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Report on the individual review of the annual submission of Sweden 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 Sweden, 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*
2019 Refinement to the 2006 IPCC Guidelines	*2019 Refinement to the 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"
B_o	maximum methane-producing capacity
BOD	biochemical oxygen demand
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
CSC	carbon stock change
DBH	diameter at breast height
DC	degradable organic component
dm	dry matter
DMI	dry matter intake
DOC	degradable organic carbon
EF	emission factor
ERT	expert review team
ERU	emission reduction unit
EU ETS	European Union Emissions Trading System
FAOSTAT	statistical database of the Food and Agriculture Organization of the United Nations
F_{COD}	annual amount of digestate from co-digesters
F_{LU}	stock change factor for land-use systems or subsystem for a particular land-use
FM	forest management
FMRL	forest management reference level
F_{ON}	total amount of organic nitrogen fertilizer applied to soils other than by grazing animals
F_{PRP}	annual amount of urine and dung nitrogen deposited by grazing animals on pasture, range and paddock
$Frac_{Conc}$	fraction of concentrates in feed
$Frac_{GASCOD}$	fraction of digestate from co-digesters that volatizes as ammonia and nitrogen oxides
$Frac_{GASF}$	fraction of synthetic fertilizer nitrogen that volatilizes as ammonia and nitrogen oxides
$Frac_{GASG}$	fraction of nitrogen from grazing animals that volatilizes as ammonia and nitrogen oxides

$Frac_{GASM}$	fraction of applied organic nitrogen fertilizer materials and of urine and dung nitrogen deposited by grazing animals that volatilizes as ammonia and nitrogen oxides
F_{SN}	annual amount of synthetic fertilizer applied to soils
GE	gross energy intake
GHG	greenhouse gas
GM	grazing land management
HFC	hydrofluorocarbon
HWP	harvested wood products
ICBM	introductory carbon balance model
IE	included elsewhere
IEA	International Energy Agency
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
IPCC good practice guidance for LULUCF	*Good Practice Guidance for Land Use, Land-Use Change and Forestry*
IPPU	industrial processes and product use
KP-LULUCF	activities under Article 3, paragraphs 3–4, of the Kyoto Protocol
Kyoto Protocol Supplement	*2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol*
LULUCF	land use, land-use change and forestry
ME	metabolizable energy
N	nitrogen
N_2	dinitrogen
N_2O	nitrous oxide
NA	not applicable
NCV	net calorific value
NE	not estimated
Nex	nitrogen excretion
NF_3	nitrogen trifluoride
NFI	national forest inventory
NH_3	ammonia
NIR	national inventory report
NO	not occurring
NO_X	nitrogen oxides
PE	person equivalent
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
SOC	soil organic carbon
SOM	soil organic matter
TOC	total organic carbon
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*

I. Introduction

1. This report covers the review of the 2022 annual submission of Sweden, 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 Roman Payo and Emma Salisbury (secretariat). Table 1 provides information on the composition of the ERT that conducted the review for Sweden.

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

Area of expertise	*Name*	*Party*
Generalist	Olia Glade	New Zealand
	Manfred Ritter	Austria
Energy	Graham Anderson	Germany
	Amir Dillawar	Guyana
	Rianne Dröge	Netherlands
	Awassada Phongphiphat	Thailand
IPPU	Kakhaberi Mdivani	Georgia
	Lorenz Moosmann	European Union
	Clemêncio Nhamtumbo	Mozambique
Agriculture	Yu'e Li	China
	Mahmoud Medany	Egypt
	Lilia Taranu	Republic of Moldova
LULUCF and KP-LULUCF	Valentin Bellassen	France
	Dinh Hung Nguyen	Viet Nam
	Nele Rogiers	Switzerland
Waste	Qingxian Gao	China
	Gabor Kis-Kovacs	Hungary
Lead reviewers	Qingxian Gao	
	Olia Glade	

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 Sweden resolve identified findings, including issues[1] designated as problems.[2] Other findings, and, if applicable, the encouragements of the ERT to Sweden to resolve related issues, are also included in this report.

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

[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.

5. Annex I presents the annual GHG emissions of Sweden, 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.

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 Sweden

Assessment			*Issue/problem ID#(s) in table 3 or 5*[a]
Date of submission	Original submission: NIR, 12 April 2022; CRF tables (version 2), 12 April 2022; SEF tables, 12 April 2022 (SEF-2021-CP1 and SEF-2021-CP2) Revised submission: 23 December 2022 (SEF-2021-CP1) and 10 February 2023 (SEF-2021-CP2) Unless otherwise specified, values from the most recent submission are included in this report		
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	L.20, L.22, L.23, L.26
	(c) Development and selection of EFs?	Yes	A.6, L.1, L.29, L.31, L.32, W.13
	(d) Collection and selection of AD?	Yes	I.13
	(e) Reporting of recalculations?	Yes	I.4
	(f) Reporting of a consistent time series?	No	
	(g) Reporting of uncertainties, including methodologies?	Yes	G.2
	(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]	No	
	(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?	No	G.6
Description of trends	Did the ERT conclude that the description in the NIR of the trends for the different gases and sectors is reasonable?	No	I.12
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	

Assessment			*Issue/problem ID#(s) in table 3 or 5[a]*
	(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	
	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?	Yes	
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	Sweden 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 23 April 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 Sweden

ID#	*Issue/problem classification*[a, b]	*Recommendation from previous review report*	*ERT assessment and rationale*
General			
G.1	CRF tables (G.1, 2020) (G.2, 2019) (G.5, 2017) Transparency	Make efforts to progress the collection of consent from plant operators and strive to report transparent data in future annual submissions while maintaining data confidentiality.	Resolved. The Party reported in its NIR (pp.63–64) that company data for several emissions sources in the energy (1.A.1 and 1.A.2) and IPPU (2.C.7) sectors are deemed confidential and that analyses have been performed regarding those sources to confirm the need to protect the confidentiality of the data provided by companies requesting confidentiality. Consequently, the Party reported these sources as confidential. Section 1.6.3 of the NIR also states that Sweden contacted all companies that raised confidentiality issues to discuss ways of resolving their concerns, which resulted in a decrease in the number of companies raising confidentiality concerns. Specifically, Sweden developed a method demonstrating the mathematical probability of identifying a certain company's data within less than a set level ("P% method"). Furthermore, Sweden reported that it is planning to hold meetings with companies that have a greater impact on the number of categories reported as confidential in the inventory and where consent has not previously been acquired. During the review, the Party clarified that it has established a productive dialogue with the companies in question and that it is planning to continue applying the P% method. The ERT considers that the recommendation has been fully addressed because the Party has clearly demonstrated its efforts to negotiate with the data producers and reduce the number of cases of confidential company data, where deemed appropriate, taking into consideration the impact of data disclosure and has documented its procedures in the NIR.
G.2	Uncertainty analysis (G.4, 2020)	Include in the NIR an uncertainty analysis for 1990 (the base year under the Convention).	Addressing. The Party reported in section 1.7 of the NIR (p.65) a general uncertainty assessment and provided information on the methodology used for the uncertainty analysis in NIR annex 7 (p.205). Both section 1.7 and annex 7 contain detailed

[3] FCCC/ARR/2020/SWE. The ERT notes that the report on the review of Sweden'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
	Convention reporting adherence		information on uncertainties with and without LULUCF for 2020. Annex 7 also includes information on uncertainties by category for the base year (1990). However, neither section 1.7 nor annex 7 includes information on the overall uncertainty for the entire inventory for the base year under the Convention (1990 for Sweden). According to paragraph 15 of the UNFCCC Annex I inventory reporting guidelines, Parties shall report uncertainties for at least the base year and the latest inventory year. During the review, the Party clarified that the value of the total uncertainty for the base year is 40.1 per cent including LULUCF (or 13,986 kt CO_2 eq, as total emissions for 1990 amount to 34,850.48 kt CO_2 eq) and 14.3 per cent excluding LULUCF (or 10,211 kt CO_2 eq, as total emissions for 1990 amount to 71,441.55 kt CO_2 eq). Sweden also informed the ERT that it will include uncertainty values for the base year and explanations of the trends in uncertainty in NIR section 1.7 in the next annual submission. The ERT considers that the recommendation has not yet been fully addressed because the Party has not yet reported the overall uncertainty values for the inventory with and without LULUCF for the base year under the Convention. The ERT emphasized that to enable the comparability of inventories, it is essential to include the overall uncertainty values for 1990 with and without LULUCF in the table representing uncertainties (similarly to the values for 2020 reported by Sweden in the 2022 submission).
G.3	Other (G.5, 2020) Comparability	(a) Complete the empty cells of CRF table 6 by including either the indirect CO_2 and N_2O emissions or the correct notation keys in accordance with paragraph 37 of the UNFCCC Annex I inventory reporting guidelines; (b) Include in the NIR information about indirect CO_2 and N_2O emissions in order to improve transparency.	Addressing. The Party reported indirect N_2O emissions for the energy, IPPU, and waste sectors in CRF table 6 and reported indirect N_2O emissions for the agriculture sector as "IE". However, the Party left blank cells in CRF table 6 for indirect N_2O emissions for the LULUCF sector and blank cells for indirect CO_2 emissions for all sectors except for the energy sector, for which the emissions were reported as "NO", even though indirect CO_2 emissions are likely to occur from energy activities (e.g. indirect CO_2 emissions associated with fugitive CH_4 emissions). NIR section 9 provides information on the calculation and methodological issues associated with estimating indirect N_2O emissions but no such information is provided on indirect CO_2 emissions. During the review, the Party clarified that it began reporting indirect N_2O emissions from atmospheric deposition of N in NO_X and NH_3 in NIR section 9 and CRF table 6 in the 2022 submission. However, the issue regarding the correct use of notation keys has not yet been resolved. The Party indicated that it is planning to resolve this issue in the 2023 submission. The ERT considers that the recommendation has not yet been fully addressed because the Party has not yet filled in the blank cells in CRF table 6 by including either the indirect CO_2 emissions (for most sectors) and N_2O emissions (for the LULUCF sector), or by using the appropriate notation keys in accordance with paragraph 37 of the UNFCCC Annex I inventory reporting guidelines.

