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Report on the individual review of the annual submission of Luxembourg submitted in 2022*

Note by the expert review team

Summary

Each Party included in Annex I to the Convention must submit an annual inventory of emissions and removals of greenhouse gases 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 review of the 2022 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 12 to 17 September 2022 in Bonn.

* In the symbol for this document, 2022 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 source	source category included in Annex A to the Kyoto Protocol
AR	afforestation and reforestation
Article 8 review guidelines	"Guidelines for review under Article 8 of the Kyoto Protocol"
C	carbon
CER	certified emission reduction
CH_4	methane
CM	cropland management
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
Convention reporting adherence	adherence to the "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"
CPR	commitment period reserve
CRF	common reporting format
EEA	European Environment Agency
EF	emission factor
EMEP	Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
ERT	expert review team
ERU	emission reduction unit
EU	European Union
F-gas	fluorinated gas
F_I	stock change factor for input of organic matter
F_{LU}	stock change factor for land use or land-use change type
FM	forest management
F_{MG}	stock change factor for management regime
FMRL	forest management reference level
GHG	greenhouse gas
GM	grazing land management
HFC	hydrofluorocarbon
HWP	harvested wood products
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
IPPU	industrial processes and product use
KP reporting adherence	adherence to the reporting guidelines under Article 7, paragraph 1, of the Kyoto Protocol
KP-LULUCF	activities under Article 3, paragraphs 3–4, of the Kyoto Protocol
LULUCF	land use, land-use change and forestry
N	nitrogen
N_2O	nitrous oxide
NA	not applicable
NE	not estimated
$N_{EFFLUENT}$	nitrogen in the effluent discharged to aquatic environments
NF_3	nitrogen trifluoride
NFI	national forest inventory

NIR	national inventory report
NO	not occurring
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
SWDS	solid waste disposal site(s)
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*
WWTP	wastewater treatment plant
Y_m	methane conversion rate

I. Introduction

1. This report covers the review of the 2022 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" (annex to decision 13/CP.20). The review took place from 12 to 17 September 2022 in Bonn, and was coordinated by María José López (secretariat). Table 1 provides information on the composition of the ERT that conducted the review for Luxembourg.

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

Area of expertise	*Name*	*Party*
Generalist	Agita Gancone	Latvia
	Ole-Kenneth Nielsen	Denmark
Energy	Yuriko Hayabuchi	Japan
	Ole-Kenneth Nielsen	Denmark
IPPU	Juan Luis Martin Ortega	El Salvador
	Alexander Valencia	Colombia
Agriculture	Paul Duffy	Ireland
	Braulio Pikman	Brazil
LULUCF and KP-LULUCF	Markus Didion	Switzerland
	Amanda Thomson	United Kingdom
	Marina Vitullo	Italy
Waste	Violeta Hristova	Bulgaria
	Erick Wamalwa Masafu	Kenya
Lead reviewers	Paul Duffy	
	Braulio Pikman	

2. The basis of the findings in this report is the assessment by the ERT of the Party's 2022 annual submission in accordance with the UNFCCC review guidelines and the Article 8 review guidelines.

3. The ERT has made recommendations that Luxembourg resolve identified findings, including issues[1] designated as problems.[2] Other findings, and, if applicable, the encouragements of the ERT to Luxembourg to resolve related issues, are also included in this report.

4. A draft version of this report was communicated to the Government of Luxembourg, which provided no comments.

5. Annex I presents the annual GHG emissions of Luxembourg, including totals excluding and including LULUCF, indirect CO_2 emissions, and emissions by gas and by sector, and contains background data on emissions and removals from KP-LULUCF, if elected by the Party, by gas, sector and activity.

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

[1] Issues are defined in decision 13/CP.20, annex, para. 81.
[2] Problems are defined in decision 22/CMP.1, annex, paras. 68–69, as revised by decision 4/CMP.11.

II. Summary and general assessment of the Party's 2022 annual submission

7. Table 2 provides the assessment by the ERT of the Party's 2022 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 2022 annual submission of Luxembourg

Assessment			*Issue/problem ID#(s) in table 3 or 5*[a]
Dates of submission	Original submission: NIR, 14 April 2022; CRF tables (version 1), 14 April 2022; SEF tables, 14 April 2022 Revised submission: NIR, 6 May 2022; CRF tables (version 2), 27 October 2022		
Review format	Centralized		
Application of the requirements of the UNFCCC Annex I inventory reporting guidelines and the Wetlands Supplement (if applicable)	Have any issues been identified in the following areas:		
	(a) Identification of key categories?	No	
	(b) Selection and use of methodologies and assumptions?	Yes	I.16
	(c) Development and selection of EFs?	Yes	I.14
	(d) Collection and selection of AD?	Yes	L.12
	(e) Reporting of recalculations?	No	
	(f) Reporting of a consistent time series?	No	
	(g) Reporting of uncertainties, including methodologies?	Yes	G.6
	(h) QA/QC?	QA/QC procedures were assessed in the context of the national system (see supplementary information under the Kyoto Protocol below)	
	(i) Missing categories, or completeness?[b]	L.19	
	(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?	Yes	
Supplementary information under the Kyoto Protocol	Have any issues been identified related to the following aspects of the national system:		
	(a) 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?	No	
	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 adherence to technical standards for data exchange?	No	

Assessment			*Issue/problem ID#(s) in table 3 or 5*[a]
	Have any issues been identified related to the reporting of information on AAUs, CERs, ERUs and RMUs and on discrepancies 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	
	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 the 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	
	Have any issues been identified related to the following reporting requirements for KP-LULUCF:		
	(a) Reporting requirements of 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 33–34?	No	
CPR	Was the CPR reported in accordance with decision 18/CP.7, annex; decision 11/CMP.1, annex; and decision 1/CMP.8, paragraph 18?	No	G.1
Adjustments	Has the ERT applied any adjustments under Article 5, paragraph 2, of the Kyoto Protocol?	No	
	Has the Party submitted a revised estimate to replace a previously applied adjustment?	NA	Luxembourg does not have a previously applied adjustment
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 assessing 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 any questions of implementation?	No	

[a] Further information on the issues identified, as well as additional findings, may be found in tables 3 and 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 recommendations included in the previous review report

8. Table 3 compiles the recommendations from previous review reports that were included in the most recent previous review report, published on 13 September 2021,[3] and had not been resolved by the time of publication of the report on the review of the Party's 2020 annual submission. The ERT has specified whether it believes the Party had resolved, was addressing or had not resolved each issue or problem by the time of publication of this review report and has provided the rationale for its determination, which takes into consideration the publication date of the most recent previous review report and national circumstances.

Table 3
Status of implementation of recommendations included in the previous review report for Luxembourg

ID#	*Issue/problem classification*[a,b]	*Recommendation from previous review report*	*ERT assessment and rationale*
General			
G.1	CPR (G.1, 2020) (G.5, 2018) KP reporting adherence	Select the CPR as the lower value between 90 per cent of the assigned amount and the value of eight times the latest inventory year reported in the annual submission using total emissions without LULUCF.	Not resolved. The Party reported in its NIR (p.672) the CPR value of eight times the latest inventory year reported in the annual submission using total emissions including LULUCF. The Party indicated in the NIR (pp.671–672) that 90 per cent of the assigned amount is 63,604,947 t CO_2 eq. However, the value is 65,209,026 t CO_2 eq in the initial review report. The ERT concludes that this potential problem of a mandatory nature does not influence the Party's ability to fulfil its commitments for the second commitment period of the Kyoto Protocol and therefore this issue was not included in the list of potential problems and further questions raised by the ERT.
G.2	Key category analysis (G.2, 2020) (G.2, 2018) (G.8, 2016) (G.8, 2015) Convention reporting adherence	Improve QA/QC in reporting on the key category analysis to ensure consistency with the UNFCCC Annex I inventory reporting guidelines by including information about the differences between the key categories identified in the NIR and those in CRF table 7.	Resolved. The Party reported in its NIR (pp.59–60) differences between the key categories identified in the NIR and in CRF table 7.
G.3	National registry (G.11, 2020) Transparency	Update the legal reference regarding publicly available information in the NIR by replacing the reference to EU regulation 2216/2004 to EU regulation 389/2013.	Not resolved. The Party has not updated the legal reference to EU regulation 389/2013 in its NIR (p.671) regarding publicly available information, but clarified during the review that the reference will be updated in its next NIR.

[3] FCCC/ARR/2020/LUX. The ERT notes that the report on the individual inventory review of Luxembourg's 2021 annual submission has not been published yet owing to insufficient funding for the review process. As a result, the latest previously published annual review report reflects the findings of the review of the Party's 2020 annual submission.

ID#	*Issue/problem classification*[a,b]	*Recommendation from previous review report*	*ERT assessment and rationale*
G.4	QA/QC and verification (G.12, 2020) Convention reporting adherence	Strengthen the implementation of the QA/QC procedures, as planned, to avoid incorrect assessment of uncertainties and inconsistencies in the NIR and the CRF tables, and report on the improvements in the NIR.	Addressing. The Party included in its NIR (p.69) planned improvements related to the quality management system. During the review, the Party clarified that over the last two years, the inventory team has received several days of QA/QC training from an external partner. The training covered, for example, general reporting guidelines, uncertainty assessment and documentation of expert judgments. In addition, Luxembourg's quality manual is being updated. The emphasis lies on improving data validation checklists (sector-specific and general) and creating relevant QA/QC procedures. In response to a question raised by the ERT, the Party provided detailed information on the status of these planned improvements, including that the new calculation method to determine land-use changes has required the revision of most calculation spreadsheets and hence most tables in the NIR for the LULUCF sector, as well as the CRF tables. Luxembourg has used this opportunity to verify those tables and make them more consistent but noted that only the short version of the checklists was filled out by sector experts. The ERT noted that not all inconsistencies in the NIR have been corrected (see IDs# I.2 and L.1 below). The ERT considers that the recommendation has not yet been fully addressed because the Party has not yet corrected all inconsistencies (i.e. those noted in IDs# I.2 and L.1 below).
G.5	Uncertainty analysis (G.7, 2020) (G.11, 2018) Convention reporting adherence	Improve the 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.	Resolved. The Party reported an uncertainty assessment in its NIR (section 1.7, pp.70–76). The ERT did not identify any inconsistencies between the uncertainty assessment reported in the NIR for 2020 and that reported in CRF table summary 2. The ERT noted that the Party has improved the QC processes for reporting on uncertainty through the integration of a sum check into the uncertainty calculation table in order to identify any differences with the reporting tables and to ensure that input uncertainties are updated each year.
G.6	Uncertainty analysis (G.13, 2020) Convention reporting adherence	Include the quantitative uncertainty assessment for the base year for all source and sink categories, as well as for the total inventory.	Not resolved. The Party reported an uncertainty assessment in NIR table 1-13 (pp.72–75) for the latest inventory year (2020) and the trend between the base year and the latest inventory year. However, a quantitative uncertainty assessment for the base year for all source and sink categories, as well as for the total inventory, has not been performed. During the review, the Party clarified that it will make efforts to include a quantitative uncertainty assessment for the base year for all source and sink categories, as well as for the total inventory in a future submission (in 2023 or 2024, depending on the human resources available).
Energy			
E.1	Fuel combustion – reference approach – liquid fuels – CO_2 (E.3, 2020) (E.17, 2018)	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.	Resolved. The Party corrected all discrepancies in jet kerosene for international aviation between CRF table 1.D and CRF table 1.A(b) by using the same national energy balance data that are submitted to the International Energy Agency, as explained in the NIR (pp.171–172).

