r/27ca6f81-088c-4b8a-bbc5-2443c32893cf). The ERT confirmed that the calculation of N applied to soils and the EFs are consistent with the 2006 IPCC Guidelines.	Yes. Transparency

ID#	Finding classification	Description of the finding with recommendation or encouragement	*Is finding an issue and/or a problem?[a] If yes, classify by type*
		The ERT recommends that the Party include in the NIR information on methodology, AD and EFs used for estimating the N_2O emissions from compost applied to soils.	
A.16	3.H Urea application – CO_2	The Party reported the emissions from urea application as "NE" in CRF table 3.G-I. In response to a previous review, the Party had indicated that the emissions from this category are below the threshold defined in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines, and provided the justification for the use of the notation key "NE" in its 2018 annual submission (NIR, pp.424 and 425; see ID# A.7 in table 3). The estimates of emissions during the period 1990–2016 were also provided in table 201 of the NIR (p.425). The ERT recommends that the Party include in its NIR information to demonstrate that the total national aggregate of estimated emissions for all gases and categories considered insignificant remains below 0.1 per cent of the national total GHG emissions, as requested by paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	Yes. Comparability
LULUCF			
L.9	4. General (LULUCF) – CO_2	Luxembourg has used several expert judgments as the basis for assumptions made in the relevant parts of the LULUCF section in the NIR. For instance, the Party made assumptions on the basis of expert judgments on fertilizer use (it assumed that this does not occur in forest land in Luxembourg; NIR section 11.3.1.2), practices of fuelwood collection (NIR, p.469), C/N ratio for mineral soils (NIR, p.473), mineral soils in grassland (NIR, p.477), uncertainty for BEF (NIR, p.496) and uncertainties for carbon stock in settlements (NIR, p.499). The ERT notes that those expert judgments were not obtained consistent with the protocol for expert elicitation in the 2006 IPCC Guidelines (vol. 1, chapter 2, p.2.6 and annex 2.A.1). The ERT recommends that the Party elaborate in the NIR the methods and underlying assumptions used in the expert judgments on fertilizer use (NIR section 11.3.1.2), practices of fuelwood collection (NIR, p.469), C/N ratio for mineral soils (NIR, p.473), mineral soils in grassland (NIR, p.477), uncertainty for BEF (NIR, p.496) and uncertainties for carbon stock in settlements (NIR, p.499). The ERT encourages the Party to document those experts judgments by including the expert elicitation protocol followed, noting the protocols for elicitation included in the 2006 IPCC Guidelines (vol. 1, chapter 2, p.2.6 and annex 2.A.1).	Yes. Transparency
L.10	4. General (LULUCF) – CO_2, CH_4 and N_2O	The NIR (p.497) provides uncertainties for the areas of land use and land-use changes. The uncertainty of the 2012 map has been included, but uncertainties related to other maps (1998, 1999, 2007) used during the assessment have not been estimated. The ERT noted that the uncertainty related to the land-use change has not been calculated and a general uncertainty of 3 per cent had been assumed for each land-use category. The ERT noted that this is not in accordance with the 2006 IPCC Guidelines (vol. 4, chapter 3, p.3.19) because the uncertainty analysis on the area data should not only account for the uncertainty on the land-use areas, but should also include the uncertainty on the annual change detection between land uses. During the review, Luxembourg explained that it will prepare new occupation maps and that it is planning to include an uncertainty assessment on land-use change detection.	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines

ID#	Finding classification	Description of the finding with recommendation or encouragement	*Is finding an issue and/or a problem?[a] If yes, classify by type*
		The ERT acknowledges that Luxembourg is preparing a new land-use map and recommends that the Party include an uncertainty assessment of the land use and land-use change maps.	
L.11	4. General (LULUCF) – CO_2	For the estimation of uncertainty on growth rates and carbon stock factors, the NIR (p.495) referred to a study published in 2015 which estimated the errors related to individual EFs extracted from the NFI. This study found that there are many sources of uncertainty related to the NFI. The ERT noted that a formula to estimate the statistical random sampling error is provided in the NIR, but the NIR does not explain how it has been applied; and parameters such as the number of samples, mean of variable and standard deviation have not been provided in table 234 of the NIR. The ERT noted that this is not in accordance with the 2006 IPCC Guidelines (vol. 1, chapter 3, p.3.40) because there is a lack of information (the population size, mean and standard deviation). Furthermore, the different types of error based on the field work limitations (including measurement and model errors) have not been discussed in the NIR. During the review, Luxembourg provided a spreadsheet with uncertainties containing details on the standard deviations and confidence boundaries of all parameters (growth rate, total carbon stock, deadwood stock).	Yes. Transparency
		The ERT recommends that the Party include in the NIR information clarifying the random and eventual systematic uncertainties associated with growth rate and carbon stock factors.	
L.12	4. General (LULUCF) – CO_2	Luxembourg reported emissions and removals from mineral soils in the NIR (p.463, table 224). During the review, the Party explained that the carbon stock change factors provided by Luxembourg are taken from the soil carbon inventory. The soil inventory results contained carbon stock factors measured by region (covering the variability in soil types and climates) and by land-use type (six classes) for one time point. The carbon stock changes are calculated for all conversions happening in Luxembourg assuming a linear change in carbon stocks over a 20-year period (IPCC methodology, approach 2). However, the ERT noted that Luxembourg did not report separately the reference soil carbon stock factors and the stock change management factors that correspond to the respective IPCC classes and land-use changes happening in the country (2006 IPCC Guidelines, vol. 4, chapter 2, p.2.34, box 2.1 (formulation B)). During the review, Luxembourg provided a report (Environment Agency Luxembourg, 2018) that provides information on future reporting for CM and GM. The report explains that Luxembourg used a tier 2 methodology by using the country-specific data and the default carbon stock change factors to calculate the reference carbon stock for Luxembourg. The ERT notes that, from the information provided, the annual country-specific carbon stock changes are not necessarily the result of land uses in an equilibrium status, but include land areas also in transition between two land uses. Therefore, when using approach 2, emissions and removals from carbon stock changes in mineral soils might be over- or underestimated.	Yes. Accuracy
		The ERT recommends that the Party demonstrate the accuracy of the soil carbon stock factors, by land use, which it used in the estimates of CO_2 emissions and removals from mineral soils, in particular so that the long-term carbon stock changes due to land-use changes are accounted or corrected for in the assessment to avoid under- or overestimation of emissions and removals, or, alternatively, the ERT recommends that the Party improve the accuracy of the soil carbon stock factors. The ERT also encourages the Party to explain more clearly in its NIR	