ID#	*Issue/problem classification*[a, b]	*Recommendation from previous review report*	*ERT assessment and rationale*
G.4	Notation keys (G.6, 2020) Transparency	Include in the NIR information that demonstrates 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 in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	Resolved. The Party reported in annex 5 to its NIR (section 5.1.1, pp.200–201) a table listing all instances of the use of the notation key "NE" in the inventory, including short explanations as to why the relevant emissions were not estimated. For sources considered insignificant, an estimated level of emissions (in kt CO_2 eq) was reported. Sweden also provided more detailed explanations demonstrating that emissions for the categories considered insignificant are below the threshold of 0.05 per cent of the total national GHG emissions excluding LULUCF, and estimated that the total emissions for those sources amounts to 4.13 kt CO_2 eq, which equates to 0.008 per cent (<0.1 per cent) of the national total GHG emissions for 2020 (NIR annex 5, section 5.1.1).
Energy			
E.1	1.A Fuel combustion – sectoral approach – all fuels and gases (E.1, 2020) (E.6, 2019) Transparency	Ensure consistency in references to data sources throughout the NIR.	Resolved. Throughout the NIR, the Party replaced references to "industrial energy statistics" with the name of the actual statistical product used. The Party provided appropriate descriptions and information in the NIR (sections 3.2 and 10.4 and annex 2).
E.2	1.A Fuel combustion – sectoral approach – solid, liquid and gaseous fuels – CO_2, CH_4 and N_2O (E.2, 2020) (E.1, 2019) (E.9, 2017) Comparability	Enhance the transparency of reporting by exploring ways to minimize the number of categories reported as confidential while protecting the confidentiality of company data, for example by (1) using weighted average EFs for one industry instead of directly citing each facility's data; (2) collecting consent from plant operators and reporting emissions in the CRF tables and NIR not as confidential information; or (3) for categories where AD and emissions are reported as confidential, maintaining AD as confidential but reporting emissions.	Resolved. The Party continued its efforts to minimize the number of categories reported as confidential by obtaining consent from companies and plant operators in cases where the data would otherwise need to be treated as confidential. This has led to fewer instances of company data being reported as confidential. A description of the Party's efforts in seeking consent to reduce the number of categories reported as confidential is provided in the NIR (section 1.6.3).
E.3	1.B.1.b Solid fuel transformation – biomass – CH_4 (E.3, 2020) (E.4, 2019) (E.7, 2017) (E.8, 2016) (E.7, 2015) Comparability	Report fugitive CH_4 emissions from charcoal production separately in category 1.A.1.c and describe in the NIR where in the CRF tables these emissions are reported.	Resolved. In the NIR (sections 3.2.8.1 and 3.3.1.2), the Party clarified which emissions are reported under subcategory 1.B.1.b. As the 2006 IPCC Guidelines do not include default EFs for fugitive emissions from charcoal production (see also footnote 5 to CRF table 1.B.1), the Party reported fugitive CH_4 emissions as "NE". Combustion CH_4 emissions from charcoal production were reported as an aggregate amount under subcategory 1.A.2.g (manufacturing industries and construction – other) because several charcoal producers have fewer than 10 employees and their reporting to the Swedish Energy Agency is aggregated with the reporting from other companies with fewer than 10 employees from the manufacturing industries and construction category. As a result, CH_4 emissions for subcategory 1.A.1.c (manufacture of solid fuels and other energy

ID#	*Issue/problem classification*[a, b]	*Recommendation from previous review report*	*ERT assessment and rationale*
			industries) were reported as "IE" (NIR p.139). The Party indicated in CRF table 9 that it is not possible to separate out fugitive CH_4 emissions from charcoal production.
E.4	1.B.2.a Oil – CO_2 (E.6, 2020) Comparability	Report on hydrogen production plants at refineries under subcategory 1.B.2.a.iv (oil refining) in CRF table 1.B.2.	Resolved. The Party reported emissions from hydrogen production at refineries in its NIR, noting that these emissions are included under category 1.B.2.a.1 (section 3.3.2.2.1, p.201) and in CRF table 1.B.2. This is consistent with the 2006 IPCC Guidelines (vol. 2, chap. 4.2.2). During the review, the Party clarified that emissions for subcategory 1.B.2.a.i (oil exploration) will be reallocated to subcategory 1.B.2.a.iv (oil refining) once Sweden decides to implement the reporting requirements of the 2019 Refinement to the 2006 IPCC Guidelines. The ERT considers that the recommendation has been addressed.
E.5	International navigation – gas/diesel oil – CO_2, CH_4 and N_2O (E.4, 2020) (E.7, 2019) Transparency	Explain in the NIR, for example in annex 2, section 2.2, the reason why the reported amount of gas/diesel oil used in international navigation is different in CRF tables 1.D and 1.A(b).	Resolved. The Party explained in the NIR (annex 4, section 4.1) the reason for the previous difference between the amount of gas/diesel oil reported in CRF tables 1.D and 1.A(b). As described in the NIR (annex 4, section 4.4.1.2), the Party revised the values reported for fuel consumption using a harmonized NCV.
E.6	International navigation – residual fuel oil – CO_2 (E.5, 2020) (E.8, 2019) Convention reporting adherence	Correct the erroneous values of residual fuel oil consumption reported in CRF table 1.A(b) for the entire time series; and improve QC to ensure that data used in the CRF tables are consistent throughout.	Addressing. The Party reported in its NIR (annex 4, section 4.1) that the NCV for residual fuel oil was harmonized between CRF tables 1.D and 1.A(b). The ERT notes that while the amounts of residual fuel oil reported in CRF table 1.A(b) for international bunkers and in CRF table 1.D for international navigation (marine bunkers) are consistent for 2019 and 2020, they differ for 2018 and all preceding years of the time series. In the NIR (annex 4, section 4.4.1.2), the Party explained that the discrepancies between the reference and the sectoral approach in the reporting of liquid fuels have not been resolved and that problems persist in relation to the quality of the statistics used. During the review, the Party noted that the reason for the difference in the reported values was explained in the 2020 NIR (annex 4, section 4.1) and that the revision of fuel consumption values using harmonized NCVs was described in the 2021 NIR (annex 4, section 4.4.1.2). The ERT considers that the recommendation has not yet been fully addressed owing to the remaining inconsistencies for the years prior to 2019, where the mean absolute annual difference between the amounts of residual fuel oil reported in CRF table 1.A(b) for international bunkers and in CRF table 1.D for international navigation (marine bunkers) is more than 2 per cent.
IPPU			
I.1	2. General (IPPU) – NF_3 (I.1, 2020) (I.1, 2019) (I.12, 2017) Comparability	Use the notation key "NO" for NF_3 both in the NIR (table ES.1) and in the CRF tables.	Resolved. The Party reported NF_3 emissions as "NO" in its NIR (section ES.2, table ES.1, p.23) and in CRF tables 2(I)s1, 2(I)s2, 2(II), 2(II).B-Hs2, summary 1.As1, summary 2, 10s5 and 10s6.

ID#	*Issue/problem classification*[a, b]	*Recommendation from previous review report*	*ERT assessment and rationale*
I.2	2.A.2 Lime production – CO_2 (I.11, 2020) Transparency	Provide an explanation of how emissions associated with lime kiln dust generated during the production of lime are estimated.	Resolved. The Party reported in its NIR (section 4.2.2.2.1, pp.225–226) that information on emissions associated with lime kiln dust is reported under the EU ETS by the individual companies. The inventory estimates reported under the Convention are based on the data reported under the EU ETS (NIR annex 8, section 8.1).
I.3	2.B.5 Carbide production – CO_2 (I.3, 2020) (I.34, 2019) Transparency	Report transparently the methodology used for estimating CO_2 emissions from acetylene use, including the AD and EFs used, in the section of the NIR on calcium carbide (category 2.B.5.b).	Resolved. The Party reported in its NIR (section 4.3.5, table 4.3.3, p.240) information on the use of the default EF for calcium carbide used for acetylene production. Regarding the AD used, the Party reported in the NIR (section 4.3.5) that calcium carbide is used for acetylene production and that the AD for the entire time series are reported in NIR table 4.3.5 (p.242).
I.4	2.C.1 Iron and steel production – CO_2 (I.7, 2020) (I.17, 2019) (I.17, 2017) Transparency	Report on any recalculations to emissions and AD across the time series for sources in the energy and IPPU sectors affected by the integrated steelworks (i.e. categories 1.A.1.a, 1.A.1.c, 1.A.2.a, 1.B.1.c and 2.C.1.b) (as a result of harmonization of the data).	Not resolved. The Party reported in its NIR (section 4.4, pp.180–183) information on the different sources of AD used. Trade statistics from the national energy balance are the main data source used for imports/exports of and stock changes in iron and steel for the reference approach. For the sectoral approach, various data sources are used. The Party is implementing a project in collaboration with the Swedish Environmental Protection Agency, the Swedish Energy Agency, Statistics Sweden and Swedish Environmental Emissions Data in order to resolve the remaining differences between the reference and the sectoral approach. During the review, the Party clarified that it will provide a report describing the efforts made over the last six years to address this issue, as well as the improvements made in conducting a transparent and clear comparison between the reference and the sectoral approach, in its next annual submission. In addition, the Party is planning to comprehensively and transparently summarize in the 2023 NIR the efforts made to explain the problems it faces in conducting the comparison between the reference and the sectoral approach. The top-down method applied for the reference approach (using the 2006 IPCC Guidelines and the national energy balance) is problematic in relation to the iron and steel industry in Sweden because the energy and material flows in the energy balance differ too greatly from those reported in the environmental reports described in Annex 8.3 to the NIR. Over recent years, Sweden has tried to harmonize and understand the differences between the two AD sets in order to find ways of decreasing the differences and reporting a more transparent comparison. However, despite those efforts and a decrease in the difference in percentage terms, large differences remain between the reference and the sectoral approach, as the Party has not found a way of harmonizing the two AD sets. The Party will therefore focus on explaining why these problems exist in the comparison between the reference and the sectoral approach for the integrated iron and steel sector and expand the method of comparison by using the whole energy balance (not only the delivery side) to demonstrate that the estimates under the sectoral approach are in line with those under the reference approach.

ID#	*Issue/problem classification*[a, b]	*Recommendation from previous review report*	*ERT assessment and rationale*
			The ERT considers that the recommendation has not yet been fully addressed because the Party has not made recalculations as a result of its efforts to harmonize and improve the accuracy of the data on emissions from the integrated steelworks.
I.5	2.C.1 Iron and steel production – CO_2 (I.8, 2020) (I.19, 2019) (I.17, 2017) Transparency	Report on the comparison between the reference approach and the sectoral approach for solid fuel energy use and emissions, and outline changes in the overall comparison as a result of improvements in the harmonization of NCVs and AD for solid fuels between steelworks operators and the Swedish Energy Agency.	Resolved. The Party reported in its NIR (annex 4, section 4.4, pp.180–181) information on the difference between the reference and the sectoral approach for solid fuels, which is caused by the use of different data sources and thus different data sets and methodologies. The large stock changes and exports of solid fuels reported in the energy balances are the main cause of the significant difference between the two approaches. Use of energy balance delivery data in the comparison with the sectoral approach is problematic owing to differences between delivery and consumption, which results in the significant and highly variable statistical differences.
I.6	2.F.2 Foam blowing agents – HFCs (I.12, 2020) Transparency	Provide the justification for not taking into account foam imported into the country in the AD used for estimating the emissions.	Resolved. The Party justified in its NIR (p.305) the reason for not estimating emissions from imported foam by explaining that most of the produced quantities of extruded polystyrene foam currently use blowing agents other than HFCs (e.g. CO_2 and hydrofluoroolefin) and by estimating the likely level of emissions (lower than 10 kg CO_2 eq from 1990 to 2012, when HFCs were used) using the per capita emissions of a comparable country (Norway).
Agriculture			
A.1	3.A.1 Cattle – CH_4 (A.1, 2020) (A.7, 2019) Transparency	Provide more detailed information and rationale in the NIR regarding the assumptions used in the calculation of dm intake for bulls and steers, in particular by explaining the correction of dm intake for the Hereford and Angus breeds.	Resolved. The Party reported the source for the assumptions used in the calculation of dm intake for bulls and steers in NIR table 5.3 (p.331). One of the references (Bertilsson (2016)) includes detailed information and the rationale for the correction of dm intake for bulls and steers.
A.2	3.A.1 Cattle – CH_4 (A.7, 2020) Transparency	(a) Include the units for all input parameters (e.g. milk yield, fat, protein and amount of energy corrected milk) used in the equations presenting the country-specific methodology used to determine dm intake and the total energy content in the CH_4 emitted for dairy and suckler cows; (b) Explain the methods used to determine GE and the average CH_4 conversion rate for dairy and suckler cows.	(a) Resolved. The Party reported in its NIR (p.329) the units (e.g. milk yield (kg/year), fat (per cent), protein (per cent) and amount of energy corrected milk (kg/year)) used in the equation for calculating energy corrected milk of dairy and suckler cows; (b) Resolved. The Party reported in its NIR (p.330) that it does not use AD on GE in the model used for calculating the CH_4 EFs for dairy and suckler cows. GE is calculated afterwards to be reported in the CRF tables. The methods used to determine the GE and average CH_4 conversion are reported in the NIR.
A.3	3.A.1 Cattle – CH_4 (A.8, 2020) Transparency	Use a consistent variable name for the fraction of concentrates in the feed for all cattle subpopulations.	Resolved. The ERT considers that the recommendation has been fully addressed because the Party used $Frac_{Conc}$ consistently to report the fraction of concentrates in the feed in its NIR.