ID#	*Issue/problem classification*[a,b]	*Recommendation from previous review report*	*ERT assessment and rationale*
	Convention reporting adherence		
E.2	1.A Fuel combustion – sectoral approach – liquid fuels – CO_2 (E.5, 2020) (E.18, 2018) Transparency	Provide in the NIR information on the biofuel import certificates and the online registry system on biofuel supply chains.	Resolved. Information on the biofuel import certificates and the online registry system on biofuel supply chains was not included in the NIR. During the review, the Party clarified that this registry is not managed by the inventory team but by another team within the Environment Agency. The inventory team is able to obtain information from the registry on demand. The Party explained that, as the biofuel import certificates are established by independent verifiers, the inventory team considers that the certificates fulfil the quality requirements for inventory input data; however, the certificates cannot be made publicly available. The ERT recognizes this and concludes that the NIR is sufficiently transparent on imports of liquid fuels pre-blended with biofuels.
E.3	1.A.3.b Road transportation – liquid fuels – CH_4 (E.7, 2020) (E.20, 2018) Transparency	Provide justification of the applicability of domestic fleet CH_4 EFs to the transborder fleet, or adopt an alternative approach, such as using default CH_4 EFs for the transborder fleet.	Resolved. The Party reported the justification of the applicability of domestic fleet CH_4 EFs to the transborder fleet in its NIR (p.243). The Party clarified that the share of diesel- and gasoline-fuelled cars in the commuter fleets is based on the shares of the fleets of neighbouring countries (Belgium, France and Germany). The detailed composition of each of these fleets (age and technology) is assumed to be identical to that of Luxembourg's domestic fleet.
E.4	1.A.3.b Road transportation – diesel – CH_4 and N_2O (E.10, 2020) (E.21, 2018) Transparency	Justify the assumptions underlying the estimation of the diesel used by transborder cars and heavy-duty vehicles, including the assumptions on the shares of the gasoline- and diesel-fuelled cars in the transborder fleet, or use an alternative approach to avoid a possible underestimation of CH_4 and N_2O emissions.	Resolved. The Party reported in its NIR (p.243) the justification of the assumptions underlying the estimation of the diesel used by transborder cars and heavy-duty vehicles, including those on the shares of the gasoline- and diesel-fuelled cars in the transborder fleet. The share of diesel- and gasoline-fuelled cars in the commuter fleets is based on the shares of the fleets of the neighbouring regions (Belgium, Grand Est (France), and Rhineland-Palatinate and Saarland (Germany)). However, the detailed composition of each of these fleets (age, technology) is assumed to be identical to the structures of Luxembourg's domestic fleet (i.e. the CH_4 IEF of the domestic gasoline-fuelled passenger car fleet is applied to the gasoline-fuelled commuting passenger car fleet, etc.), owing to a lack of region-specific fleet data from the neighbouring countries. In the case of passenger cars, the justification for assuming a similar age/technology composition of the commuter fleets is that the owners of these vehicles work in Luxembourg, have significantly higher salaries than if they were working in their home country, and thus have higher living standards than their non-commuting fellow citizens. As a consequence, the commuter fleets are assumed to be more similar to Luxembourg's domestic fleet than to the average fleet of the commuters' country of residence. For heavy-duty vehicles, the fleet composition is also considered to be identical to that of the Luxembourg fleet, which is relatively modern. This has been verified by expert judgment (personal communication) from Luxembourg's customs office. Indeed, the national and transiting heavy-duty vehicles fleets are very similar, with roughly 80 per cent of the models aged 1–5 years, 15 per cent aged 5–10 years and 5 per cent aged over 10 years.

ID#	*Issue/problem classification*[a,b]	*Recommendation from previous review report*	*ERT assessment and rationale*
E.5	1.A.4.a Commercial/institutional – biomass – CO_2, CH_4 and N_2O (E.12, 2020) (E.23, 2018) Transparency	Update the NIR text with the description of biomass fuel types and choice of EFs, and correct the entries in NIR table 107.	Resolved. The Party reported in its NIR (pp.259–260) the description of biomass fuel types and choice of EFs, as well as the corrected default CH_4 EF value for wood and wood waste.
E.6	1.A.4.b Residential – liquid fuels – CH_4 and N_2O (E.13, 2020) (E.24, 2018) Transparency	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 transborder 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.	Resolved. The Party reported in its NIR (p.262) the rationale for not reallocating any fuel to off-road use by commuters.
E.7	1.A.4.b Residential – liquid fuels – CH_4 (E.14, 2020) (E.25, 2018) Transparency	Revise the CH_4 EF for residential use of gasoline and, if choosing a non-IPCC default EF, include in the NIR a justification of its applicability to Luxembourg.	Addressing. The Party has not provided a justification in the NIR for use of a CH_4 EF for residential use of gasoline other than the IPCC default. During the review, the Party clarified that the CH_4 EFs for gasoline used in gardening equipment are based on the *EMEP/EEA air pollutant emission inventory guidebook 2019*. The Party stated that it is making efforts to justify the applicability of the EFs to Luxembourg in the NIR but considers that these values are justified as they are based on recent European measurements (*EMEP/EEA air pollutant emission inventory guidebook 2019*, section 1.A.4 (non-road mobile machinery), p.38). The ERT considers that the recommendation has not been fully addressed because the Party has not included in its NIR a justification of the applicability of the CH_4 EF to Luxembourg.
E.8	1.B.2.b Natural gas – CO_2 and CH_4 (E.15, 2020) (E.26, 2018) Completeness	Include emissions and AD estimates for venting from natural gas transmission, and include in the NIR a description of the estimation methodology.	Resolved. The Party reported in CRF table 1.B.2 and in its NIR (p.281) the estimation for venting from natural gas transmission and demonstrated that the methodology is comparable to the tier 3 approach in the 2006 IPCC Guidelines (vol. 2, chap. 4, p.4.66).
IPPU			
I.1	2. General (IPPU) (I.1, 2020) (I.1, 2018) (I.1, 2016) (I.1, 2015) (38, 2014) Transparency	Explain every recalculation, such as the update of AD and EFs for solvent and other product use.	Resolved. The Party reported in its NIR (pp.297, 354, 368 and 371) the explanation for the recalculations made in the various categories.

ID#	*Issue/problem classification*[a,b]	*Recommendation from previous review report*	*ERT assessment and rationale*
I.2	2. General (IPPU) – all gases (I.24, 2020) Convention reporting adherence	Revise NIR tables 4-1, 4-9 and 4-10 (for categories 2.C, 2.F and 2.G) so that the whole time series of emissions is consistent with data in CRF tables 2(I)s1 and 2(I)s2 and update the notes to NIR table 4-1 regarding the global warming potential values used.	Addressing. The Party corrected the inconsistencies in NIR tables 4-1, 4-9 and 4-10 (pp.287, 304 and 309). During the review, the Party clarified that the global warming potential values in the notes to NIR table 4-1 will be corrected in its next annual submission. The ERT considers that the recommendation has not yet been fully addressed because the Party has not yet corrected the global warming potential values in the notes to NIR table 4-1.
I.3	2.A.1 Cement production – CO_2 (I.25, 2020) Transparency	Provide an explanation of the emission trends in the NIR, in particular regarding significant variations in the IEF across the time series, by providing more information on the drivers influencing CO_2 emissions from cement production, such as that provided during the 2020 review regarding increased use of decarbonated compounds containing calcium oxide and magnesium oxide.	Resolved. The Party reported in its NIR (p.296) that the conversion factor (applied to take into account non-carbonate calcium oxide and magnesium oxide inputs) is based on measurements taken twice a month of total carbon, organic carbon, calcium oxide and magnesium oxide content in the raw material. Luxembourg also reported in its NIR (p.297) that recalculations were carried out on the basis of EU review suggestions (EU effort-sharing decision review 2020) for 1990–2011, changing the conversion factor from 1 to 0.93 to avoid overestimation. Furthermore, emissions resulting from various fluxes were extrapolated on the basis of 2014 values and added to the emissions for 1990–2013. The ERT concludes that the trends in emissions are sufficiently explained in the NIR.
I.4	2.D.1 Lubricant use – CO_2 (I.26, 2020) Accuracy	Correct the AD and emissions reported in CRF table 2(I).A-Hs2 for 2008–2014 so that they are consistent with the data in NIR table 4-18.	Resolved. The Party reported in NIR table 4-18 (p.320) AD and emissions consistent with those reported in CRF table 2(I).A-Hs2 for the whole time series.
I.5	2.D.2 Paraffin wax use – CO_2 (I.4, 2020) (I.11, 2018) Transparency	Explain the trend of AD and CO_2 emissions and the significant inter-annual changes between 2012 and 2013 in the NIR.	Resolved. The Party reported in its NIR (p.322) that, from 2010, AD for paraffin wax increased significantly because a new paraffin wax company began production. The ERT concludes that the trends in emissions are sufficiently explained in the NIR.
I.6	2.F Product uses as substitutes for ozone-depleting substances – HFCs, PFCs and SF_6 (I.9, 2020) (I.14, 2018) Convention reporting adherence	Estimate and report the uncertainty for each subcategory under 2.F and explain in the NIR how those uncertainties are estimated.	Resolved. The Party included in its NIR (p.367) a table containing estimations of the uncertainty for each subcategory under 2.F and corresponding explanations.
I.7	2.F Product uses as substitutes for ozone-depleting substances – HFCs (I.10, 2020) (I.15, 2018)	Revise NIR table 158 so that the HFC emissions for categories 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.	Resolved. The Party reported in NIR table 4-33 (p.357) emissions consistent with those reported in CRF table 2(I)s2.