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
		which IPCC methodology it applied to estimate CO_2 emissions and removals from mineral soils based on the soil organic carbon factors from the studies referred to.	
L.13	Land representation – CO_2	Luxembourg uses wall-to-wall maps (1989, 1999, 2007 and 2012) to estimate areas of land use and land-use change. The latest map was finalized in 2012 and, for the more recent years (2013–2016), Luxembourg has carried out a linear extrapolation. The aggregated classification used by Luxembourg to stratify the map is based on land cover only. According to the 2006 IPCC Guidelines (vol. 4, chapter 3, p.16), it is a good practice to generate regularly new land-use maps and to stratify the areas on the basis of land cover and land use based on information on management data, in particular to distinguish planted and natural forests in accordance with the forest definition.

The ERT recommends that the Party update the extrapolation for areas of land use and land use change for 2013–2016 to take into account both land use and land-use change based on information on management data. The ERT acknowledges that Luxembourg is producing a new land-use map by 2019 that may address this issue. The ERT also recommends that the Party use a stratification in accordance with the 2006 IPCC Guidelines (vol. 4, chapter 3, p.16). | Yes. Accuracy |
| L.14 | Land representation – CO_2 | The Party observed a high amount of conversions between cropland and grassland areas, mostly due to the cropping cycle introducing grasses on cropland. Therefore, for cropland and grassland areas between 1989 and 2010, it used expert judgment to correct the maps for the actual amount of cropland converted to grassland and vice versa. For the years after 2010, the expert judgment was not used, but the newly introduced LPIS was used. The ERT noted that not all grassland and cropland areas are tracked by the LPIS; however, all the areas reported in the NIR were corrected using the LPIS change rates between cropland and grassland. The ERT considers that, as the areas not tracked under the LPIS are mostly grassland along roads and highways and perennial crops (not under rotation) in which no or little land-use change occurs, the assumption is not representative for the total area corrected, and might lead to an overestimate of removals in the mineral soil pool. According to the 2006 IPCC Guidelines, estimates should neither be over- nor underestimated through use of EFs that are representative for the activity (i.e. the land area converted from cropland to grassland and vice versa).

The ERT recommends that the Party estimate the portion of grassland and cropland that falls out of the scope tracked by the LPIS system in order to correct for the bias and explain in the NIR how any potential overestimation of removals is avoided. | Yes. Accuracy |
| L.15 | Land representation – CO_2 | Luxembourg reported land-use change matrices in the NIR using approach 2 from the 2006 IPCC Guidelines (vol. 4, chapter 3, pp.3.12 and 3.13). Since the Party did not report the full land representation of the country using the 36 IPCC classes (land-use remaining and land-use conversion to other land-use classes) in the NIR it was not possible for the ERT to verify the consistency between the land-use classes and transition classes annually. Areas have been reported for the land-use classes and transition classes in CRF table 4.1. The matrices of CRF table 4.1 are consistent between consecutive years except for 1999–2000 and 2007–2008 where the final areas of the year (X-1) do not equal the initial areas of the following year (X). According to the 2006 IPCC Guidelines (vol. 4, chapter 3, p.3.13) countries should provide information on the total area that is in the categories land-use remaining and land-use conversion to other land-use classes (less than 20 years after conversion). The establishment of a land | Yes. Transparency |

ID#	Finding classification	Description of the finding with recommendation or encouragement	*Is finding an issue and/or a problem?[a] If yes, classify by type*
		representation should correct for a lag time of 20 years before 1990 so as not to incorporate a false trend in the time series. It is unclear to the ERT how Luxembourg has applied the 20-year rule while ensuring consistency.	
		The ERT recommends that the Party include (in addition to NIR table 215) a description that land representation takes into account the 20-year period for an area to be transferred from a converted category into a remaining category. The ERT encourages the Party to provide the land areas by the 36 IPCC categories in a table so that the areas are easier to compare with CRF tables 4.A–4.F.	
L.16	4.A Forest land – CO_2	The Party reported in its NIR (p.509) sector-specific QA/QC and verification procedures on AD (land areas) by comparing the OBS map ("Occupation Biophysique de Sol") with areas provided in the NFI. The NIR also includes a discussion on the consistency and technical limitations with both of those data sources regarding land-use areas. However, the ERT noted that the Party did not report on verification procedures related to the final carbon stock change factors used in the annual submission. During the review, Luxembourg referred to various publications that justify different steps of the methodology used for obtaining those EFs. The ERT considers that, in addition, providing information on peer reviews or a summary of information on error prevention in the NIR would be helpful to understanding that no under- or overestimations occur.	Not an issue/problem
		The ERT encourages the Party to include in the NIR information on verification checks for carbon stock change factors from the NFI. The ERT also encourages the Party to provide the verification checks for carbon stock change factors directly in the NIR chapter that explains methodologies on the NFI and, in the NIR chapter on sector-specific QA/QC and verification for LULUCF, refer to the complete list of country-specific checks carried out on all reporting categories by the inventory compiler. The ERT further encourages Luxembourg to elaborate on the improvement plan, based on the assessment in the QA/QC.	
L.17	4.A.1 Forest land remaining forest land – CO_2	Country-specific sample data from the NFI were used to calculate above-ground biomass factors in forest land. The NFI methodology is based on the methodology described in Alderweireld, 2015. A brief description of the carbon factors methodology is provided in the NIR (p.453). Values for BEF and ratios for above- and below-ground biomass are also provided in the NIR. The ERT noted that insufficient information is provided on how above- and below-ground biomass by tree species were derived from the sample data through use of allometric equations and, consequently, how the above- and below-ground biomass stocks for forest land in NIR table 222 were calculated. During the review, the Party explained that biomass is calculated for conifers and deciduous forests separately on the basis of information on species' distribution in the NFI and then combined on the basis of the ratio between areas of conifers and deciduous forests.	Yes. Transparency
		The ERT recommends that Luxembourg explicitly provide in the NIR the steps of the calculation of the above-ground biomass factors for forest land. The ERT encourages the Party to document more clearly which information (BEF, ratio of root to shoot, merchantable wood) is obtained from literature and which information is actually estimated through the NFI of Luxembourg.	