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A.4	3.B Manure management – N_2O (A.9, 2020) Transparency	Explain that manure used in co-digestion is omitted from CRF table 3.B(b) and provide the fraction of manure co-digested for the aggregate categories of dairy cattle, non-dairy cattle and swine along with the disaggregated values currently provided in NIR table 5.14.	Addressing. The Party reported in its NIR (table 5.14) the fraction of manure treated in co-digesters during manure management that is excluded from the agriculture sector and accounted for in the waste sector. The Party did not report the fraction of manure co-digested for the aggregate categories of non-dairy cattle and swine along with the disaggregated values currently provided in NIR table 5.14 (p.337). However, the Party did provide the fraction for the aggregate category of dairy cattle. During the review, the Party provided the percentage of anaerobic digestion of manure in co-digesters for non-dairy cattle and swine and explained that this information will be included in table 5.14 in the 2023 NIR. The ERT considers that the recommendation has not yet been fully addressed because the Party has not yet reported the fraction of manure co-digested for the aggregate categories of non-dairy cattle and swine.
A.5	3.B Manure management – CH_4 and N_2O (A.10, 2020) Convention reporting adherence	Correct the values for the ratio of manure handled in deep litter systems for 2017 and 2018 for all livestock species and update NIR table 5.12 so that all values are reported in percentages.	Resolved. The ERT considers that the recommendation has been fully addressed because the Party reported in NIR table 5.12 (p.337) the correct values for the ratio of manure handled in deep litter systems.
A.6	3.B.4 Other livestock – N_2O (A.11, 2020) Accuracy	Justify that the Nex rate applied for reindeer is appropriate to national circumstances compared with the default value and the higher value previously used in the NIR.	Not resolved. The Party did not justify in its NIR whether the Nex rate applied for reindeer is appropriate to its national circumstances. During the review, the Party clarified that it is implementing an ongoing project to update the Nex values and that the Nex rate will be reviewed and justified in the 2023 submission. The ERT noted that the 2006 IPCC Guidelines do not include a default Nex rate for reindeer but the 2019 IPCC Refinement (vol. 4, chap. 10, table 10.19) does (0.23 kg N/1000 kg animal mass/day, or 5.75 kg N/head/year assuming a 70 kg mass). The ERT noted that the Nex rate used since the 2020 submission resulted in lower N_2O emissions estimates compared rate used in previous submissions (e.g. 7.79 kt CO_2 eq lower in 2020) but higher than the estimates using the IPCC default (e.g. 0.49 kt CO_2 eq in 2020). The ERT concluded that the potential underestimate is below the significance threshold for application of an adjustment in accordance with decision 22/CMP.1, annex, paragraph 80(b), in conjunction with decision 4/CMP.11 (23.14 kt CO_2 eq for Sweden in 2020) and therefore not included in the list of potential problems and further questions raised. The ERT considers that the recommendation has not yet been addressed because the Party has not yet provided justification in the NIR on the appropriateness of the Nex rate applied for reindeer to national circumstances.
A.7	3.B.5 Indirect N_2O emissions – N_2O (A.12, 2020) Transparency	Explain in the documentation box of CRF table 3.B(b) and in CRF table 9 that N lost through leaching and run-off from manure	Resolved. The Party reported in the documentation box of CRF table 3.B(b) that N lost through leaching and run-off from manure handling and storage is reported under category 3.D.b. The Party also reported in CRF table 9 that indirect N_2O emissions from manure management are reported under subcategory 3.D.b.2.

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		handling and storage is reported under category 3.D.b.	
A.8	3.D.a.2 Organic N fertilizers – N_2O (A.14, 2020) Convention reporting adherence	Correct the value reported for 2018 in column 7 (fraction of N volatilized as N_2O, NO_X and N_2 and lost through leaching and run-off during storage of animal manure) of NIR table 5.22 and perform QA/QC checks for the other years.	Resolved. The ERT considers that the recommendation has been fully addressed because the Party reported in NIR table 5.22 (p.347) the correct fraction value for N volatilized as N_2O, NO_X and N_2 and lost through leaching and run-off during storage of animal manure for 2018 (0.0311). No other errors were identified by the ERT, suggesting that QA/QC checks have been performed.
A.9	3.G Liming – CO_2 (A.15, 2020) Transparency	Estimate CO_2 emissions from liming by applying the recommended method from figure 11.4 in the 2006 IPCC Guidelines (vol. 4). If the Party continues to use the tier 1 method, explain in the NIR why a recommended method from the 2006 IPCC Guidelines has not been followed as required by paragraph 11 of the UNFCCC Annex I inventory reporting guidelines.	Not resolved. The Party reported in its NIR (p.357) that the tier 1 method from the 2006 IPCC Guidelines was used together with the default EF for calculating CO_2 emissions from liming. CO_2 emissions for category 3.G are still identified as key (NIR table 1.4) using the approach 1 level assessment excluding LULUCF but not using approach 2. During the review, the Party clarified that, as per its response during the previous review, it is of the opinion that emissions from liming are negligible and do not justify the time and resources required to develop a tier 2 method using country-specific EFs, especially as the 2006 IPCC Guidelines (vol. 4, chap. 11.3.1) indicate that emissions estimated using the tier 2 method are likely to be less than those estimated using the tier 1 approach and that, as a result, CO_2 emissions from liming would probably no longer be identified as key. The Party explained that this information will be included in the 2023 NIR. The ERT agrees with the Party that the contribution of this category to the national total emissions excluding LULUCF (0.26 per cent for 2020), is relatively small and less than twice as big as the category with the smallest amount of emissions identified as key by level assessment using approach 1 (0.16 per cent; NIR annex 1, table A1.1). The ERT notes that, as indicated by Sweden, the 2006 IPCC Guidelines state that emissions estimated using a tier 2 method are likely to be less than those estimated using a tier 1 method. The ERT also notes that the 2006 IPCC Guidelines (vol. 1, chap. 4, figure 4.1) indicate that if using the method recommended therein significantly jeopardizes the resources required for other key categories, Parties can select a method appropriate to the available data and document why the category-specific guidance could not be followed. The ERT suggests that the Party include this information in the NIR to justify the reason for estimating the emissions using a tier 1 method.
LULUCF			
L.1	4. General (LULUCF) – CO_2 (L.8, 2020) Accuracy	Justify the use of the country-specific EF of 0.12 CO_2-C ha^{-1} $year^{-1}$ for DOC emissions from drained organic soils for forest land, cropland and grassland for the temperate region on the basis of national circumstances or, alternatively, apply the default EF for DOC from the Wetlands Supplement (table	Addressing. The Party reported in its NIR (p.467 and annex 3, p.134) that it now uses a set of country-specific EFs ranging from 0.04 to 0.1 t CO_2-C ha^{-1} $year^{-1}$ for DOC emissions from drained organic soils for forest land and grassland based on average estimates published in a study by Wallin et al. (2021). After consulting the study, however, the ERT notes that the country-specific EFs for DOC emissions are based on estimates for watersheds with more than 20 per cent drained organic soils. The actual EF for drained organic soils could therefore be significantly higher. Using the values from

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		2.2) for the temperate region while collecting new information.	the study may then result in an underestimation of emissions, which is supported by the conclusion of the study that "It is likely that the lower calculated TOC export compared to the IPCC default value was influenced by the significant mineral soil content of the catchments included in the study" (Wallin et al., p.19). During the review, the Party clarified that, on the basis of expert judgment, it decided that the EF for boreal forests was more appropriate because a recent PhD thesis (Tong, 2022) found no significant difference between drained and undrained organic soils in relation to DOC emissions. On the basis of the study by Wallin et al. and the explanations provided by Sweden, the ERT is of the view that using the default EFs for temperate forests from the Wetlands Supplement (table 2.2) may result in an overestimation of emissions, but that using the default EFs for boreal forests from the 2006 IPCC Guidelines or the country-specific EFs currently reported may result in an underestimation of emissions. The ERT therefore considers that the recommendation has not yet been fully addressed, as there may still be an underestimation of emissions for temperate forest and the Party has neither applied the default EF for DOC from the Wetlands Supplement nor collected new information justifying other country-specific EFs. The ERT notes that using the default EFs for boreal forests from the Wetlands Supplement (table 2.2) for drained organic soils in the boreal zone and the default EFs for temperate forests for drained organic soils in the temperate zone for the delimitation of climatic zones (Wetlands Supplement (table 2.2)) may result in the most accurate emission estimates until more accurate information on country-specific EFs becomes available.
L.2	4. General (LULUCF) (L.9, 2020) Transparency	Report comparable information on areas of land conversion across CRF table 4.1 and CRF tables 4.A–4.F. If there are remaining inconsistencies, provide a detailed explanation for the difference in the areas reported in CRF table 4.1 and background CRF tables 4.A–4.F.	Addressing. Sweden reported in its NIR (p.370) that it is not possible to convert the extrapolation of areas into annual values and explained that there is no IPCC guidance on extrapolation for CRF table 4.1. During the review, the Party clarified that the extrapolation of areas is implemented at the subcategory level rather than at the plot level, which complicates the reporting of extrapolated values in CRF table 4.1. The ERT notes that the explanation provided by the Party as to why it is impossible to avoid an inconsistency in the areas of land conversion reported in CRF table 4.1 and CRF tables 4.A–4.F is not yet fully transparent. In addition, the ERT notes that the NIR does not include a description of how the figures reported in CRF table 4.1 were estimated for the last four years for which the data were extrapolated. The ERT considers that the recommendation has not yet been fully addressed because the Party has not provided a detailed explanation for the reported difference in areas in its NIR or ensured consistency across CRF tables 4.1 and CRF tables 4.A–4.F.
L.3	Land representation (L.10, 2020) Transparency	Improve the transparency of the reporting on forest land by including information on the management status of forests that are not	Resolved. The Party reported in its NIR (p.468) that since no updated field measurements of living biomass or other carbon pools have been made of forest areas that are not included in the estimations of carbon removals and emissions, the carbon pools are assumed to be in a steady state. Sweden explained in the NIR that this is supported by the fact that the results of bore core sampling indicate almost zero net