ID#	*Issue/problem classification*[a,b]	*Recommendation from previous review report*	*ERT assessment and rationale*
	Convention reporting adherence		
I.8	2.F.1 Refrigeration and air conditioning – HFCs (I.11, 2020) (I.8, 2018) (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.	Resolved. The Party reported in its NIR (p.361) that, in line with the default EFs in the 2006 IPCC Guidelines, and assuming a conservative rate of 100 per cent for manufacture and decommissioning of equipment in Luxembourg, a manufacturing EF of 0.5 per cent and a decommissioning EF of 30 per cent were adopted on the basis of the expert opinion of representatives from a Luxembourg training centre for refrigeration and air-conditioning technicians and representatives from the two biggest companies in the sector. Furthermore, as decommissioned domestic equipment is exported to neighbouring countries, part of the decommissioning process does not take place in Luxembourg.
I.9	2.F.1 Refrigeration and air conditioning – HFCs (I.12, 2020) (I.16, 2018) Transparency	Correct the description in the NIR of the estimation of HFC emissions from manufacture of refrigeration equipment.	Resolved. The Party reported in its NIR (p.359) that, on the basis of a six-month emissions survey conducted in 2006 by Dometic (the only refrigerator manufacturer in the country), emissions from manufacture of refrigeration equipment in 2006 were calculated as 2 kg R134a. The manufacturing EF was reinvestigated with the producer in 2018 and found to be equal to the 2006 value, namely 2 kg, on the basis of AD. HFC emissions have been changed using the HFC EF and the description in the NIR has been corrected.
I.10	2.F.1 Refrigeration and air conditioning – HFCs (I.13, 2020) (I.9, 2018) (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.	Resolved. The Party reported in its NIR (p.358) information related to the methods used for estimating emissions for category 2.F.1 (refrigeration and air conditioning) and general information on the AD and EF applied to estimate HFC emissions.
I.11	2.F.1 Refrigeration and air conditioning – HFCs (I.15, 2020) (I.17, 2018) Transparency	Explain in the NIR the methodology used to estimate all emissions, planned and unplanned (e.g. from accidental and other unplanned releases), from manufacture of refrigeration equipment, including a description of any recovery system.	Resolved. The Party reported in its NIR (p.359) that, on the basis of a six-month emissions survey by Dometic in 2006, a manufacturing emission of 2 kg R134a was calculated for 2006. The manufacturing EF was reinvestigated with the producer in 2018 and found to be equal to the 2006 value, namely 2 kg, on the basis of AD. The resulting manufacturing EF was extrapolated for the years before and after 2006. Discussions with Dometic revealed that an additional source of emissions is accidental releases which, for 2017 for example, were 1.4 kg, as measured by the manufacturer. These emissions are accounted for in the total emissions from refrigerator production. The manufacturer employs a recovery system that is based on leak detectors. The fill and storage facilities are equipped with the detectors, which measure the concentration of the F-gases in question and activate, when appropriate, a ventilation system that sucks out and recovers the emitted gases. Any accidental emissions are not covered by the recovery systems.

ID#	*Issue/problem classification*[a,b]	*Recommendation from previous review report*	*ERT assessment and rationale*
I.12	2.F.1 Refrigeration and air conditioning – HFCs (I.16, 2020) (I.17, 2018) Convention reporting adherence	Make efforts to estimate the uncertainty of the AD and EFs used to estimate emissions from manufacture of refrigerators.	Resolved. The Party reported in its NIR (p.367) the uncertainty of the AD and EFs directly provided by the only manufacturer of refrigerators in Luxembourg.
I.13	2.F.1 Refrigeration and air conditioning – HFCs (I.18, 2020) (I.19, 2018) Transparency	Explain in the NIR the decrease in HFC emissions from 2.F.1.f (stationary air conditioning) between 2012 and 2013 including the impact of the EU regulation 517/2014 on phasing out various HFCs.	Addressing. The Party explained in its NIR (p.356) that the decrease in HFC emissions is mainly due to the implementation of EU regulation 517/2014 on fluorinated GHGs repealing regulation (EC) 842/2006. The regulation restricts and bans the use of various F-gases commonly used in stationary refrigeration and air conditioning, and led to a reduction in the amount of F-gas on the market and a substantial increase in price. The impact of these restrictions was seen in 2014 and 2015 when there were increases in HFC emissions due to stock growth and system refills taking place before the entry into force of the restrictions, followed by a decline after 2015. Both observations are corroborated by the general observations of EEA in EEA report 20/2017. The decrease in HFC emissions will gradually continue, as prices continue to increase. However, the ERT considers that the recommendation has not yet been fully addressed because the Party has not yet explained in the NIR the decrease in HFC emissions from stationary air conditioning (2.F.1.f) between 2012 and 2013.
I.14	2.F.2 Foam blowing agents – HFCs (I.19, 2020) (I.20, 2018) Accuracy	Estimate the emissions from foam blowing using country-specific data or, if this is not possible, estimate these emissions using a proxy (e.g. using per capita emissions from neighbouring Parties) and justify the applicability of the value used to the circumstances of Luxembourg.	Addressing. The Party reported in its NIR (p.365) that, despite significant efforts to collect country-specific data, it was not able to achieve an improvement in the estimation of F-gas emissions related to foam blowing. As there are no local producers, sales data would be the most appropriate data source but the Party has been unable to obtain such data. Lack of waste treatment data (despite an analysis of erroneously disposed polyurethane cans in household garbage), led to unrealistically low consumption figures for polyurethane cans (approximately half that of neighbouring countries). Therefore, as in the previous reports, the polyurethane spray emissions (HFC 134a, HFC 152a) and the extruded polystyrene emissions (HFC 134a) are estimated using the reported quantities used per inhabitant and year in Belgium, France and Germany, and their average HFC content. The ERT considers that the recommendation has not yet been fully addressed because the Party has not yet justified in the NIR the applicability of the values used to the circumstances of Luxembourg.
I.15	2.G Other product manufacture and use – N_2O and SF_6 (I.27, 2020) Convention reporting adherence	Revise NIR table 4-35 (for categories 2.G, 2.G.1 (electrical equipment) and 2.G.2.c (soundproof windows)) so that all emissions reported are consistent with the emissions reported in CRF tables 2(I)s2 and 2(II)B-H and correct the title of NIR table 4-35 (referring to category 2.G instead of 2.F).	Resolved. The Party reported in NIR table 4-35 (p.370) emissions consistent with those reported in CRF tables 2(I)s2 and 2(II)B-Hs2 and corrected the title of the table so that it refers to category 2.G.

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I.16	2.G.2 SF_6 and PFCs from other product use – SF_6 (I.20, 2020) (I.21, 2018) Accuracy	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.	Addressing. The Party reported in its NIR (p.373) the SF_6 emissions from particle accelerators. However, the ERT noted that information on medical devices and particle accelerators using SF_6 and the amount of SF_6 used to fill and refill equipment were not reported. Luxembourg reported that the corresponding data are obtained directly from the operators. During the review, the Party clarified that the corresponding data were included for the first time in its 2020 NIR. Although estimations are included in the NIR (section 4.8.2.1, p.373) details of the estimation methodology, such as information on the number of medical devices and particle accelerators using SF_6 and the amount of SF_6 used to fill and refill equipment, has not been included. The ERT considers that the recommendation has not yet been fully addressed because the Party has not yet reported its estimation methodology, including information on the number of medical devices and particle accelerators using SF_6 and the amount of SF_6 used to fill and refill equipment.
Agriculture			
A.1	3.A.2 Sheep – CH_4 (A.15, 2020) Convention reporting adherence	Consistently report Y_m values in the NIR and CRF table 3.As1 for emissions from enteric fermentation for lambs.	Resolved. The Party consistently reported in its NIR (p.423) and in CRF table 3.A the default value of 6.5 per cent for Y_m for mature sheep and the default value of 4.5 per cent for Y_m for lambs under one year old.
A.2	3.B Manure management – CH_4 (A.6, 2020) (A.3, 2018) (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 in comparison with the recommendation in the report on the review of the 2014 submission (para. 49).	Resolved. The Party reported in its NIR (section 5.4.3.2.1, pp.442–447) details regarding the methane conversion factor from the anaerobic digester. Methane conversion factors are summarized in NIR table 5-26 (pp.443–444) for the various manure management systems, the values from 2006 IPCC Guidelines have been applied and the reference for the values (10 per cent for the three categories) is provided. The values for the anaerobic digester are presented for cattle, dairy cattle and pigs and are reported as "NO" for other species.
A.3	3.D.a.4 Crop residues – N_2O (A.16, 2020) Transparency	Include in the NIR information to explain the significant inter-annual changes observed in N inputs in crop residues returned to soils, including information on the contribution of grasses, maize and wheat residues to the total N from crop residues and an explanation of the effects of rainfall pattern distribution and temperature on grasses, maize and wheat yields.	Resolved. The Party included in its NIR (section 5.6.3.2.3, pp.458–459) an explanation with references to figures on precipitation and air temperature. The figures show the variability of AD and one of the references, *Luxembourg in Figures 2021* (STATEC, 2022), shows that variations in precipitation and in air temperature led to large fluctuations in harvest crops from one year to another, which also affected crop residues.
A.4	3.G Liming – CO_2 (A.17, 2020) Transparency	Include in the NIR the source of the uncertainty value for AD for this category as	Resolved. The Party reported in its NIR (p.724) the range of uncertainty as ±20 per cent uniformly distributed, with the rationale that data are collected through interviews with the main distributors.