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
L.18	4.A.1 Forest land remaining forest land – CO_2	The Party reported in its NIR (p.458, figure 6-10) volumes of wood harvested in public and private forests. The volumes are calculated using a combination of statistical data from the Administration de la Nature et des Forêts for public forests only and data extracted from two consecutive NFIs that tracked carbon stock losses in public and private forests between 2000 and 2010. Using this method, the annual fluctuations of public forests are also applicable to private forests. The ERT noted that the annual fluctuations of harvest rates in public and private forests might not be comparable because of different management practices which, using the current methodology, could lead to a bias on total amount harvested in forest land remaining forest land. During the review, the Party explained that most private forests are coniferous and that indeed another type of management is carried out. However, the Party also explained that collection of harvest data from private forests is challenging, because there are more than 14,000 forest owners in Luxembourg.	Yes. Accuracy
		The ERT recommends that the Party collect more information on harvests in private forests directly from private landowners and compare them to the harvest rates from the NFI and report the results of this comparison in the NIR.	
L.19	4.B Cropland – CO_2	Luxembourg has reported that vineyards contain a carbon stock of 2.64 t/ha (NIR table 223). The NIR indicates that this value is based on the values from GHG inventories submitted by Germany and Switzerland in 2017. The NIR does not provide an indication of whether below-ground biomass is included. The ERT noted that according to the 2006 IPCC Guidelines (vol. 4, chapter 5, p.5.10) below-ground biomass should be consistently reported for perennial crops in cropland. During the review, the Party consulted the relevant reports used in the inventories of Switzerland and Germany and confirmed that the value reported in table 223 of Luxembourg's NIR does include below-ground biomass for all possible conversions.	Yes. Transparency
		The ERT recommends that the Party report a value for above- and below-ground biomass separately in table 223 of the NIR and explain how the average carbon stock value of vineyards was obtained (e.g. on the basis of values reported by Germany and Switzerland).	
L.20	4.G HWP – CO_2	The Party reported in its NIR (section 6.9) a comparison of statistics for industrial roundwood production, import and export from different sources including FAOSTAT and STATEC for a few years (2001–2004, 2009 and 2011) and also reported data on wood harvest minus fuelwood since the year 1990 from the forest agency of Luxembourg, which the Party considers more reliable for the inventory. Luxembourg noted in its NIR that statistics of production, import and export of wood are not always reliable and therefore they are not used to compile the inventory. Owing to unreliable statistics dating back to 2000, Luxembourg decided to apply the assumption of instant oxidation. The ERT noted that this is not in accordance with the 2006 IPCC Guidelines (vol. 4, chapter 12, p.12.8), which states that, in order to calculate the HWP variables, HWP volumes should be reported in the NIR or CRF table 4.Gs2 in order to demonstrate whether this pool is significant. During the review, the Party explained that data from FAOSTAT cannot be used because they are unreliable and only date back to the year 2000. The Party also explained that a task force has been established to, among other tasks, try to improve information on wood harvest in the country. The ERT commends Luxembourg for its ongoing effort to improve the current data set through the "wood cluster".	Yes. Accuracy

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
		The ERT recommends that the Party collect the data necessary to complement current data sets on HWP (production, import and export of industrial round wood, sawnwood and paperboard) to the extent possible and use extrapolation techniques to complete the time series.	
L.21	4 (V) Biomass burning – CH_4 and N_2O	Luxembourg indicated in the NIR (p.630) that insect infestations and to a lesser extent wildfires have occurred. During the review, the Party indicated that after infestations it is mandatory to burn wood. The Party also indicated that CO_2 emissions from these losses are already accounted under forest land remaining forest land. The ERT noted that, according to the 2006 IPCC Guidelines (vol. 4 chapter 2, p.2.41), non-CO_2 emissions for above-ground woody biomass burning on all land-use categories should also be estimated in the LULUCF sector.	Yes. Completeness
		The ERT recommends that the Party estimate and report CH_4 and N_2O emissions from biomass burning (including wildfires and controlled burning after infestations) on all land-use categories and describe in the NIR how the estimations were made.	
Waste			
W.15	5. General (waste) – CH_4	The ERT noted some inconsistencies in table 239 of the NIR (p.519). For example, for the waste sector, total emissions for 2016 are reported as 85.75 Gg CO_2 eq, but total CO_2, CH_4 and N_2O emissions are reported as "NA, IE, NA", 2.93 Gg CO_2 eq and 0.04 Gg CO_2 eq, respectively. Similar inconsistencies occur for the waste sector for the other years and, for subcategories 5.A solid waste disposal and 5.D wastewater treatment and discharge, for all years. During the review, the Party provided a revised table.	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines
		The ERT recommends that the Party correct the errors identified in table 239 of the NIR so that total emissions reported for the waste sector and subcategories 5.A solid waste disposal and 5.D wastewater treatment are consistent with the sum of the CO_2, CH_4 and N_2O emissions reported for the same categories.	
W.16	5.A Solid waste disposal on land – CH_4	The Party reported in its NIR (p.533) that an oxidation factor of 0.1 is used for estimating CH_4 emissions from solid waste disposal sites. The ERT noted that the 2006 IPCC Guidelines (vol. 5, chapter 3, p.3.15, table 3.2) indicate that the use of the oxidation factor of 0.1 is justified for well-managed solid waste disposal sites covered with oxidizing material (e.g. soil or compost). During the review, the Party explained that solid waste disposal sites in Luxembourg use such an oxidation layer by gradually covering different parts of the solid waste disposal sites with a layer of soil.	Yes. Transparency
		The ERT recommends that the Party provide in the NIR information justifying the use of an oxidation factor of 0.1 by explaining that solid waste disposal sites in Luxembourg are covered with oxidizing material as indicated in the 2006 IPCC Guidelines, because they are operated by gradually covering different parts of the solid waste disposal sites with a layer of soil.	
W.17	5.A Solid waste disposal on land – CH_4	The Party reported in its NIR (p.533) that it used the single-phase model based on a bulk waste methane generation rate of 0.08 from the 2006 IPCC Guidelines to estimate CH_4 emissions from waste landfilled after the biological pre-treatment (indirectly deposited waste). The ERT noted that the 2006 IPCC Guidelines (vol. 5, chapter 3, p.3.17, table 3.3) indicate a default value for bulk waste methane generation rate of 0.09 (range 0.08–0.10) in wet boreal and	Yes. Transparency