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		included in the estimations of carbon removals and emissions.	growth and that reporting no CSCs in living biomass on forest land is therefore justified. The ERT agrees with this reasoning.
L.4	4.A Forest land – CO_2 (L.2, 2020) (L.2, 2019) (L.7, 2017) Transparency	Report transparently the change of forest land to wetlands and other land, and the change from wetlands and other land to forest land, as well as the accompanying gains and losses in the carbon pools where methods are provided in the 2006 IPCC Guidelines, by providing information on whether a land-use change from forest land is caused by the fact that the national requirements for forest land are no longer met or by the fact that the dominant land use is no longer forestry, and, in cases where the allocation of the land under forest land was not "temporary unstocked" but the land use really changed, consider using a subcategory for this land-use change.	Resolved. The Party included in the NIR (pp. 367 and 374) information on the change of forest land to wetlands and other land, and the change from wetlands and other land to forest land, and more generally on land-use changes to and from unmanaged land. The areas converted and the CSC in forest land converted to other land were reported.
L.5	4.A Forest land – CO_2 (L.3, 2020) (L.3, 2019) (L.7, 2017) Transparency	Document and report the procedure describing when forest land is considered to have changed to other land, taking into consideration that the definition of forest land used by the Party does not restrict forest land to productive forest and that the 2006 IPCC Guidelines also include, under managed land, land that performs ecological or social functions.	Resolved. The Party provided in its NIR (p.374) information on the change of forest land to other land, and more generally on land-use changes to and from unmanaged land.
L.6	4.A Forest land – CO_2 (L.4, 2020) (L.5, 2019) (L.7, 2017) Transparency	Report on the improved national system of rules for the assessment of land-use changes.	Resolved. The NIR (pp. 367 and 374) now clearly describes the decision rules to assess land-use changes. See ID#s L.4 and L.5 above.
L.7	4.A Forest land – CO_2 (L.11, 2020) Transparency	Include information in the NIR on the methodology and factors used for estimating the validated values of CSC from stump and root systems of the deadwood pool; and the procedures (if any) for using validated values to calculate or adjust reported values of CSC in the deadwood pool, or clarify that these values are provided for information purposes only.	Resolved. The net removals from stumps (in the deadwood pool) reported by the Party were calculated as follows: growth – net removals from living biomass (inflow) – modelled decomposition (outflow). The method used for validating values of net removals from stumps was based on the following calculation: harvest statistics (inflow) – modelled decomposition (outflow). Relevant information was provided in the NIR (NIR annex 3, p.125).

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L.8	4.A.2 Land converted to forest land (L.12, 2020) Transparency	When reporting in the NIR on CSC due to the conversion of wetlands and other land to forest land, distinguish between conversion due to natural causes and conversion due to human activities, and include the information provided during the review.	Addressing. The Party reported in its NIR (p.374) that all CSCs to and from other land are now reported but not CSCs resulting from conversion to wetlands because there is no IPCC method available, except for calculating land converted for peat extraction. The ERT noted, however, that there is a method in the 2006 IPCC Guidelines for reporting emissions from land converted to flooded land. During the review, the Party clarified that a study (Peacock et al., 2021) concluded that all dams or other reservoirs in the country were created long before 1990 and that there was therefore no area to be reported under land converted to managed wetlands for the entire time series. The ERT considers that the recommendation will be fully addressed when the conclusions from this study on the absence of conversions to flooded land since 1970 are included in the NIR.
L.9	4.B.1 Cropland remaining cropland – CO_2 (L.13, 2020) Transparency	Report on how the CSC that was previously reported for the "young" carbon pool of SOM is currently considered in the calculations of the reported CSC in the SOM pool of cropland remaining cropland.	Resolved. The "young" carbon pool is no longer directly considered in the calculations of CSC in the SOM pool in cropland remaining cropland but is only indirectly considered as an input to the "old" carbon pool of SOM. Relevant information was provided in the NIR (NIR annex 3, p.137).
L.10	4.B.2 Land converted to cropland – CO_2 (L.14, 2020) Convention reporting adherence	Correct the information reported in table A3:2.12 in annex 3 to the NIR.	Resolved. The inconsistency in the information reported has been corrected (NIR annex 3, p.144) and the EFs for emissions from organic soils in forest land and grassland converted to cropland reported in NIR table A3:2.12 now refer to table footnote 2 (i.e. explaining that the EF is the same as for forest land remaining forest land).
L.11	4.B.2 Land converted to cropland – CO_2 (L.15, 2020) Accuracy	Recalculate the estimated emissions from organic soils on land converted to cropland for 2018 by including DOC emissions.	Resolved. The IEF (0.46 t C/ha for the entire time series) for organic soils now includes DOC emissions. Emissions from organic soils on land converted to cropland were recalculated for 2018.
L.12	4.C Grassland – CO_2 (L.5, 2020) (L.6, 2019) (L.8, 2017) Accuracy	Provide information on the choice of the country-specific CO_2 EF for drained organic soils in grassland.	Resolved. The Party reported in the NIR (annex 3, p.132) that the results of an investigation carried out by Sweden suggest that the Party should continue to use the IPCC default EFs for drained forest land as the country-specific EFs for drained organic grassland until new data for this type of land are available, preferably in the form of measurement results of GHG emissions.
L.13	4.F.2 Land converted to other land – CO_2 (L.6, 2020) (L.7, 2019) (L.3, 2017) (L.8, 2016) (L.8, 2015) Completeness	Report emissions from the loss of living biomass and emissions and removals from mineral soil carbon for all conversions to other land.	Resolved. Sweden reported information on CSCs from living biomass and mineral soils in forest land, grassland (mineral soils only), wetlands and settlements converted to other land in CRF table 4.F.

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L.14	4(II) Emissions/removals from drainage and rewetting and other management of organic/mineral soils – CH_4 (L.7, 2020) (L.9, 2019) (L.9, 2017) Transparency	Report in the NIR that the EF per ha for all ditches is country-specific, because the area of ditches is estimated based on a factor for the fraction of the drained area (i.e. 2.5 per cent for forest land and 5 per cent for grassland and cropland) and this factor is applied to the country-specific EF by land use.	Resolved. The Party reported in the NIR (annex 3, p.146) the fraction of the drained area occupied by ditches (i.e. 2.5 per cent for forest land and 5 per cent for grassland and cropland).
L.15	4(II) Emissions/removals from drainage and rewetting and other management of organic/mineral soils – CO_2 and N_2O (L.16, 2020) Transparency	Include areas of drained organic soils of land converted to forest land and land converted to grassland in table A3:2.9, maintaining the stratification by natural zone and nutrient status. Alternatively, provide information on how the areas of organic soils reported in table A3:2.9 were combined with the areas of land converted to forest land and grassland, taking into account the stratification by natural zone and nutrient status.	Resolved. Information on how the emissions from organic soils on land converted to forest land and grassland are combined with the emissions from the "land remaining land" categories was included in the NIR (annex 3, p.141).
L.16	4(V) Biomass burning – CO_2, CH_4 and N_2O (L.17, 2020) Transparency	Include information in the NIR on how values of burned biomass were estimated for different forest types, including the approach used to allocate these emissions from the categories used by the Swedish Civil Contingencies Agency to IPCC categories.	Resolved. The NIR (annex 3, p.148) clearly describes how the values of burned biomass were estimated for different forest types.
L.17	4(V) Biomass burning – CO_2, CH_4 and N_2O (L.18, 2020) Accuracy	Include in the NIR justification of the use of a methodology and EFs from the IPCC good practice guidance for LULUCF for burned biomass or apply a tier 1 methodology and EFs from the 2006 IPCC Guidelines. The Party may also wish to consider developing a country-specific methodology and/or EFs.	Resolved. Sweden justified in its NIR (p.386) that the country-specific EFs for burned biomass were appropriate based on field observations.
L.18	4.G HWP – CO_2 (L.19, 2020) Transparency	Include all sources of information used for calculating quantities of HWP, as well as information on how these data were combined to calculate country-specific conversion factors for the different types of HWP reported in the NIR (section 6.4.2.6).	Resolved. Sweden indicated in the NIR (p.384) that the conversion factors applied for the different types of HWP are 0.62 t/m³ for wood-based panels, 0.4 t/m³ for sawn wood, and 0.9 t woody biomass/t paper. The Party also reported in its NIR (p.384) the reference for the conversion factor for wood-based panels. For paper, the value used is the same as the one provided in the Kyoto Protocol Supplement (table 2.8.1). For sawn

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			wood, the value used is slightly lower than the value in the Kyoto Protocol Supplement (0.458 for sawn wood (aggregate)).
Waste			
W.1	5.A Solid waste disposal on land – CH_4 (W.1, 2020) (W.3, 2019) Transparency	Describe more transparently in the NIR how the amount of CH_4 recovered and used for energy and the amount flared is determined, in particular that the information from Avfall Sverige, the Swedish waste management association, is supplemented by information on additional landfills in operation and all closed landfills, which are excluded from the data provided by Avfall Sverige.	Resolved. The ERT considers that the recommendation has been fully addressed because the Party added the following text to the footnote under NIR table 7.5 (p.405): "The information from Avfall Sverige is supplemented by SMED on additional landfills in operation and all closed landfills, which are excluded by Avfall Sverige."
W.2	5.A Solid waste disposal on land – CH_4 (W.2, 2020) (W.3, 2019) Transparency	Describe how CH_4 use and flaring are calculated (i.e. on the basis of the energy production in MWh and using the lower heating value for CH_4).	Resolved. The ERT considers that the recommendation has been fully addressed because the Party reported in its NIR (p.404) that the recovered and flared CH_4 from landfill gas is calculated on the basis of the energy production in MWh using the lower heating value for CH_4. The ERT was able to verify this information using the data reported in NIR tables 7.4 and 7.5 (pp.404–405). For example, in 2020, 149,507 MWh landfill gas was recovered, which can be converted to 538,225 GJ. As the total amount of recovered and flared gas in 2020 was 10,727 t, the conversion factor used must have been 50.2 GJ/t, which is acceptable as a lower heating value for CH_4.
W.3	5.A Solid waste disposal on land – CH_4 (W.10, 2020) Consistency	Provide more transparently in the NIR the reason for the reduction in the DOC content of industrial waste and update the entire time series on the basis of the new data set.	Resolved. The ERT considers that the recommendation has been fully addressed because the Party included in its NIR (p.418) additional information on the fluctuating DOC values for different waste categories for 2010–2018 reported in NIR table 7.17. In the NIR (p.418), the Party explained the reasons for the variation in the DOC values for the "European Waste Classification for Statistics" categories (e.g. some landfills were granted exemption from the national ban on landfilling of organic waste). Newly available DOC values were used for the recalculations in both the 2021 and the 2022 submissions.
W.4	5.D Wastewater treatment and discharge – N_2O (W.3, 2020) (W.4, 2019) Transparency	Describe more transparently in the NIR the methodologies used for the estimation of N_2O emissions from wastewater, along with the AD and EFs used. Specifically, explain that: (a) Both direct emissions from wastewater treatment plants and indirect emissions due to discharge of N on open waters are estimated; (b) Direct emissions are estimated on the basis of available statistics on N in the influent of large wastewater treatment plants	(a) Resolved. The Party clearly stated in its NIR (p.435) that both direct and indirect emissions were quantified; (b) Addressing. The Party reported in its NIR (p.436) that available statistics on N in the influent of large wastewater treatment plants were used for the estimates of direct emissions at large wastewater treatment plants. The EF used (0.0074 N_2O-N/kg N) was also included in the 2022 NIR (p.436) (and in the 2020 NIR). The ERT considers that this issue has not been fully addressed because the Party did not report in the NIR the AD used for the estimation of direct N_2O emissions (total measured amount of N in the influent of large wastewater treatment plants). During the review, the Party explained that this information will be included in the 2023 NIR;