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		well as the rationale for estimating the uncertainty value.	
A.5	3.H Urea application – CO_2 (A.14, 2020) (A.16, 2018) Transparency	Include in the 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 in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	Resolved. The Party reported in its NIR (p.477) that urea application has been accounted for since the 2021 submission for the entire time series despite being below the significance threshold. A correction to a conversion factor was implemented for the current submission and fully documented in the NIR.
LULUCF			
L.1	4. General (LULUCF) (L.1, 2020) (L.6, 2018) (L.14, 2016) (L.14, 2015) Convention reporting adherence	Ensure accuracy in the NIR text, tables and figures and consistency between the NIR and CRF tables, and improve the QC procedures.	Addressing. The Party removed some of the previous inconsistencies, but the following remain, as identified by the Party and confirmed by the ERT: (a) Carbon stock for settlements in NIR tables 6-22 and 11-2 presented as 4.3 t C/ha was recalculated and should be 7.77 t C/ha (NIR, p.534); (b) For areas of land-use change from and to forest and AR and deforestation, the area for 2020 in the column "Art. 3.3 D areas since 1990" (1.39 kha) of NIR table 11.1 is not consistent with that in CRF table NIR-2 (1.41 kha); (c) Carbon stock for perennial cropland in NIR tables 6-22, 6-23 and 11-2 presented as 6.4 t C/ha was recalculated and should be 8.24 t C/ha, which affects the values in NIR table 11-4. During the review, the Party clarified that it is aware of the inconsistencies in the NIR and had intended to correct them. Furthermore, Luxembourg confirmed that the correct values were used in the calculations and that the inconsistencies in the NIR will be corrected in its next annual submission. The ERT considers that the recommendation has not yet been fully addressed because the Party's reporting still includes some inconsistencies between the NIR and CRF tables.
L.2	4. General (LULUCF) – CO_2 (L.2, 2020) (L.9, 2018) Transparency	Elaborate in the NIR the methods and underlying assumptions used for the expert judgment on: (a) Fertilizer use (2020 NIR p.695); (b) Practices of fuelwood collection (2020 NIR, p.545); (c) C/N ratio for mineral soils (2020 NIR, p.560);	Resolved. The Party elaborated on the methods in the NIR: (a) Use of fertilizer in forests has been prohibited by law since 2018 and was not a common practice before 2018 (p.643); (b) Carbon losses from fuelwood collection are accounted for through the results of the NFI (p.504); (c) Separate soil analysis of the C/N ratio does not exist for the various soil uses (e.g. forest land and grassland). According to expert judgment (from the Administration of Technical Agricultural Services), the best current available ratio value remains 12 (p.518);

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		(d) Mineral soils in grassland (2020 NIR, p.564); (e) Uncertainty for the biomass expansion factor (2020 NIR, p.581); (f) Uncertainties for carbon stock in settlements (2020 NIR, p.584).	(d) The 2006 IPCC Guidelines tier 1 assumption that carbon stock changes are neutral (i.e. net emissions are equal to net removals) is used by the Party for mineral soils in grassland. It is therefore assumed there was no change in relative stock change factors (tillage factor F_{MG}; land-use factor F_{LU}; input factor F_I) during 1990–2020 and these factors are set by default to 1. Consequently, there is no change in carbon stocks in grassland soils due to management (p.522); (e) No expert opinion could be found on the uncertainty for the biomass expansion factor. The uncertainty remains an estimated value and was sufficiently justified (p.541); (f) The biomass carbon stock for settlements is not known, because it was estimated by analysing land-use maps of settlement areas. It was therefore assumed that the uncertainty is identical to the uncertainty proposed by the 2006 IPPC Guidelines (vol. 4) default value for perennial cropland, annual cropland and grassland (p.545). The Party used a spreadsheet to document the expert judgments provided in the LULUCF and KP-LULUCF chapters of its NIR (p.515). During the review, the Party provided the ERT with the spreadsheet to demonstrate that expert judgment is now appropriately tracked.
L.3	4. General (LULUCF) – CO_2, CH_4 and N_2O (L.3, 2020) (L.10, 2018) Convention reporting adherence	Include an uncertainty assessment of the land-use and land-use change maps.	Resolved. The Party reported in its NIR (p.542) uncertainty estimates of land-use states and changes for all relevant time periods.
L.4	4. General (LULUCF) – CO_2 (L.4, 2020) (L.11, 2018) Transparency	Include in the NIR information clarifying the random and eventual systematic uncertainties associated with growth rate and carbon stock factors.	Resolved. The Party reported in its NIR (table 6-32) the relevant statistical information (sample size, mean, standard deviation) explaining the derivation of the uncertainty estimate.
L.5	4. General (LULUCF) – CO_2 (L.5, 2020) (L.12, 2018) Accuracy	Demonstrate the accuracy of the soil carbon stock factors, by land use, which are 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, improve the accuracy of the soil carbon stock factors.	Resolved. The Party implemented a spatially explicit methodology for land-use mapping (see also ID# L.6 below), which is described in its NIR (section 6.1.3). This resulted in a new stratification of soil type (pp.509–510) that facilitated a more accurate and consistent estimation of soil carbon stock factors.
L.6	Land representation – CO_2	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	Resolved. The Party revised and updated the land-use change methodology with more recent data. It reported in its NIR (section 6.1.3) on its revised approach for deriving land-use change information. During the review, the Party also provided a background

ID#	*Issue/problem classification*[a,b]	*Recommendation from previous review report*	*ERT assessment and rationale*
	(L.6, 2020) (L.13, 2018) Accuracy	change on the basis of information on management data.	document (Kleeschulte et al., 2021), which it had not cited in the NIR because it was not published at the time of writing.
L.7	Land representation – CO_2 (L.7, 2020) (L.13, 2018) Accuracy	Use a stratification in accordance with the 2006 IPCC Guidelines (vol. 4, chap. 3, p.16).	Resolved. The Party reported in its NIR on the new land-use and land-cover maps for 2015 and 2018 (table 6-3, p.486) which, overall, are consistent with the 2006 IPCC Guidelines (see ID# L.19 in table 5).
L.8	Land representation – CO_2 (L.8, 2020) (L.14, 2018) Accuracy	Estimate the portion of grassland and cropland that falls outside the scope tracked by the Land Parcel Identification System in order to correct for the bias; and explain in the NIR how any potential overestimation of removals is avoided.	Resolved. The Party reported in its NIR (table 6-3, p.486) on the new land-use and land-cover maps for 2015 and 2018 (see ID# L.7 above). As a result, land-use changes between cropland and grassland are identified with higher accuracy because grassland and cropland areas falling outside of the Land Parcel Identification System scope are now tracked using additional land-use maps (NIR, p.513).
L.9	Land representation – CO_2 (L.9, 2020) (L.15, 2018) Transparency	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.	Resolved. The Party reported in its NIR (table 6-11, p.492) the full time series extending back to 1971 demonstrating that the 20-year transition period was considered.
L.10	Land representation – CO_2 (L.16, 2020) Comparability	Ensure the consistency of the areas in CRF table 4.1 for 1999–2012 so that the final areas for the year (X-1) equal the initial areas for the following year (X).	Resolved. The Party performed plausibility checks on final and initial areas for different years and ensured consistency. The checks by the ERT identified no further inconsistencies.
L.11	4.A.1 Forest land remaining forest land – CO_2 (L.10, 2020) (L.17, 2018) Transparency	Explicitly provide in the NIR the steps of the calculation of the above-ground biomass factors for forest land.	Resolved. The Party reported in its NIR (p.500) the necessary information, namely the intermediate steps used to derive volume and then biomass.
L.12	4.A.1 Forest land remaining forest land – CO_2 (L.11, 2020) (L.18, 2018) Accuracy	Collect more information on harvests in private forests directly from private landowners and compare them with the harvest rates from the NFI and report the results of this comparison in the NIR.	Addressing. The Party explained that it was not able to obtain data on wood harvest from private forest owners. The Party explained that a new forestry code is currently going through parliament which will make reporting of wood harvest greater than 40 m^3 compulsory. The Party explained that a new NFI is being planned and will be implemented over the next few years. Based on the new NFI data, additional data on forest harvest in private forests should be available for the 2023 submission. The ERT considers that the recommendation has not yet been fully addressed because the Party has not yet collected more information on harvests in private forests directly from private landowners.
L.13	4.B Cropland – CO_2 (L.12, 2020) (L.19, 2018) Transparency	Report a value for above- and below-ground biomass separately in table 223 of the NIR.	Resolved. The Party reported a separate value for above- and below-ground biomass in its NIR (p.508).

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L.14	4.G HWP – CO_2 (L.17, 2020) Transparency	Include information about both the national data source or reference used to complete the HWP time series in the NIR and the factors to convert from product units to carbon in the NIR and CRF table 4.Gs2, correct the information about the half-life of sawnwood in CRF table 4.Gs1 and include information about imports and exports in CRF table 4.Gs2.	Addressing. The Party reported the source of the national data in the NIR (p.550). It also reported the half-life for sawnwood in CRF table 4.Gs1, which is 35 years. This is identical to the value reported in the NIR (section 6.9, p.549). The Party did not report in the NIR the factors used for converting from product units to carbon. The Party did not report information about imports and exports in CRF table 4.Gs2. During the review, the Party clarified that it used a carbon conversion factor of 0.229 Mg C/m³ for sawnwood and a carbon conversion factor for sawnwood of 0.269 Mg C/m³ for wood-based panels, which it derived from table 2.8.1 of the *2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol* (p.161). The Party will include this information in its 2023 submission. Regarding information about imports and exports of sawnwood, wood panels and paper and paperboard, the Party clarified in the NIR that it uses the production approach (p.549) and that these data are not used by the Party for calculating emissions and removals in the HWP pool; hence the data are not collected and cannot be reported in CRF table 4.Gs2. The ERT considers that the recommendation has not yet been fully addressed because the Party has not yet reported the carbon conversion factors in the NIR and in CRF table 4.Gs2.
L.15	4(IV).2 N leaching and run-off – N_2O (L.18, 2020) Convention reporting adherence	Correct the values of the AD and IEF for N leaching and run-off in CRF table 4(IV).	Resolved. The Party reported the correct estimates consistently in CRF table 4(IV) and reported on the derivation of the data in the NIR (section 6.3.4.2.3, p.519).
L.16	4(V) Biomass burning – CH_4 and N_2O (L.15, 2020) (L.21, 2018) Completeness	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.	Resolved. The Party reported that CH_4 and N_2O emissions from biomass burning are insignificant and reported as "NE" in CRF table 4(V). The Party provided the justification in its NIR (p.667).
Waste			
W.1	5.A Solid waste disposal on land – CH_4 (W.2, 2020) (W.16, 2018) Transparency	Provide in the NIR information justifying the use of an oxidation factor of 0.1 by explaining that SWDS 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 SWDS with a layer of soil.	Resolved. The Party reported in its NIR (pp.576–577) information justifying the use of an oxidation factor of 0.1 by explaining that SWDS are operated by gradually covering different parts of the SWDS with a layer of soil.