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
		temperate climates. During the review, the Party explained that it used the lower end of the range for default methane generation rate when estimating CH_4 emissions from indirectly deposited waste because, in Luxembourg, the pre-treatment before disposal to solid waste disposal sites leads to substantial decay (aerobic) of organic components, including rapidly degradable waste components. The ERT agrees with this explanation. The ERT recommends that the Party provide in its NIR information justifying the use of the methane generation rate of 0.08 for estimating CH_4 emissions from indirectly deposited waste by including the information that the pre-treatment before disposal to solid waste disposal sites leads to substantial decay (aerobic) of organic components, including rapidly degradable waste components.	
W.18	5.B.2 Anaerobic digestion at biogas facilities – CH_4	The ERT noted inconsistencies in CH_4 emissions between NIR table 255 (p.554) and CRF table 5.B (e.g. CH_4 emissions in 2016 are 0.45 kt and 0.51 kt CH_4 in NIR table 255 and CRF table 5.B, respectively). During the review, the Party explained that the values provided in the CRF table are correct. The ERT recommends that the Party ensure the consistency of the data on CH_4 emissions reported in NIR table 255 and CRF table 5.B.	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines
W.19	5.D.1 Domestic wastewater – N_2O	According to the NIR (pp.566 and 567), the Party used protein intake data from FAO (http://www.fao.org) to estimate N_2O emissions from domestic wastewater. In response to a question raised by the ERT to clarify whether the data used in the estimation is protein supply or protein consumption, the Party explained that it used protein consumption data of Austria from the FAO website because no country-specific data are available for Luxembourg. The ERT noted the protein consumption data available in FAO Statistical Yearbooks (e.g. FAO Statistical Yearbook 2010) and that FAOSTAT provides data for Luxembourg on protein supply (http://www.fao.org/faostat/en/#country). During the review, the Party presented provisional estimates based on protein consumption data from FAO Statistical Yearbook 2010. The ERT noted that the revised estimates indicate that the missing emissions do not seem to exceed the significance threshold established in the UNFCCC Annex I inventory reporting guidelines, paragraph 37(b) (5.01–5.61 kt CO_2 eq for 2013–2016 for the 2018 annual submission). The maximum missing emissions amount to 0.952 kt CO_2 eq (0.0084 per cent of national total GHG emissions) in 2003 and a minimum of 0.355 kt CO_2 eq (0.0028 per cent of national total GHG emissions) in 2004 and 0.454 kt CO_2 eq (0.0045 per cent of national total GHG emissions) in 2016. The ERT noted that this underestimation is below the significance threshold established in the UNFCCC Annex I inventory reporting guidelines (5.01–5.61 kt CO_2 eq for 2013–2016 for the 2018 annual submission). The ERT recommends that the Party use country-specific protein consumption data for its estimation of N_2O emissions from domestic wastewater treatment and explain any change in the estimations in its NIR.	Yes. Accuracy
W.20	5.D.1 Domestic wastewater – N_2O	In CRF table 5.D, the amount of sludge removed from domestic wastewater is reported as "NE". During the review, the Party explained that sewage sludge removed from domestic wastewater in Luxembourg is used in agriculture as a fertilizer (reported under 3.D), or is either incinerated in the cement production plant (reported under 1.A.2.f) or exported. The final report on sewage sludge generation is available at https://data.public.lu/en/datasets/boues-	Yes. Accuracy

ID#	Finding classification	Description of the finding with recommendation or encouragement	*Is finding an issue and/or a problem?[a] If yes, classify by type*
		depuration. The ERT noted that N in sludge removed is not considered in the estimation of the N_2O emissions from domestic wastewater treatment. According to the 2006 IPCC Guidelines (vol. 5, chapter 6, section 6.3.1.3), N removed with sludge should be subtracted from total amount of N in the wastewater effluent to avoid double counting of N_2O emissions. During the review, the Party explained that the country-specific approach it used in the estimations has limitations and that Luxembourg will use the tier 1 approach of the 2006 IPCC Guidelines (vol. 5, chapter 6, p.6.25) starting from its 2019 annual submission until new information and data become available to validate the country-specific approach.	
		The ERT recommends that the Party ensure that N in sludge removed is considered in the estimation of the N_2O emissions from domestic wastewater treatment to avoid double counting of the N_2O emissions.	
W.21	5.D.1 Domestic wastewater – N_2O	The ERT noted that non-consumed protein added to wastewater ($F_{NON-CON}$) has not been taken into account in the estimation of N_2O emissions from domestic wastewater treatment. The 2006 IPCC Guidelines (vol. 5, chapter 6, table 6.11) provide default values for $F_{NON-CON}$. During the review, the Party presented provisional revised estimates using the IPCC default value for countries without garbage disposal of 1.1 for $F_{NON-CON}$ (the Party used this value because garbage disposal is not common in Luxembourg). The ERT noted that the missing emissions do not exceed the significance threshold established in the UNFCCC Annex I inventory reporting guidelines (5.01–5.61 kt CO_2 eq for 2013–2016 for the 2018 annual submission). The maximum missing emissions amount to 1.12 kt CO_2 eq (0.0091 per cent of national total GHG emissions) in 2007 and a minimum of 0.656 kt CO_2 eq (0.0064 per cent of national total GHG emissions) in 2015 and 0.670 kt CO_2 eq (0.0066 per cent of national total GHG emissions) in 2016. The ERT noted that this underestimation is below the significance threshold established in the UNFCCC Annex I inventory reporting guidelines (5.01–5.61 kt CO_2 eq for 2013–2016 for the 2018 annual submission). The Party also explained that the country-specific method used to estimate N_2O emissions from domestic wastewater treatment has limitations. Therefore, Luxembourg will use the tier 1 approach of the 2006 IPCC Guidelines (vol. 5, chapter 6, p.6.25) starting from its 2019 annual submission until new information and data become available to validate the country-specific approach.	Yes. Accuracy
		The ERT recommends that the Party ensure that N_2O emissions from non-consumed protein are included in N_2O emissions from domestic wastewater treatment.	
W.22	5.D.2 Industrial wastewater – CH_4	The NIR (p.564) states that industrial wastewater and sewage sludge are treated under aerobic conditions and, as a result, there are no CH_4 emissions. The CH_4 emissions from industrial wastewater are reported as "NO" in CRF table 5.D. The ERT noted that according to the 2006 IPCC Guidelines (vol. 5, chapter 6, table 6.8), default methane conversion factors for aerobic treatment are 0 (zero) and 0.3 for well managed and not well managed (overloaded) plants, respectively. During the review, the Party explained that Luxembourg has two industrial wastewater treatment plants which are well managed and treat wastewater below their designed maximum loads. Based on weekly analysis of effluent, their wastewater discharge is well below the thresholds set out in the discharge permit (e.g. biochemical oxygen demand, chemical oxygen demand, total N).	Yes. Transparency