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		and a country-specific EF of 0.0074 kg N_2O-N/kg N in the influent; (c) Indirect emissions are calculated using the default EF from the 2006 IPCC Guidelines (vol. 5, chap. 6.3.1.2); (d) Available statistics on N in the effluent of large wastewater treatment plants are used as AD for indirect emissions; (e) For the part of the population not connected to large wastewater treatment plants an estimate is made of N discharge on open waters on the basis of the amount of N per capita in the influent of wastewater treatment plants.	(c) Resolved. The Party clearly reported in its NIR (p.436) that the default EF from volume 5, chapter 6.3.1.2 of the 2006 IPCC Guidelines (0.005 N_2O-N/kg N) was used to calculate indirect emissions; (d) Resolved. The Party explained in its NIR (p.436) that available statistics on N in the effluent of large wastewater treatment plants were used as AD for indirect emissions; (e) Resolved. The Party explained in its NIR (pp.436–437) that for the part of the population connected to smaller wastewater treatment plants (<2,000 PE), an estimate was made of N discharge on open waters on the basis of the amount of N per capita in the influent of these wastewater treatment plants after subtracting the assumed industrial load.
W.5	5.D.1 Domestic wastewater – CH_4 (W.4, 2020) (W.5, 2019) Transparency	Describe more transparently in the NIR how the amount of CH_4 generated and emitted at wastewater treatment plants is estimated (i.e. that emissions from the wastewater treatment ponds and sludge treatment are estimated separately).	Resolved. The Party reported additional information in its NIR (pp.433–434) on the methodological description of how the amount of CH_4 generated and emitted at wastewater treatment plants is estimated.
W.6	5.D.1 Domestic wastewater – CH_4 (W.5, 2020) (W.5 2019) Transparency	Explain that: (a) All wastewater treatment plants are well managed and the CH_4 correction factor is assumed to be 0; (b) The application of equation 6.1 from the 2006 IPCC Guidelines (vol. 5, chap. 6) results in negligible CH_4 emissions from water ponds; (c) CH_4 generation from anaerobic digestion of sludge treatment is estimated on the basis of total organics in wastewater removed, the amount of sludge generated and the CH_4 potential of the sludge, and that 4 per cent of CH_4 generation is assumed to be emitted.	(a) Resolved. The Party clarified in its NIR (p.433) that all wastewater treatment plants were assumed to be well managed and the CH_4 correction factor was therefore assumed to be 0; (b) Resolved. On the basis of the above assumption, the application of equation 6.1 from the 2006 IPCC Guidelines results in negligible CH_4 emissions from water ponds, as described in the NIR (p.433), since the correction factor is 0; (c) Addressing. The Party included additional information in its NIR (pp.433–434) with the following description: "CH_4 emissions from on-site sludge treatment is estimated on the basis of total organics in wastewater removed, the amount of sludge generated and the CH_4 potential of the sludge. The emissions are between 4 and 7 per cent of the CH_4 generation from sludge treatment." However, as BOD of sludge appears to be the most important AD used in the emission calculations, the ERT considers that this issue is not fully addressed because the Party has not included information in the NIR on how the value of DC in sludge removed reported in CRF table 5.D was determined. During the review, the Party explained that this information will be included in the 2023 NIR.
W.7	5.D.1 Domestic wastewater – CH_4	Describe clearly in the NIR that the average temperatures in Sweden are low, and that therefore direct emissions due to methanogenesis in septic tanks are assumed to	Resolved. The ERT considers that the recommendation has been fully addressed because the Party reported in its NIR (p.431) that CH_4 emissions due to methanogenesis of total organics in wastewater in septic tanks are assumed to be very low owing to the low temperatures in the septic tanks attributed to the average annual air temperatures in

ID#	*Issue/problem classification*[a, b]	*Recommendation from previous review report*	*ERT assessment and rationale*
	(W.6, 2020) (W.6, 2019) Transparency	be at a very low level, as explained in the 2006 IPCC Guidelines (vol. 5, chap. 6, p.6.7), according to which CH_4 production is unlikely below 15 °C because methanogens are not active.	Sweden (e.g. 4.8 °C for 1991–2005). According to the 2006 IPCC Guidelines (vol. 5, chap. 6, p.6.7), CH_4 production is unlikely below 15 °C because methanogens are not active.
W.8	5.D.2 Industrial wastewater – CH_4 (W.7, 2020) (W.7, 2019) Transparency	Describe more transparently in the NIR how the amount of CH_4 generated and emitted from industrial wastewater treatment is estimated; in other words, distinguish between emissions from aerobic wastewater treatment ponds, on-site treatment of sludge generated in those aerobic ponds, and anaerobic digestion of wastewater.	Resolved. The ERT considers that the recommendation has been fully addressed because the Party clearly stated in its NIR (p.434) that emissions from aerobic and anaerobic wastewater treatment are estimated separately (see also ID# W.9 below).
W.9	5.D.2 Industrial wastewater – CH_4 (W.8, 2020) (W.7, 2019) Transparency	Explain in the NIR that: (a) All aerobic wastewater treatment plants are well managed, and the CH_4 correction factor is assumed to be 0. For these installations, the application of equation 6.1 of the 2006 IPCC Guidelines results in negligible CH_4 emissions; (b) CH_4 generation from sludge treatment is estimated on the basis of statistics for energy recovery. Similar energy statistics are used to quantify CH_4 generation from anaerobic digestion of wastewater; (c) CH_4 emissions from both sludge treatment and anaerobic digestion of wastewater are subsequently estimated, assuming 5 per cent of CH_4 being emitted in 1990–2000; a gradual decrease from 5 to 2 per cent in 2001–2009; and 2 per cent from 2010 onward.	(a) Resolved. The Party reported in its NIR (p.434) that "all aerobic wastewater treatment plants are well managed, and the CH_4 correction factor is assumed to be 0. For these installations, the application of equation 6.4 of the 2006 IPCC Guidelines results in negligible CH_4 emissions". The ERT noted that the recommendation refers, probably owing to a typo, to equation 6.1 for domestic wastewater rather than to equation 6.4 for industrial wastewater and that the original issue (ID# W.7 in document FCCC/ARR/2019/SWE) refers to equation 6.1 in the description of the issue; (b) Resolved. The Party explained in its NIR (p.434) the country-specific method applied to estimate emissions from anaerobic wastewater treatment by first quantifying CH_4 generation on the basis of energy statistics; (c) Resolved. Using the values for CH_4 generated from the above-mentioned country-specific approach, the Party calculated CH_4 emissions as loss of CH_4 in the biogas production process, assuming 5 per cent of CH_4 being emitted in 1990–2000, a gradual decrease from 5 to 2 per cent in 2001–2009, and 2 per cent from 2010 onward. The EF used (i.e. 5 to 2 per cent) is based on expert judgment, as reported in the NIR (p.434).
W.10	5.D.2 Industrial wastewater – CH_4 (W.9, 2020) (W.7, 2019) Transparency	Improve the justification provided for the trend in the EF (from 5 to 2 per cent), making clear that it is based on expert judgment on the effect of an increased awareness of CH_4 leakages at biogas facilities and efforts to minimize CH_4 leakages from those facilities.	Resolved. The Party reported additional information in its NIR (p.434), explaining that: "According to wastewater treatment expertise, the loss of CH_4 in the energy recovery process should be between 2 and 5 per cent, assuming 5 per cent of CH_4 being emitted in 1990–2000; a gradual decrease from 5 to 2 per cent in 2001–2009; and 2 per cent from 2010 onwards. The EF (from 5 to 2 per cent) it is based on expert judgment on the effect of an increased awareness of CH_4 leakages at biogas facilities and efforts to minimize CH_4 leakages from those facilities."

ID#	*Issue/problem classification*[a, b]	*Recommendation from previous review report*	*ERT assessment and rationale*
KP-LULUCF			
KL.1	Article 3.3 activities – CO_2, CH_4 and N_2O (KL.1, 2020) (KL.1, 2019) (KL.7, 2017) Transparency	Revise the comment to table NIR-2 to clarify that the extrapolation of areas for land use and land-use conversion is done using the trends and not using extrapolated land-use conversions for individual plots.	Resolved. The NIR (p.486) has been updated regarding the comment to CRF table NIR-2. The ERT considers that the issue has therefore been resolved in relation to KP-LULUCF, although a related transparency issue remains in relation to the LULUCF sector (see ID# L.2 above).
KL.2	FM – CO_2, CH_4 and N_2O (KL.2, 2020) (KL.3, 2019) (KL.8, 2017) Transparency	Report information that supports the assumption that land-use changes from forest to wetlands or other land (if they happen) are not taking place in combination with deforestation activities.	Addressing. See ID# L.8 above. 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.
KL.3	HWP – CO_2 (KL.3, 2020) Transparency	Include in the NIR information on how emissions from the HWP pool that have been accounted for during the first commitment period have been excluded from the accounting for the second commitment period as required by decision 2/CMP.8, annex II.	Resolved. The Party included in the NIR (p.499) justification that the contribution of emissions from the HWP pool to the accounting during the first commitment period has been excluded from the accounting for the second commitment period: during the first commitment period, instantaneous oxidation was assumed, resulting in the absence of accounting quantity related to the HWP pool.

[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 Sweden 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, 2021 and 2018 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 Sweden, and had not been addressed by the Party at 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 Sweden

ID#	*Previous recommendation for issue*	*Number of successive reviews issue not addressed*[a]
General	No issues identified.	
Energy		

ID#	*Previous recommendation for issue*	*Number of successive reviews issue not addressed*[a]
E.6	Correct the erroneous values of residual fuel oil consumption reported in CRF table 1.A(b) for the entire time series; and improve QC to ensure that data used in the CRF tables are consistent throughout.	3 (2019–2022)
IPPU		
I.4	Report on any recalculations to emissions and AD across the time series for sources in the energy and IPPU sectors affected by the integrated steelworks (i.e. categories 1.A.1.a, 1.A.1.c, 1.A.2.a, 1.B.1.c and 2.C.1.b) (as a result of harmonization of the data).	4 (2017–2022)
Agriculture	No issues identified.	
LULUCF	No issues identified.	
Waste		
W.4	Explain that: (b) Direct emissions are estimated on the basis of available statistics on N in the influent of large wastewater treatment plants and a country-specific EF of 0.0074 kg N_2O-N/kg N in the influent.	3 (2019–2022)
W.6	Explain that: (c) CH_4 generation from anaerobic digestion of sludge treatment is estimated on the basis of total organics in wastewater removed, the amount of sludge generated and the CH_4 potential of the sludge, and that 4 per cent of CH_4 generation is assumed to be emitted.	3 (2019–2022)
KP-LULUCF		
KL.2	Report information that supports the assumption that land-use changes from forest to wetlands or other land (if they happen) are not taking place in combination with deforestation activities.	4 (2017–2022)

[a] Reports on the reviews of the 2018 and 2021 annual submissions of Sweden have not yet been published. Therefore, 2018 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 Sweden that are additional to those identified in table 3.