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W.2	5.D Wastewater treatment and discharge – N_2O (W.5, 2020) (W.10, 2018) (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.	Resolved. Luxembourg revised the calculation methodology in its 2021 inventory submission. The Party reported in its NIR (section 7.5.2.3, pp.607–611) information on the separated emission calculations of the four types of WWTP operating in Luxembourg and the revised parameters, including a revised N_2O EF for plants with significant denitrification. During the review, the Party provided the ERT with the spreadsheets containing the calculations showing that the applied methodology is in accordance with the 2006 IPCC Guidelines (vol. 5, chap. 6, box 6.1).
W.3	5.D Wastewater treatment and discharge – N_2O (W.6, 2020) (W.11, 2018) (W.3. 2016) (W.3, 2015) (79, 2014) Accuracy	Take into account the N removed in the sludge spread on agricultural fields when estimating the N_2O emissions from wastewater in order to avoid double counting and revise the method used to estimate N_2O emissions from wastewater handling.	Resolved. Luxembourg revised the calculation methodology in its 2021 inventory submission. The Party reported in its NIR (p.610) that it is assumed that 35 per cent of $N_{EFFLUENT}$ is removed as N removed with sludge for older WWTPs, and 85 per cent is removed for plants with denitrification. The assumption is based on measurements of N in the influent and effluent at several plants. A default value of N removed with sludge of 0 was applied for septic tanks, in line with the 2006 IPCC Guidelines, avoiding double counting of N_2O emissions from wastewater handling.
W.4	5.D.1 Domestic wastewater – N_2O (W.7, 2020) (W.13, 2018) (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.	Resolved. Luxembourg revised the calculation methodology in its 2021 inventory submission and recalculated N_2O emissions for the entire time series. The Party reported in its NIR (p.609) that the N_2O emissions from domestic wastewater treatment have been evaluated by applying the tier 1 method described in the 2006 IPCC Guidelines. The Party also justified its use of the tier 1 methodology by demonstrating that the category is not key (2006 IPCC Guidelines, chap. 6.3.1.1, N_2O from domestic wastewater effluent).
W.5	5.D.1 Domestic wastewater – N_2O (W.9, 2020) (W.20, 2018) Accuracy	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.	Resolved. Luxembourg revised the calculation methodology used for its 2021 inventory submission and recalculated N_2O emissions for the entire time series. The Party reported in its NIR (p.609) that the N_2O emissions from domestic wastewater treatment have been evaluated by applying the tier 1 method described in the 2006 IPCC Guidelines. During the review, the Party provided the ERT with the spreadsheets containing the calculations in accordance with the 2006 IPCC Guidelines (vol. 6, chap. 5, box 6.1) and demonstrating that the N in sludge removed was considered in the estimation of the N_2O emissions from domestic wastewater treatment and double counting avoided.
W.6	5.D.1 Domestic wastewater – N_2O (W.14, 2020) Transparency	(a) When using the methods from the 2006 IPCC Guidelines (vol. 5, chap. 6), use parameters such as $N_{EFFLUENT}$ with the same meaning as in the 2006 IPCC Guidelines (which is N in the effluent discharged to aquatic environments and not N generated by the population connected to WWTPs without denitrification); (b) Report consistently in the NIR and CRF table 5.D whether sludge removal has been	Luxembourg revised its information on the calculation methodologies in its 2021 inventory submission, as follows: (a) Resolved. The Party reported in its NIR (p.610) the methodology used for determining $N_{EFFLUENT}$, which is in accordance with the 2006 IPCC Guidelines (vol. 5, chap. 6, equation 6.8), as well as the parameters used; (b) Addressing. The Party reported in its NIR (p.610) that, in order to estimate N from sludge, it has assumed that the majority of $N_{EFFLUENT}$ will be removed by sludge. Thus, sludge removal has been taken into consideration in the estimates for category 5.D.1. However, no information on estimated quantities of sludge removed is provided in either the NIR or the CRF tables. In CRF table 5.D sludge removed is reported as "NE". During

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		taken into consideration in the estimates for category 5.D.1, and whether the amount of sludge removed has been estimated;	the review, the Party clarified that CH_4 emissions from septic tanks and mechanical treatment are calculated without any sludge removal being considered, therefore sludge removed is reported as "NE";
		(c) Report consistently in the NIR that the value of 35 per cent represents the sludge removal instead of the denitrification rate and clarify that it is applied to all biological WWTPs without denitrification;	(c) and (d) Resolved. The Party reported in its NIR (pp.609–611) the methodology used for evaluating N_2O emissions from municipal wastewater, including percentages of N removed in sludge (i.e. 0 per cent for septic tanks, 35 per cent for mechanical WWTPs, 35 per cent for biological WWTPs without denitrification, and 85 per cent for biological WWTPs with denitrification). The methodology and equations presented in the NIR are in accordance with the 2006 IPCC Guidelines.
		(d) Correct the equation on page 654 of the 2020 NIR so that it is clear that 65 per cent, instead of 35 per cent, of N is considered in the estimation of emissions.	The ERT considers that the recommendation has not yet been fully addressed because the Party has not yet reported consistently in the NIR and CRF table 5.D whether the amount of sludge removed has been estimated and there is no explanation for reporting "NE" in CRF table 9.
W.7	5.D.2 Industrial wastewater – CH_4 (W.11, 2020) (W.22, 2018) Transparency	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 Luxembourg's two WWTPs are well managed and treat wastewater below their designed maximum loads.	Resolved. The Party reported in its NIR (pp.611–612) that the two industrial plants in Luxembourg are operated in aerobic mode with active injection of air/oxygen in order to exclude any anaerobic process. Further, the sludge formed is either pumped off, thickened, dehydrated and exported for incineration, or pumped off and transported to a biogas facility for anaerobic digestion.
W.8	5.D.2 Industrial wastewater – N_2O (W.12, 2020) (W.23, 2018) Transparency	Improve the transparency of the documentation in the NIR on the country-specific values for the denitrification rate (70 per cent) by providing a clear explanation of how the values are derived, the assumptions used and the appropriateness of the values used.	Resolved. The Party revised the calculation methodology and the emission calculations for industrial wastewater are based on plant-specific data. The denitrification rate is based on measurements by plant operators. The methodological description and the assumptions used are presented in the NIR (pp.613–614).
W.9	5.D.3 Other (wastewater treatment and discharge) – N_2O (W.13, 2020) (W.14, 2018) (W.4, 2016) (W.4, 2015) (78, 2014) Accuracy	Review the estimates for all discharges of wastewater, including those from WWTPs, to confirm there are no underestimates, and that all N_2O emissions are estimated and N removal at these plants should be considered in the estimates.	Resolved. Luxembourg revised the calculation methodology used for its 2021 inventory submission and recalculated N_2O emissions for the entire time series. Both the N_2O emissions from treatment at the plants and N_2O emissions from the effluent discharged from the plants have been estimated, and N removal at these plants has been considered in the estimates.
KP-LULUCF			
KL.1	General (KP-LULUCF) – CO_2 (KL.1, 2020) (KL.5, 2018)	Correct NIR table 274 so that it is consistent with the values reported in CRF tables 4(KP-I)A.1 and NIR-2.	Addressing. The Party removed some inconsistencies between NIR table 11-1 (i.e. previously table 274) and CRF table NIR-2. However, minor inconsistencies remain for

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	Convention reporting adherence		the values of 2020 and 1990 (i.e. values for AR and deforestation in NIR table 11-1 have not been updated). During the review, the Party clarified that it is aware of the remaining inconsistencies and the ERT noted that the inconsistencies have no effect on the estimates reported in CRF table 4 (KP-I) A.1, which are consistent with the information in CRF table NIR-2. The ERT concludes that this potential problem of a mandatory nature does not influence the Party's ability to fulfil its commitments for the second commitment period of the Kyoto Protocol and therefore this issue was not included in the list of potential problems and further questions raised by the ERT.
KL.2	General (KP-LULUCF) – CO_2 (KL.2, 2020) (KL.6, 2018) Accuracy	Use a stratification for KP-LULUCF activities in accordance with the 2006 IPCC Guidelines (vol. 4, chap. 3, p.16).	Resolved. The Party reported in its NIR (table 6-3, pp.486 and 640) on the new land-use and land-cover maps for 2015 and 2018 which are, overall, consistent with the 2006 IPCC Guidelines (see ID# L.7 above). The Party clarified that, owing to the small size of the forest and the consequently low number of NFI samples, a further stratification of forests would likely result in poor accuracy of the planted forest stratum.
KL.3	General (KP-LULUCF) – CO_2 (KL.9, 2020) Accuracy	Use the minimum land area of 0.5 ha in the definition of forest for KP-LULUCF, as included in the report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of Luxembourg and use the same minimum land area in the definition of forest for the LULUCF sector.	Resolved. The Party reported in its NIR (p.636) the forest definition applied. It also reported that this forest definition follows the definition used for the NFI and the land-use maps. The ERT noted that the applied definition is not the same as the one given in the Party's initial report to facilitate the calculation of the assigned amount for the second commitment period. During the review, Luxembourg confirmed that it has never applied the forest definition given in the Party's initial report to facilitate the calculation of the assigned amount for the second commitment period. It also confirmed that the forest definition was used consistently over time for reporting under both the Kyoto Protocol and the Convention. The ERT noted that the reporting by Luxembourg is not in line with the requirements of decisions 2/CMP.7 and 2/CMP.8 to apply the same forest definition in the first and second commitment periods and included this issue in the list of potential problems and further questions raised by the ERT, recommending that the Party provide revised estimates for all affected activities (i.e. AR, deforestation and FM), by considering also the implications of and consistency with the FMRL and the reported technical correction as well as with its LULUCF reporting under the Convention. The Party submitted revised estimates on 27 October 2022 prepared in response to the recommendation made in the list of potential problems and further questions raised by the ERT during the 2022 review. These revised estimates were based on the forest definition given in the Party's initial report to facilitate the calculation of the assigned amount for the second commitment period as required by decisions 2/CMP.7 and 2/CMP.8, and they were accepted by the ERT.
KL.4	AR – CO_2 (KL.5, 2020) (KL.3, 2018) (KL.7, 2016)	Provide references for biomass growth rates used for AR areas.	Resolved. The Party reported in its NIR (p.641) that the source of the biomass growth rates presented in NIR table 11-2 is the NFI, an extract of which is contained in NIR table 6-15 (p.502).