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
		The ERT recommends that the Party provide information in the NIR to justify the use of the notation key "NO" for reporting CH_4 emissions from industrial wastewater treatment by explaining that the two wastewater treatment plants are well managed and treat wastewater below their designed maximum loads.	
W.23	5.D.2 Industrial wastewater – N_2O	N_2O emissions from industrial wastewater treatment are estimated using a country-specific method (NIR, pp.569–572). The ERT noted that there is no methodology in the 2006 IPCC Guidelines for the estimation of N_2O emissions from industrial wastewater (except for industrial wastewater that is co-discharged with domestic wastewater). The ERT commends Luxembourg for estimating N_2O emissions from industrial wastewater treatment using a country-specific approach. However, no clear explanation is provided on how the country-specific denitrification rate of 70 per cent is derived (e.g. measurement, literature). During the review, the Party explained that the denitrification rate is based on weekly measurements of the input and output of the two industrial wastewater treatment plants.	Yes. Transparency
		The ERT recommends that Luxembourg improve the transparency of its documentation in the NIR on the country-specific values for the denitrification rate (70 per cent) by providing a clear explanation on how the values are derived, the assumptions used and appropriateness of the values used.	
KP-LULUCF			
KL.5	General (KP-LULUCF) – CO_2	The NIR (section 11.1.3.1) states that the area of FM equals the total of forest land remaining forest land (Convention) plus the areas converted to forest land (Convention) minus the afforestation since 1990. However, when the ERT applied the previous equation to NIR table 274, the numbers do not seem to add up and thus the time series does not seem to be consistent. For example, in year 2000, the area under FM amounts to 88.52 kha, which is different from the value reported for forest land remaining forest land (82.21 kha) plus conversions to forest land (13.48 kha) minus afforestation since 1990 (7.00 kha), which amounts 88.69 kha. The differences appear to be the rounding for the areas of afforestation since 1990 (which is reported as 7.18 in CRF table 4(KP-I)A.1. In addition, the areas under KP-LULUCF activities reported for 2000 are different in the CRF tables compared with the NIR (e.g. for deforestation CRF table NIR 2 reports 4.55 kha but NIR table 274 reports 4.42 kha). During the review, the Party explained that in NIR table 274, the columns for AR and deforestation were misaligned by one year. This means that, in 2000, the values for 1999 were shown for AR and deforestation. During the review, Luxembourg updated NIR table 274 and demonstrated that the updated table was consistent with CRF table NIR 2.	Yes. Adherence to reporting guidelines under Article 7, paragraph 1, of the Kyoto Protocol
		The ERT recommends that the Party correct NIR table 274 so that it is consistent with the values reported in CRF tables 4(KP-I)A.1 and NIR 2.	
KL.6	General (KP-LULUCF) – CO_2	Luxembourg has provided a forest definition in the NIR (table 205) stating that forest land is all forest and wooded land according to the FAO TBRA2000 definition, with parameters of minimum land area 0.5 ha, crown cover 10 per cent and height 5 metres. The forest types are conifers, deciduous and mixed forests and the definitions of each type are also included. The ERT noted that this forest definition does not distinguish planted forests from natural forests. According to the Kyoto Protocol Supplement those land uses should be separated. The ERT also noted that the Party incorrectly reported the minimum land area as 0.05 ha (and not 0.5 ha) in CRF table NIR-1.	Yes. Adherence to the UNFCCC Annex I inventory reporting guidelines

ID#	Finding classification	Description of the finding with recommendation or encouragement	Is finding an issue and/or a problem?[a] If yes, classify by type
		The ERT noted the issue for the LULUCF sector described in ID# L.13 above and recommends that the Party use a stratification for KP-LULUCF activities in accordance with the 2006 IPCC Guidelines (vol. 4, chapter 3, p.16). The ERT also recommends that the Party correct the minimum land area reported in CRF table NIR-1 to show 0.5 ha and not 0.05 ha.	
KL.7	AR – CO_2	Luxembourg has not elected CM and GM. However, Luxembourg reported estimates of land areas under those activities (e.g. in 2016 the Party reported 0.01 kha and 0.04 kha for CM and GM, respectively, in CRF table NIR-2). During the review, the Party confirmed that it has not elected CM or GM and explained that the areas reported for CM and GM in CRF table NIR-2 are the annual areas that are converted from grassland and cropland to afforestation. The ERT recommends that the Party correct the information reported in CRF table NIR-2 on CM and GM, and report the conversion of cropland and grazing land to forest land (afforestation) under "other" converted to forest land (afforestation).	Yes. Adherence to reporting guidelines under Article 7, paragraph 1, of the Kyoto Protocol
KL.8	Biomass burning – CH_4 and N_2O	The ERT noted the issue for the LULUCF sector described in ID# L.21 above. The ERT recommends that the Party estimate and report CH_4 and N_2O emissions from biomass burning (including wildfires and controlled burning after infestations) for all appropriate KP-LULUCF activities and describe in the NIR how the estimations were made.	Yes. Completeness
KL.9	FM	The Party reported its FM cap as 3,585.341 kt CO_2 eq in CRF table accounting. The ERT noted that the FM cap was determined during the review of the report to facilitate the calculation of the assigned amount as 450.550 kt CO_2 eq (3,604.402 kt CO_2 eq for the duration of the commitment period) (see FCCC/IRR/2016/LUX, table 4, rows "3.5% of total base-year GHG emissions, excluding LULUCF and including indirect CO_2 emissions, final value, as calculated by the ERT" and "3.5% of total base-year GHG emissions, excluding LULUCF and including indirect CO_2 emissions, multiplied by eight, final value, as reported by the Party and agreed by the ERT"). The ERT recommends that the Party report its FM cap as 3,604.402 kt CO_2 eq in CRF table accounting.	Yes. Adherence to reporting guidelines under Article 7, paragraph 1, of the Kyoto Protocol