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

ID#	*Finding classification*	*Description of finding with recommendation or encouragement*	*Is finding an issue/problem?*[a]
General			
G.5	Article 3.14	Sweden reported that there have been changes in its reporting of the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol since its previous annual submission. The Party described the changes in NIR sections 15.3 (p.513) and 15.6 (p.515), including changes in the energy tax for manufacturing industry, agriculture, forestry and aquaculture. In its NIR (section 15.6, p. 515), Sweden also provided information on a new national centre for promoting carbon dioxide capture and storage. The ERT concluded that, taking into account the confirmed changes in the reporting, the information provided is complete and transparent.	Not an issue/problem
G.6	Notation keys	The Party reported in its NIR (annex 5, table A5.1) a table listing all instances of the use of the notation key "NE" in the inventory, including short explanations and an estimated likely level of emissions (see #ID G.4 in table 3). However, the ERT noted that: (a) For category 2.G (other product manufacture and use), justification of the insignificance of sources was not provided; (b) For subcategory 2.F.1.d (transport refrigeration – disposal), the Party explained that HFC-125 and HFC-143a emissions for 2000–2002 were reported as "NE" (previous years were reported as "NO") because no data are available for 2000–2002. Analysis conducted by the ERT of the AD for HFC disposal for this category shows that there is only a small increase in the AD from 2003 to 2004, followed by a sharp rise in 2005 (for HFC-125: 0.09 t, 0.11 t and 0.41 t for 2003, 2004 and 2005 respectively; for HFC-143a: 0.11 t, 0.13 t and 0.49 t respectively), which means that the data available for the year closest to 2000–2002 (2003 or interpolated back from 2004) could be considered to backcast the AD for the category in order to estimate the emissions. During the review, the Party clarified that: (a) For category 2.G, the SF_6 emissions from the largest accelerator in Sweden, MAX IV, are lower than 1 kg SF_6/year (or 22,800 kg CO_2 eq, or 0.028 kt CO_2 eq). As a result, Sweden believes that total emissions for category 2.G will be very low and consistently below the significance threshold (23.14 kt CO_2 eq for Sweden in 2020). Sweden indicated that this information will be included in the 2023 submission, including in CRF table 9; (b) For subcategory 2.F.1.d, the assumption in the Swedish model is that no refrigerated trailers and refrigerated trucks were equipped with R404a cooling systems during 1990–1992, 30 per cent of refrigerated trucks and refrigerated trailers had R404a in their cooling systems during 1993 and 1994, and 100 per cent had R404a in their cooling systems from 1995 onward. This means that emissions from disposal increase significantly between 2004 and 2005 since the	Yes. Convention reporting adherence

ID#	*Finding classification*	*Description of finding with recommendation or encouragement*	*Is finding an issue/problem?*[a]
		lifespan of the equipment is 10 years. Taking this into consideration, Sweden will report HFC-125 and HFC-143a emissions for subcategory 2.F.1.d for 1990–1992 as "NO" instead of "NE" in the 2023 submission. The ERT recommends that the Party include justification for the insignificance of emissions for category 2.G and report HFC-125 and HFC-143a emissions for subcategory 2.F.1.d as "NO" for 2000–2002 if emissions did not occur in those years.	
G.7	QA/QC and verification	The Party reported in its NIR (section 4.3.8, p.244) information on the reallocation of GHG emissions for category 2.B.8 (petrochemical and carbon black production) to category 2.B.10 (other – chemicals) using the notation key "IE" in CRF table 2(I).A-Hs1. However, an explanation of the use of the notation key "IE" was not provided in CRF table 9 or in the NIR. The ERT also noted several cases where the Party reported incorrect notation keys in some CRF tables; for example, category 2.A.3 (glass production), where "NE" was reported for the AD but a numerical value was provided for CO_2 emissions, and category 2.C.7 (other – metal industry), where AD values were reported, CO_2 emissions were reported as confidential and CH_4 emissions were reported as "NE" (the 2006 IPCC Guidelines do not include a methodology for estimating non-energy CH_4 emissions for this category, so reporting CH_4 emissions for this category is not mandatory). During the review, the Party clarified that this was partly caused by the difficulty of disaggregating the production processes involved in glass production as the category covers several different production processes, while in other cases, the incorrect use of notation keys was due to human error. Sweden indicated that it will correct the above-mentioned use of notation keys in the 2023 submission. Sweden also informed the ERT that within the national QA/QC system, notation keys are checked on an annual basis, both during the preparation of the annual inventory and as a result of the various (national and international) inventory reviews. The ERT welcomes the Party's response and explanations and encourages Sweden to strengthen its QA/QC procedures to ensure the correct use of notation keys.	Not an issue/problem
G.8	Uncertainty analysis	The Party reported in its NIR (p.65) that when including LULUCF in national total emissions, the uncertainty for 2020 increases to ±103 per cent from 5.8 per cent excluding LULUCF, which is due to the combination of large (and increasing) net removals from LULUCF in combination with the marked decrease in fossil fuel emissions. The ERT noted that, with regard to uncertainty, paragraph 4(e) of the UNFCCC Annex I inventory reporting guidelines states that uncertainties should be reduced as far as practicable. The ERT noted that uncertainties reported in Sweden's inventory including LULUCF have increased significantly over recent years. For example, in the 2012 NIR the Party reported uncertainties for emissions including LULUCF at 25 per cent and excluding LULUCF at 4.1 per cent, while in the 2022 NIR the Party reported that the total uncertainty was 103 per cent including LULUCF and 5.8 per cent excluding LULUCF. The ERT further noted that these changes in the uncertainties reported with and without LULUCF do not reflect changes in data quality but rather the way in which the uncertainty of total emissions including LULUCF was calculated (using the method from the 2006 IPCC Guidelines, vol. 1, chap. 3.2.3.1). This method was developed before the period when countries began working towards carbon neutrality and their emissions were still substantially higher than their removals. However, over the past decade, Sweden's emissions have decreased significantly and, as a result, the difference between its emissions and removals is now very low. The ERT considers that such cases are specifically addressed in the 2019 Refinement to the 2006 IPCC Guidelines (chap. 3.2.3.1, footnote 4) and, as a result, a different approach to calculating overall uncertainties for	Not an issue/problem

ID#	*Finding classification*	*Description of finding with recommendation or encouragement*	*Is finding an issue/problem?*[a]
		total net emissions has been introduced for such situations. The ERT points out that switching to this approach is by no means mandatory, but suggests that Sweden give it consideration.	
Energy			
E.7	Fuel combustion – reference approach – CO_2 – liquid fuels	The Party reported in its NIR (annex 4, section 4.4.1.2) on the ongoing discrepancies between the reference and sectoral approaches for liquid fuels (4.0 per cent for energy consumption and 1.3 per cent for CO_2 emissions) and the challenges in using data from the new questionnaires used with data providers. Sweden also described the ongoing efforts made by the relevant agencies to solve these problems. The ERT recommends that the Party include in its NIR the results of continued efforts to address the discrepancies between the reference and sectoral approaches for liquid fuels and the challenges in using data from the new questionnaires used with data providers along with the outcomes of work on resolving quality issues in the data sources used for estimating GHG emissions.	Yes. Convention reporting adherence
E.8	International navigation – CO_2, CH_4 and N_2O – all fuels	The Party reported in its NIR (section 3.2.2, p.125) on a study (Hedlund and Lidén (2010)) investigating differences between the data reported to IEA and the UNFCCC. During the review, the Party clarified that data harmonization work has been carried out on the basis of the 2010 study. Fuel use by navigation is based on sales statistics and split into domestic and international navigation. In addition, the NCVs for fuels have been harmonized so that the GHG inventory contains the same values as those reported to IEA. During the review, the Party explained that section 3.2.2 in 2022 NIR will not be included in the 2023 NIR because it is deemed obsolete. The Party also explained that the method for calculating emissions from international navigation will be thoroughly described in section 3.2.2.2 in the 2023 NIR. The ERT recommends that the Party include in its NIR information explaining that data harmonization work was carried out after the 2010 study mentioned in NIR section 3.2.2, that fuel use by navigation is based on sales statistics and split into domestic and international navigation, and that the NCVs for fuels have been harmonized so that the GHG inventory contains the same values as those reported to IEA.	Yes. Transparency
IPPU			
I.7	2.A.3 Glass production – CO_2	The Party reported in its NIR (section 4.2.3.1) information on emissions from glass production. However, the Party reported glass production AD as "NE" in CRF table 2(I).A-Hs1 and reported CO_2 emissions from glass production in the same CRF table (e.g. 15.55 kt CO_2 eq for 2020). During the review, the Party clarified that AD on produced amount of float and container glass were acquired from the annual environmental reports published by the two major producers. However, the AD were reported as "NE" for glass production since there are also small glass-producing facilities for which no AD were available. AD for glass wool production were not available either. The ERT recommends that the Party report the AD available in CRF table 2(I).A-Hs1 and explain in the documentation box and in the NIR why the AD are not complete.	Yes. Convention reporting adherence
I.8	2.B.5 Carbide production – CO_2	The Party reported in its 2021 NIR (section 4.3.5.5, p.237) information on recalculations for this category. Following the recalculations, all CO_2 emissions from carbide furnace gas combustion and flaring are reported under the IPPU sector in subcategory 2.B.5.b (carbide production – calcium carbide). The recalculated CO_2 emissions increased unevenly between 1990 and 2020. For 1990, emissions increased by more than six times the original estimate, while for 2020 the emissions increased by about five times the original estimate. Neither the 2021 NIR nor	Yes. Transparency

ID#	Finding classification	Description of finding with recommendation or encouragement	Is finding an issue/problem?[a]
		the 2022 NIR includes an explanation of the uneven increase in the recalculated CO_2 emissions for the time series. During the review, the Party clarified that the reason for the uneven increase in emissions is that the emissions reported in the 2020 submission (total CO_2 emissions from carbide gas combustion and flaring) were calculated in direct proportion to carbide production, while the corresponding emissions reported in the 2022 submission were not. In the 2020 submission, emissions reported under category 2.B.5 were estimated for carbide gas flaring only, using the ratio "flaring time/total production time", which had no direct connection to the carbide production volumes. Some of the emissions currently included in category 2.B.5, namely emissions from carbide gas combustion, were reported in the 2020 submission under subcategory 1.A.2.c (manufacturing industries and construction – chemicals). These emissions were calculated on the basis of the amounts of combusted carbide gas reported by the facilities in their quarterly fuel statistics. According to the Party this reporting was not directly linked to carbide production volumes either and, moreover, was probably incomplete for several years of the time series. This explains why replacing the emissions reported for carbide gas combustion under subcategory 1.A.2.c and carbide gas flaring under category 2.B.5 with total emissions reported under category 2.B.5 directly linked to carbide production volumes resulted in uneven changes in emissions. The ERT recommends that the Party explain in more detail the methodology used to estimate CO_2 emissions from carbide production (category 2.B.5) in its NIR.	
I.9	2.B.5 Carbide production – CO_2	The Party reported in its NIR (section 4.3.5, table 4.3.4, p.241) the AD for produced calcium carbide and the amount of calcium carbide for acetylene production (table 4.3.5, p.242) for the whole time series. The Party also reported in its NIR (table 4.3.3, p.240) information on the use of the IPCC default EF for carbide use for acetylene production. However, the Party reported the AD and CO_2 IEF for category 2.B.5 as "NA" in CRF table 2(I).A-Hs1, but estimated and reported CO_2 emissions (e.g. 39.00 kt CO_2 eq for 2020). The ERT noted that this is not in accordance with the paragraph 37(c) of the UNFCCC Annex I inventory reporting guidelines because "NA" should be reported for activities under a given source/sink category that do occur within the country but do not result in emissions or removals of a specific gas. During the review, the Party clarified that amounts of carbide produced and carbide used for acetylene production are attributable to different processes with different EFs; therefore, given that no specific guidance on this issue appears to be provided in the 2006 IPCC Guidelines, it previously decided that aggregating these amounts in one set of AD would not be appropriate. AD for subcategory 2.B.5.b (carbide production – calcium carbide) were therefore reported as "NA". However, in its 2023 submission, Sweden will report a sum of produced carbide and carbide used for acetylene production in CRF table 2(I).A-Hs1. The ERT recommends that the Party report AD as a sum of produced carbide and carbide used for acetylene production in CRF table 2(I).A-Hs1 and explain this way of reporting AD in the documentation box and in the NIR.	Yes. Transparency
I.10	2.C.1 Iron and steel production – CO_2	The Party reported in its NIR (section 4.4.1.1, p.252) information on sources of CO_2 emissions from iron ore pellet production. The main sources are limestone and dolomite and, to a smaller extent, bentonite, organic binder, olivine and quartzite. The Party also reported in its NIR (section 4.4.1.2, p.259) that emissions of CO_2 from the use of limestone and dolomite are collected from data reported under the EU ETS for 2005 onward. For the years before 2005, the Party used the EF for limestone and dolomite use from the 2006 IPCC Guidelines to calculate CO_2 emissions and a purity of 97 and 100 per cent, respectively, was used for carbonate. According to the information reported in CRF table 2(I).A-Hs2, the IEF for subcategory 2.C.1.e (iron and steel production – pellet) was	Yes. Transparency