ID#	*Issue/problem classification*[a,b]	*Recommendation from previous review report*	*ERT assessment and rationale*
	(KL.7, 2015) Transparency		
KL.5	FM (KL.7, 2020) (KL.9, 2018) KP reporting adherence	Report the FM cap as 3,604.402 kt CO_2 eq in the CRF accounting table.	Resolved. The Party reported the correct value of the cap of 3,604.402 kt CO_2 eq in the CRF accounting table.
KL.6	Biomass burning – CH_4 and N_2O (KL.8, 2020) (KL.8, 2018) Completeness	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.	Resolved. The Party reported that CH_4 and N_2O emissions from biomass burning are insignificant and provided the justification in its NIR (p.667).

[a] References in parentheses are to the paragraph(s) and the year(s) of the previous review report(s) in which the issue or problem was raised. Issues are identified in accordance with paras. 80–83 of the UNFCCC review guidelines and classified as per para. 81 of the same guidelines. Problems are identified and classified as problems of transparency, accuracy, consistency, completeness or comparability in accordance with para. 69 of the Article 8 review guidelines in conjunction with decision 4/CMP.11.

[b] The report on the review of the 2021 annual submission of Luxembourg was not available at the time of this review. Therefore, the recommendations reflected in this table are taken from the 2020 annual review report. For the same reason, 2019 and 2017 are excluded from the list of review years in which issues could have been identified.

IV. Issues and problems identified in three or more 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 and/or problems included in table 4 have been identified in three or more successive reviews, including the review of the 2022 annual submission of Luxembourg, and had not been addressed by the Party by the time of publication of this review report.

Table 4
Issues and/or problems identified in three or more successive reviews and not addressed by Luxembourg

ID#	*Previous recommendation for issue*	*Number of successive reviews issue not addressed*[a]
General		
G.1	Select the CPR as the lower value between 90 per cent of the assigned amount and the value of eight times the latest inventory year reported in the annual submission using total emissions without LULUCF.	3 (2018–2022)
Energy		
E.7	Revise the CH_4 EF for residential use of gasoline and, if choosing a non-IPCC default EF, include in the NIR a justification of its applicability to Luxembourg.	3 (2018–2022)

ID#	*Previous recommendation for issue*	*Number of successive reviews issue not addressed*[a]
IPPU		
I.13	Explain in the NIR the decrease in HFC emissions from 2.F.1.f (stationary air conditioning) between 2012 and 2013 including the impact of the EU regulation 517/2014 on phasing out various HFCs.	3 (2018–2022)
I.14	Estimate the emissions from foam blowing using country-specific data or, if this is not possible, estimate these emissions using a proxy (e.g. using per capita emissions from neighbouring Parties) and justify the applicability of the value used to the circumstances of Luxembourg.	3 (2018–2022)
I.16	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 SF6 and the SF_6 amount used to fill and refill equipment.	3 (2018–2022)
Agriculture	No issues identified.	
LULUCF		
L.1	Ensure accuracy in the NIR text, tables and figures and consistency between the NIR and CRF tables, and improve the QC procedures.	4 (2015–2022)
L.12	Collect more information on harvests in private forests directly from private landowners and compare them with the harvest rates from the NFI and report the results of this comparison in the NIR.	3 (2018–2022)
Waste	No issues identified.	
KP-LULUCF		
KL.1	Correct NIR table 274 so that it is consistent with the values reported in CRF tables 4(KP-I)A.1 and NIR-2.	3 (2018-2022)

[a] The reports on the reviews of the 2017, 2019 and 2021 annual submissions of Luxembourg have not yet been published. Therefore, 2017, 2019 and 2021 were not included when counting the number of successive years for this table. In addition, as the reviews of the Party's 2015 and 2016 annual submissions were conducted together, they are not considered successive reviews and 2015/2016 is counted as one year.

V. Additional findings made during the individual review of the Party's 2022 annual submission

10. Table 5 presents findings made by the ERT during the individual review of the 2022 annual submission of Luxembourg that are additional to those identified in table 3.

Table 5
Additional findings made during the individual review of the 2022 annual submission of Luxembourg

ID#	*Finding classification*	*Description of finding with recommendation or encouragement*	*Is finding an issue/problem?*[a]
General		No general findings additional to those included in table 3 were made by the ERT during the review.	
Energy		No findings for the energy sector additional to those included in table 3 were made by the ERT during the review.	
IPPU		No findings for the IPPU sector additional to those included in table 3 were made by the ERT during the review.	
Agriculture		No findings for the agriculture sector additional to those included in table 3 were made by the ERT during the review.	
LULUCF			
L.17	4. General (LULUCF) – CO_2	The Party reported in its NIR (p.485) that the categories forest land remaining forest land and land converted to cropland, grassland and settlements were identified as key categories. The Party reported carbon stock changes in mineral soils and litter on forest land remaining forest land in the NIR (pp.505 and 507), and biomass carbon stock changes on land converted to cropland, grassland and settlements using a tier 1 approach (pp.516, 522 and 533). The ERT noted that the Party did not report the justification required by the 2006 IPCC Guidelines (vol. 4, chap. 1, decision trees in figures 1.2–1.3, pp.1.11–1.12). During the review, the Party clarified that in the case of mineral soils and litter on forest land remaining forest land, efforts are under way to improve the reporting for soil while for litter no data are available; and in the case of biomass carbon stock changes on land converted cropland, grassland and settlements tier 1 and tier 2 methods are applied on the basis of the country-specific carbon biomass stocks for forest land converted to other land uses. The Party also identified financial constraints as a limiting factor and that resources need to be prioritized. The ERT recommends that the Party follow up on its plans to improve the reporting on mineral soils on forest land remaining forest land and, in order to justify the application of tier 1 methods for categories that are determined to be key categories in accordance with the UNFCCC Annex I inventory reporting guidelines (para. 11), explain why it was unable to implement a recommended method in accordance with the decision tree in the 2006 IPCC Guidelines (vol. 1, chap. 4, figure 4.1, p.4.6).	Yes. Transparency
L.18	4.A Forest land – CO_2	The Party reported in its NIR (table 6-5, p.489) the definition of land-use categories, which also includes a definition of forest land. It also reported in its NIR (table 6-14, p.496) a definition of forest used for developing the NFI. The ERT noted that the two definitions for forest land are not fully consistent: in NIR table 6-5 two forest definitions are given for 1990–2011 and 2012–2020, namely minimum area of 0.1 ha (1990–2011) and 0.05 ha (2012–today), tree crown cover ≥10 per cent and tree height at maturity ≥6 m (1990–2011) and ≥3 m (2012–2020); whereas in NIR table 6-14 the parameters are minimum area of 0.05, tree crown cover ≥5 per cent and tree height at maturity ≥5m.	Yes. Transparency

ID#	*Finding classification*	*Description of finding with recommendation or encouragement*	*Is finding an issue/problem?*[a]
		The ERT considers that this is not in accordance with paragraph 4 of the UNFCCC Annex I inventory reporting guidelines. During the review, the Party referred to the results of the second NFI to clarify what is considered as forest (https://environnement.public.lu/dam-assets/fr/forets/publications/IFL2_fr/foret-lux-en-chiffres-2.pdf). According to table 2.1 in this document four forest strata exist: *forêt*, *bosquets*, *autres terres boisées* and *autres terres en milieu forestier*. The ERT recommends that the Party report a unique forest definition in its NIR and emissions/removals according to the strata identified in the NFI as recommended in the 2006 IPPC Guidelines (vol. 4, chap. 4, p.4.8).	
L.19	4.A.1 Forest land remaining forest land – CO_2	The Party applied a tier 1 methodology for estimating soil and litter carbon stock changes on forest land remaining forest land (NIR, pp.505 and 507 respectively, and CRF table 4.A), justifying this approach by assuming that no soil carbon stock changes occur. The ERT noted that this is not in accordance with the UNFCCC Annex I inventory reporting guidelines because emissions/removals from these pools can be expected to occur, and an assumption that the pools are in equilibrium needs to be justified. According to the 2006 IPCC Guidelines (vol. 4, chap. 4, p.4.20) the equilibrium assumption only assumes that carbon losses are compensated by carbon gains, in which case the reporting should be "NE" for GHG emissions by sources and removals by sinks that have not been estimated but for which a corresponding activity may occur (decision 24/CP.19, para. 37(b)). During the review, the Party clarified that it applied the tier 1 methodology and assumption owing to an incomplete scientific basis and the resulting uncertainty. Carbon stock changes in litter and mineral soils are very dynamic processes and Luxembourg agrees that carbon stock changes are most likely changing continuously and confirms it will report "NE" in its 2023 submission. The ERT recommends that the Party report "NE" for carbon stock changes in mineral soils and litter on forest land remaining forest land and, in the absence of quantitative data, provide a justification for its assumption based on the appropriate approach (vol. 4, chap. 2.2.2) and the decision trees for dead organic matter (vol. 4, chap. 2, figure 2.3) and mineral soils (vol. 4, chap. 2, figure 2.4) from the 2006 IPCC Guidelines.	Yes. Completeness
Waste		No findings for the waste sector additional to those included in table 3 were made by the ERT during the review.	
KP-LULUCF		No findings for KP-LULUCF additional to those included in table 3 were made by the ERT during the review.	

[a] Recommendations made by the ERT during the review are related to issues as defined in para. 81 of the UNFCCC review guidelines or problems as defined in para. 69 of the Article 8 review guidelines.