[a] Recommendations made by the ERT during the review are related to issues as defined in paragraph 81 of the UNFCCC review guidelines, or problems as defined in paragraph 69 of the Article 8 review guidelines. Encouragements are made to the Party to address all findings not related to such issues or problems.

VI. Application of adjustments

11.   The ERT has not identified the need to apply any adjustments to the 2018 annual submission of Luxembourg.

VII. Accounting quantities for activities under Article 3, paragraph 3, and, if any, activities under Article 3, paragraph 4, of the Kyoto Protocol

12.   Luxembourg has elected commitment period accounting and therefore the issuance and cancellation of units for KP-LULUCF activities is not applicable for the 2018 review.

VIII. Questions of implementation

13.   No questions of implementation were identified by the ERT during the individual review of the 2018 annual submission.

Overview of greenhouse gas emissions and removals for Luxembourg for submission year 2018 and data and information on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, as submitted by Luxembourg in its 2018 annual submission

1.   Tables 6–9 provide an overview of total GHG emissions and removals as submitted by Luxembourg.

Table 6
Total greenhouse gas emissions for Luxembourg, base year[a]–2016
(kt CO_2 eq)

	Total GHG emissions excluding indirect CO_2 emissions		Total GHG emissions including indirect CO_2 emissions[b]		Land-use change (Article 3.7 bis as contained in the Doha Amendment)[c]	KP-LULUCF activities (Article 3.3 of the Kyoto Protocol)[d]	KP-LULUCF activities (Article 3.4 of the Kyoto Protocol)	
	Total including LULUCF	Total excluding LULUCF	Total including LULUCF	Total excluding LULUCF			CM, GM, RV, WDR	FM
FMRL								–418.00
Base year	12 853.12	12 804.79	NA	NA	268.38		NA	
1990	12 834.30	12 785.97	NA	NA				
1995	9 528.33	10 095.37	NA	NA				
2000	8 964.66	9 666.67	NA	NA				
2010	12 021.08	12 174.24	NA	NA				
2011	11 781.87	12 056.62	NA	NA				
2012	11 414.11	11 774.87	NA	NA				
2013	10 698.63	11 234.92	NA	NA		–132.48	NA	–436.29
2014	10 319.35	10 776.27	NA	NA		–131.60	NA	–359.70
2015	9 880.84	10 287.46	NA	NA		–130.73	NA	–306.47
2016	9 550.68	10 041.74	NA	NA		–129.86	NA	–390.23

Note: Emissions/removals reported in the sector other (sector 6) are not included in total GHG emissions.

[a]   Base year refers to the base year under the Kyoto Protocol, which is 1990 for CO_2, CH_4 and N_2O, and 1995 for HFCs, PFCs, SF_6 and NF_3. Luxembourg has not elected any activities under Article 3, paragraph 4, of the Kyoto Protocol. For activities under Article 3, paragraph 3, of the Kyoto Protocol and FM under Article 3, paragraph 4, only the inventory years of the commitment period must be reported. CO_2, CH_4 and N_2O emissions included in the base year do not include the net emissions minus removals from conversion of forests (deforestation) that were included in Luxembourg's initial report for the second commitment period of the Kyoto Protocol for the base year and subsequently used for the calculation of the assigned amount.

[b]   The Party has not reported indirect CO_2 emissions in CRF table 6.

[c]   The value reported in this column refers to 1990.

[d]   Activities under Article 3, paragraph 3, of the Kyoto Protocol, namely AR and deforestation.

Table 7
Greenhouse gas emissions by gas for Luxembourg, excluding land use, land-use change and forestry, 1990–2016
(kt CO_2 eq)

	$CO_2{}^a$	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3
1990	11 812.04	631.40	341.65	0.0001	NO	NO	0.88	NO
1995	9 118.08	618.85	338.74	18.31	NO	NO	1.39	NO
2000	8 672.87	623.56	338.73	29.58	NO	NO	1.93	NO
2010	11 161.18	630.52	322.22	53.46	NO	NO	6.87	NO
2011	11 056.89	605.56	330.51	56.34	NO	NO	7.31	NO
2012	10 795.02	596.84	316.59	58.73	NO	NO	7.68	NO
2013	10 241.22	601.53	321.77	62.36	NO	NO	8.05	NO
2014	9 767.85	614.33	318.53	67.12	NO	NO	8.44	NO
2015	9 272.56	620.71	317.89	67.42	NO	NO	8.89	NO
2016	9 016.41	625.05	325.27	65.77	NO	NO	9.23	NO
Per cent change 1990–2016	**−23.7**	**−1.0**	**−4.8**	**91 987 902.0**	**NA**	**NA**	**953.7**	**NA**

Note: Emissions/removals reported in the sector other (sector 6) are not included in total GHG emissions.
[a] Luxembourg did not report indirect CO_2 emissions in CRF table 6.