ID#	*Finding classification*	*Description of finding with recommendation or encouragement*	*Is finding an issue/problem?*[a]
		approximately 0.004, that is, 7.5 times lower than the default EF of 0.03 (2006 IPCC Guidelines, vol. 3, chap. 4, table 4.1, p.4.25). The Party reported in its NIR (section 4.4.1.2, p.259) that under the EU ETS, information on the amounts of carbon bound in products is taken into account and the average of these figures was extended to include earlier years of the time series. During the review, the Party clarified that the reported CO_2 emissions are based on facility-specific data on the quantities of the raw materials used and their specific carbon content provided either through direct contact with the facilities or, for 2005 onward, using data reported under the EU ETS. The emissions are estimated on the basis of the mass-balance approach (i.e. for the carbon content of each carbon-based material, the carbon stored in products and associated CO_2 emissions are reported under the EU ETS). Additionally, the Party shared the estimation data supporting the mass-balance approach. According to the updated version of the *Best Available Techniques Reference Document for Iron and Steel Production* (Remus et al., 2013) (chap. 4, table 4.1, p.188), the source for the default EF provided in the 2006 IPCC Guidelines (vol. 3, chap. 4, table 4.1, p.4.25), the CO_2 emission range is between 0.017 and 0.193 kt/kt produced iron ore pellet depending on the composition of raw materials used including limestone, dolomite, bentonite, organic binder, olivine and quartzite. Since Sweden reported only non-energy-related emissions for iron ore pellet production under subcategory 2.C.1.e, the default EF is not relevant for comparison purposes. The ERT recommends that the Party provide information in the NIR on the mass-balance approach applied, including the list of raw materials taken into account for the estimation of CO_2 emissions from iron ore pellet production. The ERT also recommends that the Party transparently report a description of the pellet production process indicating the allocation of energy-related emissions. The ERT further recommends that Sweden collect information on the carbon content both in raw materials and in pellet production, reporting them as national totals if necessary to protect confidential information, in order to explain the low value of the IEF reported in CRF table 2(I).A-Hs2 for estimating CO_2 emissions from pellet production for 2020 under subcategory 2.C.1.e.	
I.11	2.C.1 Iron and steel production – CO_2	The Party reported in its NIR (section. 4.4.1.1, p.252) information on changes in the emission trend of CO_2 emissions. For instance, CO_2 emissions from pig iron production for 2019 increased because of the larger amounts of limestone used per unit of raw iron (CO_2 emissions increased from 1,546.56 in 2018 to 2,541.03 kt CO_2 in 2019, an increase of 64.3 per cent). Furthermore, the Party reported that in 2020, both production of pig iron and CO_2 emissions decreased to the 2018 level (CO_2 emissions in 2020 were reported as 1,707.66 kt CO_2), without explaining the reason for the decrease. During the review, the Party clarified that in 2020, CO_2 emissions per unit of production decreased, mostly owing to the replacement of carbon-rich residues with iron ore pellets that have a significantly lower carbon content. The ERT recommends that the Party provide in the NIR information explaining that the high CO_2 IEF for 2019 (0.80 t/t) was due to the extensive use of carbon-rich residues (i.e. with a high carbon content) instead of the iron ore pellets used in pig iron production in 2018 and 2020 (IEFs of 0.53 and 0.60 t/t respectively).	Yes. Transparency
I.12	2.D.1 Lubricant use – CO_2	The Party reported in its NIR (section 4.5.1, figure 4.5.1, p.278) information on the CO_2 emission trend for lubricant use (category 2.D.1). The trend in CO_2 emissions shows a decrease since 2013 (from 290.75 kt CO_2 in 2013 to 197.61 kt CO_2 in 2020, a decline of 32.0 per cent) but the NIR does not include an explanation of the changes in the trend. During the review, the Party clarified that the data are provided by the Swedish Energy Agency. The amount	Yes. Transparency

ID#	Finding classification	Description of finding with recommendation or encouragement	Is finding an issue/problem?[a]
		of lubricant consumed varies significantly between years. The ERT notes that the response provided during the review did not identify the underlying drivers for the 32.0 per cent decline in lubricant use. The ERT recommends that the Party provide in the NIR information on the causes of the declining trend in lubricant use in the country since 2013.	
I.13	2.G.2 SF_6 and PFCs from other product use – SF_6 and PFCs	The Party reported in its NIR (section 4.8.2, pp.315–316) information on SF_6 and PFC emissions from other product use for the subcategory other (2.G.2.c) only. Information on military applications (subcategory 2.G.2.a) and accelerators (subcategory 2.G.2.b) was not reported in the NIR and the associated emissions were not reported either (the Party left blank and greyed-out cells in CRF table 2(II).B-Hs2). The ERT noted that this is not in accordance with paragraph 37 of the UNFCCC Annex I inventory reporting guidelines because Parties included in Annex I to the Convention should clearly indicate the sources and sinks which are not considered in their inventories but which are included in the 2006 IPCC Guidelines, and explain the reasons for such exclusion. The ERT considers that it is likely that emissions from military applications and accelerators occur in the country. During the review, the Party clarified that no specific information is available on military applications using SF_6 or PFCs as heat transfer fluids in high-powered electronic applications. It is unclear whether radar systems with SF_6 and/or heat transfer fluids with PFCs for electronic equipment are present in Sweden with insignificant potential emissions. Sweden has no data on the total number and types of accelerators used in the country. However, data from the largest accelerator in Sweden, MAX IV, indicate that SF_6 emissions from that accelerator are potentially lower than 1 kg/year (i.e. 23,900 kg CO_2 eq, or 0.024 kt CO_2 eq), which is well below the significance threshold (23.14 kt CO_2 eq for Sweden in 2020) and, as a result, the emissions could be considered insignificant. The underestimation is below the significance threshold for application of an adjustment in accordance with decision 22/CMP.1, annex, paragraph 80(b), in conjunction with decision 4/CMP.11 and therefore not included in the list of potential problems and further questions raised. The ERT recommends that the Party investigate the occurrence of SF_6 or PFC emissions from military applications (subcategory 2.G.2.a) and report its findings in the NIR, and estimate and report SF_6 and PFC emissions if applicable, for the entire time series. The ERT also recommends that the Party estimate and report SF_6 emissions from accelerators (subcategory 2.G.2.b) or, if the Party considers these emissions insignificant, demonstrate that the likely level of emissions is below the significance threshold established in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	Yes. Accuracy
Agriculture			
A.10	3.A.1 Cattle – CH_4	The Party reported that "Gross Energy intake (GE) is calculated by multiplying DMI with the energy content of silage and concentrate, respectively" (NIR p.330). However, the Party reported the equation for calculating GE as follows: GE = DMI × ME_Feed. The ERT noted inconsistencies between the description of the method (which refers to the energy content of silage and concentrate) and the equation (which refers to ME_Feed, the metabolizable energy content in the feed). The ERT also noted that the Party did not provide information on gross energy in silage and concentrate. During the review, the Party clarified that this issue is due to an incorrect description in the NIR. GE is described as being the product of DMI and ME_Feed where ME_Feed is the metabolizable energy in the feed. However, the equation should use gross energy in the feed rather than the metabolizable energy. In the calculations, the gross energy in the feed has been used. Thus, the calculations are correct but have been inaccurately described in the NIR.	Yes. Convention reporting adherence

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		Since GE is used in the Ym equation, the Party's calculations for Ym are also correct. The description of the GE equation will be corrected in the next submission. The ERT recommends that the Party correct the equation for GE in its NIR and provide information on gross energy in silage and concentrate respectively.	
A.11	3.A.1 Cattle – CH_4	The Party reported the equation for calculating fatty acid content in feed in its NIR (p.330) as follows: $FA = Frac_{Conc} \times Conc\_F + (1 - Frac_{Conc}) \times Silage\_F$, where Conc_F = fat content in concentrate (43g/kg dm) and Silage_F = fat content in silage (12 g/kg dm). The ERT noted inconsistencies in the reported unit of fatty acid content and Conc_F and Silage_F (fat content). During the review, the Party clarified that the description of the equation for fatty acid content was reported incorrectly, and that Conc_F and Silage_F are fatty acid content in the respective feeds. The Party informed the ERT that this will be clarified in the NIR of the next annual submission. The ERT recommends that the Party correct in the NIR (section 5.2.2.1.1) the description of the unit of Conc_F and Silage_F in the equation for fatty acid content in feed.	Yes. Convention reporting adherence
A.12	3.A.1 Cattle – CH_4	Sweden reported in the NIR the population of heifers, bulls and steers (p.332), disaggregated CH_4 EFs for heifers, bulls and steers under different age categories (p.331) and the aggregated CH_4 EFs for heifers, bulls and steers (p.333). The Party did not report the disaggregated population or the age composition of heifers, bulls and steers under different age categories. The ERT was unable to check the aggregated EFs without the disaggregated population or the age composition of heifers, bulls and steers under different age categories. During the review, the Party clarified that the assumed age composition for bulls and steers is 85 per cent between one and two years and 15 per cent above two years; for heifers, the corresponding figures are 70 and 30 per cent respectively. Heifers, bulls and steers below one year are categorized as calves and their emissions are calculated using a different EF. The Party explained that this information will be included in the 2023 NIR. The ERT recommends that the Party report the population of heifers, bulls and steers by age used to derive the CH_4 EFs in order to improve the transparency of the calculations.	Yes. Transparency
A.13	3.D.a.2.c Other organic fertilizers applied to soils – N_2O	The Party reported the amount of N in other organic fertilizers applied to soils for 2020 in NIR tables 5.22 and 5.29 (6,974 t N). However, the value reported in CRF table 3.D for subcategory 3.D.a.2.c is different (9,882.1 t N). During the review, the Party clarified that the value reported in CRF table 3.D includes a fraction of digestate from co-digesters, while the value reported in NIR tables 5.22 and 5.29 excludes the digestate from co-digesters. The Party informed the ERT that it will include the co-digestate in the NIR tables in the next annual submission. The ERT recommends that the Party report the N in other organic fertilizers applied to soils consistently between the NIR and CRF tables.	Yes. Convention reporting adherence
A.14	3.D.b Indirect N_2O emissions from managed soils – N_2O	The ERT was unable to replicate the AD of "Volatilized N from agricultural inputs of N" and "N from fertilizers and other agricultural inputs that is lost through leaching and run-off" reported in CRF table 3.D for categories 3.D.b.1 and 3.D.b.2 using the equation and parameters reported in the NIR (p.353 and tables 5.27–5.31). During the review, the Party clarified that the digestate from co-digesters is included in the calculations for categories 3.D.b.1 and 3.D.b.2) but NIR section 5.4.2 has not been updated with this information. The Party confirmed that this will be corrected in the NIR of the next annual submission. The Party also indicated that the equation it used for estimating	Yes. Transparency