VI. Application of adjustments

11. The ERT did not identify the need to apply any adjustments for the 2022 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. Table I.5 presents the accounting quantities for KP-LULUCF reported by Luxembourg and the final values agreed by the ERT. The final quantities of units to be issued and cancelled are presented in table I.6.

VIII. Questions of implementation

13. No questions of implementation were identified by the ERT during the individual review of the Party's 2022 annual submission.

Annex I

Overview of greenhouse gas emissions and removals and data and information on activities under Article 3, paragraphs 3–4, of the Kyoto Protocol, as submitted by Luxembourg in its 2022 annual submission

1. Tables I.1–I.4 provide an overview of the total GHG emissions and removals as submitted by Luxembourg.

Table I.1
Total greenhouse gas emissions and removals for Luxembourg, base year–2020
(kt CO_2 eq)

	Total GHG emissions excluding indirect CO_2 emissions		*Total GHG emissions and removals including indirect CO_2 emissions*[a]		*Land-use change (Article 3.7 bis as contained in the Doha Amendment)*[b]	*KP-LULUCF (Article 3.3 of the Kyoto Protocol)*[c]	*KP-LULUCF (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[d]	12 911.05	12 748.66	NA	NA	268.38		NO, NA	
1990	12 895.38	12 732.99	NA	NA				
1995	9 645.73	10 090.93	NA	NA				
2000	9 111.72	9 664.53	NA	NA				
2010	12 136.78	12 168.53	NA	NA				
2011	11 850.34	12 052.28	NA	NA				
2012	11 516.18	11 809.92	NA	NA				
2013	10 812.95	11 276.75	NA	NA		0.17	NO, NA	498.59
2014	10 407.08	10 797.43	NA	NA		0.21	NO, NA	427.23
2015	9 971.35	10 317.72	NA	NA		0.24	NO, NA	379.09
2016	9 646.93	10 078.73	NA	NA		0.28	NO, NA	466.25
2017	9 951.75	10 261.75	NA	NA		0.32	NO, NA	368.45
2018	10 417.38	10 561.47	NA	NA		0.36	NO, NA	203.15
2019	10 469.88	10 732.70	NA	NA		0.40	NO, NA	318.28
2020	8 731.52	9 064.90	NA	NA		0.35	NO, NA	377.06

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

[a] The Party did not report indirect CO_2 emissions in CRF table 6.

[b] The value reported in this column relates to GHG emissions from conversion of forests (deforestation) in 1990 as contained in the report on the review of the Party's report to facilitate the calculation of the assigned amount for the commitment period of the Kyoto Protocol.

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

[d] "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, para. 4, of the Kyoto Protocol. For activities under Article 3, para. 3, of the Kyoto Protocol and FM under Article 3, para. 4, only the inventory years of the commitment period must be reported.

Table I.2
Greenhouse gas emissions and removals by gas for Luxembourg, excluding land use, land-use change and forestry, 1990–2020
(kt CO_2 eq)

	CO_2[a]	*CH_4*	*N_2O*	*HFCs*	*PFCs*	*Unspecified mix of HFCs and PFCs*	*SF_6*	*NF_3*
1990	11 823.35	588.91	319.85	0.00	NO	NO	0.88	NO
1995	9 151.73	594.82	327.84	15.15	NO	NO	1.39	NO
2000	8 709.96	593.32	328.24	31.08	NO	NO	1.93	NO
2010	11 202.16	588.06	317.73	53.67	NO	NO	6.90	NO
2011	11 102.96	562.79	322.64	56.55	NO	NO	7.34	NO
2012	10 867.48	558.52	317.30	58.91	NO	NO	7.72	NO
2013	10 325.36	563.03	317.81	62.45	NO	NO	8.08	NO
2014	9 828.19	572.39	321.74	66.64	NO	NO	8.46	NO
2015	9 347.47	574.93	319.68	66.73	NO	NO	8.92	NO
2016	9 089.23	584.93	330.13	65.17	NO	NO	9.27	NO
2017	9 261.20	587.73	334.80	68.58	NO	NO	9.44	NO
2018	9 566.67	586.49	335.85	62.72	NO	NO	9.73	NO
2019	9 751.73	572.02	340.20	58.80	NO	NO	9.95	NO
2020	8 096.51	580.55	322.25	55.97	NO	NO	9.62	NO
Percentage change 1990–2020	**–31.5**	**–1.4**	**0.7**	**78 282 723.9**	**NA**	**NA**	**997.6**	**NA**

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

Table I.3
Greenhouse gas emissions and removals by sector for Luxembourg, 1990–2020
(kt CO_2 eq)

	Energy	*IPPU*	*Agriculture*	*LULUCF*	*Waste*	*Other*
1990	10 301.40	1 608.67	717.91	162.39	105.01	NO
1995	8 260.40	1 004.10	725.32	–445.20	101.11	NO
2000	8 088.97	753.28	717.09	–552.81	105.19	NO
2010	10 734.95	658.23	680.07	–31.75	95.27	NO

	Energy	*IPPU*	*Agriculture*	*LULUCF*	*Waste*	*Other*
2011	10 621.98	669.98	669.19	–201.94	91.12	NO
2012	10 422.87	639.27	657.90	–293.74	89.88	NO
2013	9 895.98	622.03	668.51	–463.80	90.23	NO
2014	9 393.44	632.47	680.44	–390.35	91.08	NO
2015	8 918.18	623.83	689.85	–346.37	85.85	NO
2016	8 637.30	646.11	711.57	-431.80	83.75	NO
2017	8 803.65	656.52	717.81	-310.01	83.77	NO
2018	9 109.18	655.12	715.52	–144.08	81.65	NO
2019	9 276.68	672.30	706.50	–262.82	77.22	NO
2020	7 647.94	630.13	712.32	–333.38	74.51	NO
Percentage change 1990–2020	**–25.8**	**–60.8**	**–0.8**	**–305.3**	**–29.0**	**NA**

Notes: (1) Luxembourg did not report emissions or removals for the sector other (sector 6); the corresponding cells in the CRF tables were left blank; (2) Luxembourg did not report indirect CO_2 emissions in CRF table 6.

Table I.4

Greenhouse gas emissions and removals from activities under Article 3, paragraphs 3–4, of the Kyoto Protocol by activity, base year–2020, for Luxembourg

(kt CO_2 eq)

	Article 3.7 bis as contained in the Doha Amendment[a]	*Activities under Article 3.3 of the Kyoto Protocol*		*FM and elected activities under Article 3.4 of the Kyoto Protocol*				
	Land-use change	*AR*	*Deforestation*	*FM*	*CM*	*GM*	*RV*	*WDR*
FMRL				–418.00				
Technical correction				40.18				
Base year[b]	268.38				NO, NA	NO, NA	NA	NA
2013		–3.52	3.69	–498.59	NO, NA	NO, NA	NA	NA
2014		–3.53	3.74	–427.23	NO, NA	NO, NA	NA	NA
2015		–3.54	3.79	–379.09	NO, NA	NO, NA	NA	NA
2016		–3.55	3.83	–466.25	NO, NA	NO, NA	NA	NA
2017		–3.56	3.88	–368.45	NO, NA	NO, NA	NA	NA
2018		–3.57	3.93	–203.15	NO, NA	NO, NA	NA	NA
2019		–3.58	3.98	–318.28	NO, NA	NO, NA	NA	NA
2020		–3.68	4.03	–377.06	NO, NA	NO, NA	NA	NA
Percentage change base year–2019					**NA**	**NA**	**NA**	**NA**

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

[a] The value reported in this column relates to 1990.
[b] Luxembourg has not elected to report on any activities under Article 3, para. 4, of the Kyoto Protocol. For activities under Article 3, para. 3, of the Kyoto Protocol, and FM under Article 3, para. 4, only the inventory years of the commitment period must be reported.

2. Table I.5 provides information on the Party's accounting quantities for reporting under Article 3, paragraphs 3–4, of the Kyoto Protocol.

Table I.5
Accounting quantities for activities under Article 3, paragraph 3, and forest management and any elected activities under Article 3, paragraph 4, of the Kyoto Protocol for Luxembourg
(kt CO_2 eq)

	Net emissions/removals										
GHG source/sink activity	*Base year*[b]	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*Total*[c]	*Accounting parameters*	*Accounting quantities*[a]
A.1. AR		–3.522	–3.532	–3.542	–3.552	–3.561	–3.571	–3.580	–3.676	–28.536		–28.535
Excluded emissions from natural disturbances		NA	NA	NA	NA	NA	NA	NA	NA	NA		NA
Excluded subsequent removals from land subject to natural disturbances		NO	NO	NO	NO	NO	NO	NO	NO	NO		NO
A.2. Deforestation		3.689	3.737	3.786	3.835	3.884	3.932	3.981	4.030	30.874		30.874
B.1. FM										–3 038.098		–15.537
Net emissions/ removals		–498.590	–427.230	–379.087	–466.250	–368.449	–203.149	–318.279	–377.064	–3 038.098		
Excluded emissions from natural disturbances[d]		NA	NA	NA	NA	NA	NA	NA	NA	NA		NA
Excluded subsequent removals from land subject to natural disturbances		NA	NA	NA	NA	NA	NA	NA	NA	NA		NA
Any debits from newly established forest		NO	NO	NO	NO	NO	NO	NO	NO	NO		NO
FMRL[e]											-418.000	

GHG source/sink activity	*Net emissions/removals*										*Accounting parameters*	*Accounting quantities*[a]
	Base year[b]	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*Total*[c]		
Technical corrections to FMRL											40.180	
FM cap											3 604.402	–15.537
B.2. CM (if elected)	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA		NO, NA
B.3. GM (if elected)	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA		NO, NA
B.4. RV (if elected)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA
B.5. WDR (if elected)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA

[a] The accounting quantity is the total quantity of units to be issued or cancelled for a particular activity.

[b] Net emissions and removals from CM, GM, RV and/or WDR, if elected, in the Party's base year as established in decision 9/CP.2.

[c] Cumulative net emissions and removals for all years of the commitment period reported in the annual submission under review.

[d] The Party indicated in its report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol its intention to apply the provisions from natural disturbances to its accounting of AR and FM at the end of the commitment period. The Party decided not to exclude emissions and subsequent removals from natural disturbances in its accounting for the 2022 annual submission.