Table 8
Greenhouse gas emissions by sector for Luxembourg, 1990–2016
(kt CO_2 eq)

	Energy	IPPU	Agriculture	LULUCF	Waste	Other
1990	10 263.87	1 640.25	773.50	48.33	108.35	NO
1995	8 207.82	1 031.71	751.18	−567.04	104.65	NO
2000	8 029.97	779.35	748.82	−702.01	108.53	NO
2010	10 679.75	675.55	719.75	−153.17	99.19	NO
2011	10 556.36	692.31	712.80	−274.75	95.14	NO
2012	10 357.46	633.34	692.49	−360.76	91.59	NO
2013	9 816.11	617.65	709.00	−536.29	92.16	NO
2014	9 330.51	633.83	718.62	−456.92	93.32	NO
2015	8 836.07	627.51	736.26	−406.62	87.61	NO

	Energy	IPPU	Agriculture	LULUCF	Waste	Other
2016	8 551.86	652.06	752.06	−491.05	85.75	NO
Per cent change 1990–2016	**−16.7**	**−60.2**	**−2.8**	**−1 115.9**	**−20.9**	**NA**

Notes: (1) Emissions/removals reported in the sector other (sector 6) are not included in total GHG emissions. (2) Luxembourg did not report indirect CO_2 emissions in CRF table 6.

Table 9

Greenhouse gas emissions/removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol by activity, base year[a]–2016, for Luxembourg

(kt CO_2 eq)

	Article 3.7 bis as contained in the Doha Amendment[b]	Article 3.3 of the Kyoto Protocol		FM and elected Article 3.4 activities of the Kyoto Protocol				
	Land-use change	*AR*	*Deforestation*	*FM*	*CM*	*GM*	*RV*	*WDR*
FMRL				−418.00				
Technical correction				181.68				
Base year	268.38				NA	NA	NA	NA
2013		−179.37	46.90	−436.29	NA	NA	NA	NA
2014		−176.28	44.68	−359.70	NA	NA	NA	NA
2015		−173.19	42.46	−306.47	NA	NA	NA	NA
2016		−170.10	40.24	−390.23	NA	NA	NA	NA
Per cent change base year–2016					**NA**	**NA**	**NA**	**NA**

Note: Values in this table include emissions on lands subject to natural disturbances, if applicable.

[a] Luxembourg has not elected any activities under Article 3, paragraph 4, of the Kyoto Protocol. For activities under Article 3, paragraph 3, of the Kyoto Protocol, and FM under Article 3, paragraph 4, only the inventory years of the commitment period must be reported.

[b] The value reported in this column refers to 1990.

2. Table 10 provides an overview of relevant key data for Luxembourg's reporting under Article 3, paragraphs 3 and 4, of the Kyoto Protocol.

Table 10
Key relevant data for Luxembourg under Article 3, paragraphs 3 and 4, of the Kyoto Protocol in the 2018 annual submission

Key parameters	Values
Periodicity of accounting	(a) AR: commitment period accounting
	(b) Deforestation: commitment period accounting
	(c) FM: commitment period accounting
	(d) CM: not elected
	(e) GM: not elected
	(f) RV: not elected
	(g) WDR: not elected
Election of activities under Article 3, paragraph 4	None
Election of application of provisions for natural disturbances	Yes, for AR and FM
3.5% of total base-year GHG emissions, excluding LULUCF	450.550 kt CO_2 eq (3 604.402 kt CO_2 eq for the duration of the commitment period) (see ID# KL.9 in table 5)
Cancellation of AAUs, ERUs, CERs and/or issuance of RMUs in the national registry for:	
1. AR in 2016	NA
2. Deforestation in 2016	NA
3. FM in 2016	NA
4. CM in 2016	NA
5. GM in 2016	NA
6. RV in 2016	NA
7. WDR in 2016	NA

Annex II

Information to be included in the compilation and accounting database

Tables 11–14 include the information to be included in the compilation and accounting database for Luxembourg. Data shown are from the original annual submission of the Party, including the latest revised estimates submitted, adjustments (if applicable), as well as the final data to be included in the compilation and accounting database.

Table 11
Information to be included in the compilation and accounting database for 2016, including on the commitment period reserve, for Luxembourg
(t CO_2 eq)

	Original submission	*Revised estimates*	*Adjustment*	*Final*
CPR	65 209 026			65 209 026
Annex A emissions for 2016				
CO_2	9 002 956	9 016 413		9 016 413
CH_4	625 049			625 049
N_2O	325 272			325 272
HFCs	65 771			65 771
PFCs	NO			NO
Unspecified mix of HFCs and PFCs	NO			NO
SF_6	9 233			9 233
NF_3	NO			NO
Total Annex A sources	**10 028 280**	**10 041 738**		**10 041 738**
Activities under Article 3, paragraph 3, of the Kyoto Protocol for 2016				
3.3 AR	–170 098			–170 098
3.3 Deforestation	40 240			40 240
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol for 2016				
3.4 FM	–390 230			–390 230

Table 12
Information to be included in the compilation and accounting database for 2015, for Luxembourg
(t CO_2 eq)

	Original submission	*Revised estimates*	*Adjustment*	*Final*
Annex A emissions for 2015				
CO_2	9 259 659	9 272 556		9 272 556
CH_4	620 706			620 706
N_2O	317 892			317 892
HFCs	67 423			67 423
PFCs	NO			NO
Unspecified mix of HFCs and PFCs	NO			NO
SF_6	8 885			8 885
NF_3	NO			NO
Total Annex A sources	**10 274 565**	**10 287 462**		**10 287 462**

Activities under Article 3, paragraph 3, of the Kyoto Protocol for 2015

	Original submission	Revised estimates	Adjustment	Final
3.3 AR	−173 190			−173 190
3.3 Deforestation	42 460			42 460
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol for 2015				
3.4 FM	−306 473			−306 473

Table 13
Information to be included in the compilation and accounting database for 2014, for Luxembourg
(t CO_2 eq)

	Original submission	Revised estimates	Adjustment	Final
Annex A emissions for 2014				
CO_2	9 757 506	9 767 850		9 767 850
CH_4	614 331			614 331
N_2O	318 527			318 527
HFCs	67 122			67 122
PFCs	NO			NO
Unspecified mix of HFCs and PFCs	NO			NO
SF_6	8 441			8 441
NF_3	NO			NO
Total Annex A sources	**10 765 928**	**10 776 272**		**10 776 272**
Activities under Article 3, paragraph 3, of the Kyoto Protocol for 2014				
3.3 AR	−176 282			−176 282
3.3 Deforestation	44 679			44 679
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol for 2014				
3.4 FM	−359 703			−359 703