[e] As inscribed in the appendix to the annex to decision 2/CMP.7 in kt CO_2 eq per year.

3. Table I.6 provides an overview of key data from Luxembourg's reporting under Article 3, paragraphs 3–4, of the Kyoto Protocol.

Table I.6
Key data for Luxembourg under Article 3, paragraphs 3–4, of the Kyoto Protocol from its 2022 annual submission

Parameter	*Data*
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
Elected activities under Article 3, paragraph 4, of the Kyoto Protocol	None
Election of application of provisions for natural disturbances[a]	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)
Cancellation of AAUs, CERs and ERUs and/or issuance of RMUs in the national registry for:	
1. AR	Issue 28 535 RMUs
2. Deforestation	Cancel 30 874 units
3. FM	Issue 15 537 RMUs

Note: Values in this table reflect the accounting quantities for activities under Article 3, para. 3, and FM and any elected activities under Article 3, para. 4, of the Kyoto Protocol as reported in table I.5.

[a] The Party decided not to exclude emissions and subsequent removals from natural disturbances in its accounting for the 2022 submission.

Annex II

Information to be included in the compilation and accounting database

Tables II.1–II.8 include the information to be included in the compilation and accounting database for Luxembourg. Data shown are from the Party's annual submission, including the latest revised estimates submitted, adjustments (if applicable) and the final data to be included in the compilation and accounting database.

Table II.1
Information to be included in the compilation and accounting database for 2020, including on the commitment period reserve, for Luxembourg
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
CPR	**63 604 947**	**65 209 026**	**–**	**65 209 026**
Annex A emissions				
CO_2	8 096 513	–	–	8 096 513
CH_4	580 552	–	–	580 552
N_2O	322 248	–	–	322 248
HFCs	55 972	–	–	55 972
PFCs	NO	–	–	NO
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	9 617	–	–	9 617
NF_3	NO	–	–	NO
Total Annex A sources[a]	9 064 903	–	–	9 064 903
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–28 682	–3 676		–3 676
Deforestation	17 829	4 030		4 030
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–353 891	–377 064		–377 064

[a] The sum of the values for the individual gases and groups of gases may not match the total owing to rounding.

Table II.2
Information to be included in the compilation and accounting database for 2019 for Luxembourg
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	9 751 728	–	–	9 751 728
CH_4	572 022	–	–	572 022
N_2O	340 202	–	–	340 202
HFCs	58 798	–	–	58 798
PFCs	NO	–	–	NO
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	9 951	–	–	9 951
NF_3	NO	–	–	NO
Total Annex A sources[a]	10 732 701			10 732 701
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–28 819	–3 580		–3 580
Deforestation	18 024	3 981		3 981

	Original submission	*Revised submission*	*Adjustment*	*Final value*
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–290 990	–318 279		–318 279

[a] The sum of the values for the individual gases and groups of gases may not match the total owing to rounding.

Table II.3
Information to be included in the compilation and accounting database for 2018 for Luxembourg
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	9 566 671	–	–	9 566 671
CH_4	586 494	–	–	586 494
N_2O	335 849	–	–	335 849
HFCs	62 720	–	–	62 720
PFCs	NO	–	–	NO
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	9 732	–	–	9 732
NF_3	NO	–	–	NO
Total Annex A sources[a]	10 561 467	–	–	10 561 467
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–29 486	–3 571		–3 571
Deforestation	18 170	3 932		3 932
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–167 269	–203 149		–203 149

[a] The sum of the values for the individual gases and groups of gases may not match the total owing to rounding.

Table II.4
Information to be included in the compilation and accounting database for 2017 for Luxembourg
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	9 261 198	–	–	9 261 198
CH_4	587 729	–	–	587 729
N_2O	334 800	–	–	334 800
HFCs	68 583	–	–	68 583
PFCs	NO	–	–	NO
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	9 442	–	–	9 442
NF_3	NO	–	–	NO
Total Annex A sources[a]	10 261 752	–	–	10 261 752
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–30 149	–3 561		–3 561
Deforestation	18 315	3 884		3 884
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–346 281	–368 449		–368 449

[a] The sum of the values for the individual gases and groups of gases may not match the total owing to rounding.

Table II.5
Information to be included in the compilation and accounting database for 2016 for Luxembourg
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	9 089 235	–	–	9 089 235
CH_4	584 927	–	–	584 927
N_2O	330 135	–	–	330 135
HFCs	65 171	–	–	65 171
PFCs	NO	–	–	NO
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	9 266	–	–	9 266
NF_3	NO	–	–	NO
Total Annex A sources[a]	10 078 735	–	–	10 078 735
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–30 810	–3 552		–3 552
Deforestation	18 461	3 835		3 835
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–452 447	–466 250		–466 250

[a] The sum of the values for the individual gases and groups of gases may not match the total owing to rounding.

Table II.6
Information to be included in the compilation and accounting database for 2015 for Luxembourg
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	9 347 466	–	–	9 347 466
CH_4	574 930	–	–	574 930
N_2O	319 680	–	–	319 680
HFCs	66 728	–	–	66 728
PFCs	NO	–	–	NO
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	8 918	–	–	8 918
NF_3	NO	–	–	NO
Total Annex A sources[a]	10 317 722			10 317 722
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–31 028	–3 542		–3 542
Deforestation	41 201	3 786		3 786
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–376 949	–379 087		–379 087

[a] The sum of the values for the individual gases and groups of gases may not match the total owing to rounding.

Table II.7
Information to be included in the compilation and accounting database for 2014 for Luxembourg
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	9 828 191	–	–	9 828 191
CH_4	572 389	–	–	572 389
N_2O	321 743	–	–	321 743
HFCs	66 644	–	–	66 644

	Original submission	*Revised submission*	*Adjustment*	*Final value*
PFCs	NO	–	–	NO
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	8 462	–	–	8 462
NF_3	NO	–	–	NO
Total Annex A sources[a]	10 797 430	–	–	10 797 430
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–31 342	–3 532		–3 532
Deforestation	41 025	3 737		3 737
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–429 982	–427 230		–427 230

[a] The sum of the values for the individual gases and groups of gases may not match the total owing to rounding.

Table II.8
Information to be included in the compilation and accounting database for 2013 for Luxembourg
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	10 325 364	–	–	10 325 364
CH_4	563 033	–	–	563 033
N_2O	317 814	–	–	317 814
HFCs	62 453	–	–	62 453
PFCs	NO	–	–	NO
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	8 084	–	–	8 084
NF_3	NO	–	–	NO
Total Annex A sources[a]	11 276 749	–	–	11 276 749
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–31 654	–3 522		–3 522
Deforestation	40 850	3 689		3 689
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–508 062	–498 590		–498 590

[a] The sum of the values for the individual gases and groups of gases may not match the total owing to rounding.

Annex III

Additional information to support findings in table 2

Missing categories that may affect completeness

The only category for which an estimation method is included in the 2006 IPCC Guidelines that was reported as "NE" or for which the ERT otherwise determined that there may be an issue with the completeness of the reporting in the Party's inventory is 4.A.1 forest land remaining forest land (CO_2) – carbon stock changes in mineral soil and litter (see ID# L.19 in table 5).

Annex IV

Reference documents

A. Reports of the Intergovernmental Panel on Climate Change

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

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IPCC. 2019. *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. E Calvo Buendia, K Tanabe, A Kranjc, et al. (eds.). Geneva: IPCC. Available at https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html.

B. UNFCCC documents

Annual review reports

Reports on the individual reviews of the 2013, 2014, 2015, 2016, 2018 and 2020 annual submissions of Luxembourg, contained in documents FCCC/ARR/2013/LUX, FCCC/ARR/2014/LUX, FCCC/ARR/2015/LUX, FCCC/ARR/2016/LUX, FCCC/ARR/2018/LUX and FCCC/ARR/2020/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/documents/510888.

Annual status report for Luxembourg for 2022. Available at https://unfccc.int/sites/default/files/resource/asr2022_LUX.pdf.

C. Other documents used during the review

Responses to questions during the review were received from Nora Becker (Environment Agency, Ministry of the Environment, Climate and Sustainable Development of Luxembourg), including additional material on the methodology and assumptions used. The following references may not conform to UNFCCC editorial style as some have been reproduced as received:

EEA Report No 20/2017Data reported by companies on the production, import, export and destruction of fluorinated greenhouse gases in the European Union, 2007-2016. Available at https://www.eea.europa.eu/publications/fluorinated-greenhouse-gases-2017.

EMEP. (2019). EMEP/EEA air pollutant emission inventory guidebook 2019. European Environmental Agency.

Gembloux Agro-Bio Tech, 2015. Exploitation des données de l'inventaire forestier national permanent du Grand-Duché de Luxembourg pour quantifier la biomasse ligneuse en forêt.

Kleeschulte et al. 2021. Support to LULUCF reporting in Luxembourg; Roll out of the LULUCF methodology for the Grand Duchy of Luxembourg. Available at https://data.public.lu/en/datasets/r/ae5da94b-fa53-4b4f-b438-b2528c9c1f7f.

Korzeniowska, K., Kleeschulte, S. Carrão, H. 2020. Support to LULUCF reporting in Luxembourg: Feasibility study on the application of geographically explicit land-use data to estimate changes in the Grand Duchy of Luxembourg between 1989 and 2018. Niederanven.

Ministry of the Environment, Climate and Sustainable Development of Luxembourg. 2019. National Forestry Accounting Plan – Luxembourg. National Forestry Accounting Plan and Reference Levels for 2021–2025 in accordance with Regulation (EU) 2018/841.

STATEC, 2022. Luxembourg in Figures 2021. Available at https://statistiques.public.lu/en/publications/series/luxembourg-en-chiffres/2021/luxembourg-en-chiffres.html.

Stevens, A., van Wesemael, Bas, Marx, S., Leydet. L. 2014a. Mapping Topsoil Organic Carbon Stocks in Grand-Duchy of Luxembourg. Universite catholique de Louvain.

Stevens, A., van Wesemael, Bas, Marx, S., Leydet. L. 2014b. Mapping Topsoil Organic Carbon Content in Grand-Duchy of Luxembourg. Universite catholique de Louvain.

Universite de Liege. 2015. Biomass and carbon stocks of the Luxembourg forest: Estimates and uncertainties based on NFI data.