Table 14
Information to be included in the compilation and accounting database for 2013, for Luxembourg
(t CO_2 eq)

	Original submission	Revised estimates	Adjustment	Final
Annex A emissions for 2013				
CO_2	10 233 338	10 241 217		10 241 217
CH_4	601 525			601 525
N_2O	321 769			321 769
HFCs	62 362			62 362
PFCs	NO			NO
Unspecified mix of HFCs and PFCs	NO			NO
SF_6	8 051			8 051
NF_3	NO			NO
Total Annex A sources	**11 227 046**	**11 234 924**		**11 234 924**
Activities under Article 3, paragraph 3, of the Kyoto Protocol for 2013				
3.3 AR	−179 375			−179 375
3.3 Deforestation	46 898			46 898
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol for 2013				
3.4 FM	−436 290			−436 290

Annex III

Additional information to support findings in table 2

Missing categories that may affect completeness

The categories for which methods are included in the 2006 IPCC Guidelines that were reported as "NE" or for which the ERT otherwise determined that there may be an issue with the completeness of reporting in the Party's inventory are the following:

(a) SF_6 emissions from particle accelerators under category 2.G.2 SF_6 and PFCs from other product use (see ID# I.21 in table 5);

(b) CH_4 and N_2O emissions from biomass burning (including wildfires and controlled burning after infestations) on all land-use categories (see ID# L.21 in table 5);

(c) CH_4 and N_2O emissions from biomass burning (including wildfires and controlled burning after infestations) on all appropriate KP-LULUCF activities (see ID# KL.8 in table 5).

Annex IV

Documents and information used during the review

A. Reference documents

IPCC reports

IPCC. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. S Eggleston, L Buendia, K Miwa, et al. (eds.). Hayama: Institute for Global Environmental Strategies. Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl.

IPCC. 2014. *2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol*. T Hiraishi, T Krug, K Tanabe, et al. (eds.). Hayama: Institute for Global Environmental Strategies. Available at http://www.ipcc-nggip.iges.or.jp/public/kpsg.

IPCC. 2014. *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*. T Hiraishi, T Krug, K Tanabe, et al. (eds.). Geneva: IPCC. Available at http://www.ipcc-nggip.iges.or.jp/public/wetlands/.

Annual review reports

Reports on the individual review of the 2011–2016 annual submissions of Luxembourg, contained in documents FCCC/ARR/2011/LUX, FCCC/ARR/2012/LUX, FCCC/ARR/2013/LUX, FCCC/ARR/2014/LUX, FCCC/ARR/2015/LUX and FCCC/ARR/2016/LUX, respectively.

Other

Aggregate information on greenhouse gas emissions by sources and removals by sinks for Parties included in Annex I to the Convention. Note by the secretariat. Available at https://unfccc.int/sites/default/files/resource/AGI%20report_2018.pdf.

Annual status report for Luxembourg for 2018. Available at https://unfccc.int/sites/default/files/resource/asr2018_LUX.pdf .

European Environment Agency. 2016. *EMEP/EEA Air Pollutant Emission Inventory Guidebook 2016*. Luxembourg City: Publications Office of the European Union. Available at https://www.eea.europa.eu/publications/emep-eea-guidebook-2016.

B. Additional information provided by the Party

Responses to questions during the review were received from Mr. Marc Schuman (Environment Agency, Ministry of Sustainable Development and Infrastructures), including additional material on the methodology and assumptions used. The following documents[1] were also provided by Luxembourg:

Alderweireld, M. (2015). *Exploitation des données de l'inventaire forestier national permanent du Grand-Duché de Luxembourg pour quantifier la biomasse ligneuse en forêt (Use of data from the permanent national forest inventory of the Grand Duchy of Luxembourg to quantify woody biomass in the forest)*. Gembloux Agro-bio tech (University of Liege).

DLG (2008): *Abschätzung der Stickstoffausscheidung bei der Milchkuh auf Basis von Milchharnstoffgehalt und Milchleistung – Arbeiten der DLG/Band 199* (Estimation of nitrogen excretion in the dairy cow on the basis of milk urea content and milk yield - work of the DLG / Band 199).

---

[1] Reproduced as received from the Party.

Dumont M, Luning L, Yildiz I and Koop K (2013). *Methane emissions in biogas production*. The Biogas Handbook – Science, production and applications, pp.248–266. Edited by Wellinger A, Murphy J and Baxter D. Woodhead Publishing.

Environment Agency Luxembourg (2018). *Estimation on emissions and removals from CM and GM for the purpose of reporting under Art.3.2.a and Art.3.2.b of Decision 529/2013/EU*. 15 March 2018.

Flesch TK, Desjardins RL and Worth D (2011). *Fugitive methane emissions from an agricultural biodigester*. Biomass and Bioenergy, vol. 35, issue 9, pp.3927–3935.

Reddy CM, DeMello JA, Carmichael CA, Peacock EE, Xu L and Arey JS. (2008). *Determination of Biodiesel Blending Percentages Using Natural Abundance Radiocarbon Analysis: Testing the Accuracy of Retail Biodiesel Blends*. Environ. Sci. Technol. 2008, 42, 7, pp.2476–2482. Available at https://pubs.acs.org/doi/abs/10.1021/es071814j.

Règlement grand-ducal du 24 avril 2017 relatif à la mise en place d'un système national pour la surveillance, l'évaluation et la déclaration des émissions de gaz à effet de serre et des polluants atmosphériques et la déclaration d'autres informations ayant trait au changement climatique et à la pollution atmosphérique (Grand-Ducal Regulation of 24 April 2017 on the establishment of a national system for the monitoring, evaluation and reporting of greenhouse gas emissions and air pollutants and the reporting of other information relating to climate change and air pollution).
Available at http://legilux.public.lu/eli/etat/leg/rgd/2017/04/24/a446/jo.

Loi du 18 décembre 2015 modifiant la loi modifiée du 21 mars 2012 relative aux déchets (Law of 18 December 2015 amending the amended law of 21 March 2012 on waste). Available at http://legilux.public.lu/eli/etat/leg/loi/2015/12/18/n17/jo.