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		N_2O emissions from atmospheric deposition was $N_2O\text{-}N = [(F_{SN} \times Frac_{GASF}) + (F_{ON} \times Frac_{GASM}) + (F_{COD} \times Frac_{GASCOD}) + (F_{PRP} \times Frac_{GASG})] \times EF_4$., and not the equation reported in NIR section 5.4.2.2.1. The Party explained that this equation will be corrected in the 2023 NIR.	
		The ERT recommends that the Party (1) explain, in NIR sections 5.4.2.2.1 and 5.4.2.2.2, that the digestate from co-digesters is included in the calculation of indirect N_2O emissions for categories 3.D.b.1 and 3.D.b.2 and (2) correct the equation reported in the NIR for estimating N_2O emissions from atmospheric deposition to: $N_2O\text{-}N = [(F_{SN} \times Frac_{GASF}) + (F_{ON} \times Frac_{GASM}) + (F_{COD} \times Frac_{GASCOD}) + (F_{PRP} \times Frac_{GASG})] \times EF_4$.	
A.15	3.G Liming – CO_2	The ERT noted that the equation used for calculating CO_2 emissions from limestone and dolomite reported in the NIR (p.357) is not correct. An opening bracket and closing bracket should probably be included to group carbon from limestone and dolomite before multiplying them by the CO_2/C conversion factor. During the review, the Party clarified that the brackets are missing and that this will be corrected for the 2023 submission.	Yes. Convention reporting adherence
		The ERT recommends that the Party correct the equation for calculating CO_2 emissions from limestone and dolomite reported in the NIR by adding opening and closing brackets around the parameters for limestone and dolomite before multiplying them by the CO_2/C conversion factor.	
LULUCF			
L.19	4. General (LULUCF) – CO_2, CH_4 and N_2O	In its NIR (annex 3, p.120), Sweden explained the principle for upscaling its plot data and provided several equations. The ERT noted that providing equations reflects very transparent reporting. However, the description of variable Âi indicates that the area is estimated based on Horvitz-Thompson, but the Horvitz-Thompson method is not explained. In addition, given that $\hat{X}i$ is already upscaled for the area in the first formula (reported on p.121), the ERT does not understand why there is another scaling for the area in the second formula (reported on p.120).	Yes. Transparency
		During the review, the Party explained the general principles for the upscaling procedure, namely that each plot represents a given area, which may be more or less large depending on the sampling density in each stratum. The ERT understands these principles and considers them to be adequate. However, the ERT remains confused by the formulas used.	
		The ERT recommends that Sweden improve the transparency of estimators used for upscaling plot data on page 120 of annex 3 to the NIR.	
L.20	4. General (LULUCF) – CO_2	The Party reported in its NIR (annex 3, p.141) that several EFs for CSCs in mineral soils for land conversions were based on the average soil carbon stocks as measured in the NFI, whereas its reporting of CSCs in mineral soils for forest land remaining forest land and grassland remaining grassland is based on direct measurements of CSCs in the NFI plots. The ERT noted that this is likely to result in double counting as CSCs in the NFI plots in land conversion categories are counted in the EF for land remaining land categories. In addition, substantial CSCs after conversion take place over a much longer time period than the arbitrary default 20-year transition period for reporting under the UNFCCC. As a result, the combination of tier 1 or tier 2 methods for land conversion categories and tier 3 methods for land remaining land categories necessarily results in double counting.	Yes. Accuracy
		During the review, the Party explained that estimates of CSCs in mineral soils for forest land remaining forest land and grassland remaining grassland are only based on NFI plots in these categories, thereby excluding NFI plots in land converted to forest land and land converted to grassland. The Party further explained that the share of NFI plots	

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		in land remaining land categories that have recently undergone a conversion amounts to less than 1 per cent of the area of these categories and that their impact on the estimated CSCs is therefore negligible. The ERT is of the view that excluding plots that have not recently undergone land-use changes is not sufficient to avoid double counting where estimates for land-use changes are based on changes in average soil carbon stocks (tier 2). The negligible character of this double count is not obvious and should be demonstrated, in particular as such legacy effects can typically last more than 100 years and will necessarily be growing over time as more former "land converted to" plots enter the "land remaining land" categories. The ERT recommends that the Party explain in its NIR for forest land and grassland why double counting of emissions or removals from mineral soils between land conversion categories and land remaining land categories is negligible despite the combination of tier 1 or tier 2 methods for land conversion categories and tier 3 methods for land remaining land categories or revise the estimates in order to avoid double counting of emissions or removals between the "land converted to" categories in the early years of the reporting period and the "land remaining land" categories in the later years of the reporting period.	
L.21	Land representation – CO_2, CH_4 and N_2O	The assumptions used for land-use changes between 1970 and 1990 are not explicitly described in the NIR. Since Sweden has chosen the default transition period of 20 years between land categories, data or assumptions on land-use changes necessarily start in 1970 for estimating areas of land categories in 1990 (see 2006 IPCC Guidelines, vol. 4, chap. 4, p.4.33). During the review, the Party clarified that it has established permanent plots for 1983–1987 for all land-use types and that during the first NFI, the field team assessed what had been former land use over the previous 20 years. The ERT recommends that Sweden better describe the assumptions used for land-use changes between 1970 and 1990 in the NIR, for example by providing one representative land-transition matrix for that period.	Yes. Transparency
L.22	4.A Forest land – CO_2	The Party indicated in its NIR that trees with a 0–99 mm DBH are assumed to result in net removals of 3.986 Mt CO_2/year over the entire time series (NIR annex 3, p.123). The ERT noted that the number, biomass and basal area of small trees (0–99 mm DBH) are unlikely to be constant over time if the age structure changes. The total removals from small trees are therefore unlikely to be constant either. The ERT also questioned whether the removals from small trees are counted a second time when they reach 100 mm DBH. Indeed, the stock difference method suggests that the entire biomass of a tree appearing in a NFI plot in 2020 because it exceeds 100 mm DBH is counted as a removal between 2020 and 2015 (the previous inventory year for this plot) whereas all the carbon stored by that tree before reaching 100 mm DBH would already have been counted as part of the net removals of trees with a 0-99 mm DBH. The ERT recommends that Sweden better explain why they report small trees <100 mm in DBH as constant net removals in the NIR. The ERT notes that, according to the good practice guidance in the 2006 IPCC Guidelines (vol. 4, chap. 4, p.4.72), Parties can choose to report the removals associated with small trees (understory) as zero. The ERT also recommends that Sweden explain how it avoids double counting when small trees reach 100 mm DBH.	Yes. Accuracy
L.23	4.A Forest land – CO_2	The Party reported in its NIR (pp.124–127) that the litter pool is the sum of fine litter (measured), coarse litter (a fixed proportion of the measured part of deadwood) and annual litterfall (modelled). The NIR (pp.124–127) lists the articles providing verification for the modelled components of both deadwood and litter.	Yes. Accuracy

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		During the review, the Party provided these articles to the ERT. The ERT notes that the articles demonstrate the validity of the model used for below-ground deadwood (stump decomposition). However, the ERT considers that the articles provided for the litterfall model are not sufficient to demonstrate its validity. For example, for Norway spruce, of all models presented in Berg et al. (1999a), Sweden selected a model involving latitude, basal area and age, whereas the model involving latitude, precipitation and temperature – which would simulate no change over time – has the highest adjusted r-square values (i.e. the best fit, among the models considered, between the model and the experimental data). In all cases, the small sample size (34 plots) and the high r-square values for all models indicate high co-linearity and, hence, likely low external validity. Similarly, for Scots pine, the model selected by Berg et al. (1999b), applying a stepwise procedure, is not the model used by Sweden for its estimates. The Party commented that it could not use the models with the highest r-squares because it does not have temperature and rainfall measurements from the plots, and because stand age is not measured for all NFI plots. The ERT considers that interpolated values for temperature and rainfall can easily be obtained from open-access climate databases and, more importantly, that using the models with the highest r-square would still be problematic because of the low external validity. The ERT also notes that for Norway spruce, using the model with the highest r-square would simulate no change in litterfall over time even if temperature and rainfall measurements from the plots were available. The ERT recommends that Sweden provide in its NIR the time series for each deadwood and litter subcomponent separately so that the model estimates can be transparently distinguished from the measurements. The ERT also recommends that Sweden reconsider its litterfall models, either verifying them against independent measurements or reverting to a simpler tier 1 or tier 2 approach. The ERT notes that litterfall estimates are likely to result in minor CSCs and that a higher-tier approach is therefore probably not mandatory because the contribution in emissions and removals could be considered not substantial.	
L.24	4.A.1 Forest land remaining forest land – CO_2	Sweden reported deadwood and coarse litter in land conversions using a tier 2 method (NIR p.360), but the description provided in the NIR (annex 3, p.141) does not follow the tier 2 method provided in the 2006 IPCC Guidelines (vol. 4, chap. 2, p.2.26) because the IPCC tier 2 method is based on a simple model of inflow and outflow, whereas Sweden mixes actual litter and deadwood measurements for some subpools with simple models for non-measured subpools. More importantly, the ERT noted that Sweden assumes that the deadwood and coarse litter pools follow the same trend as the corresponding land remaining land category. The ERT considers that the assumption appears to be accurate but is not consistent with the values reported in the CRF tables where, for example, the IEF for deadwood differs between forest land remaining forest land (0.06 t C/ha) and cropland converted to forest land (0.05 t C/ha), and where the IEF for dead organic matter differs between cropland remaining cropland (0.0007 t C/ha) and forest land converted to cropland (–1.50 t C/ha). During the review, the Party clarified that the CSCs for deadwood and coarse litter were generally estimated for an entire category (e.g. forest land) and then distributed to the subcategories in proportion to their respective area. The Party mentioned, however, that there were some exceptions: the “stumps” component of deadwood was assumed to be entirely in forest land remaining forest land, thus explaining its higher IEF, while all litter was assumed to be lost following deforestation, thus explaining the discrepancies in cropland subcategories. The ERT recommends that Sweden categorize its method for estimating deadwood and coarse litter in land conversions as tier 3 and describe how the estimates at the category level are distributed to subcategories and the exceptions (for stumps and litter) to this general rule.	Yes. Transparency

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L.25	4.A.1 Forest land remaining forest land – CO_2	The Party reported in its NIR (p.373 and annex 3, pp.121–122) that CSCs in living biomass of forest land remaining forest land were extrapolated for the last four years of the time series (2017–2020) because the NFI cycle was not yet complete for all plots for those years. The ERT noted that if the projections were made at the subcategory level (in this instance, for forest land remaining forest land), the reported CSCs would be expected to be constant for 2017–2020. During the review, the Party clarified that this was not exactly the case because if a plot is harvested between two measurements, the year of harvest is randomly assigned, creating slight inter-annual variation. The ERT recommends that the Party improve the documentation of its interpolation and extrapolation procedure of CSCs in the NIR.	Yes. Transparency
L.26	4.A.1 Forest land remaining forest land – CO_2	The Party reported in its NIR (annex 3, pp.121–122) that CSCs in living biomass of forest land remaining forest land were extrapolated for the last four years of the time series (2017–2020) because the NFI cycle was not yet complete for all plots for those years. The ERT noted that over the last three annual submissions, the projected values for year y–3 in the submission of year y+2 systematically turned out to be between 4 and 9 per cent lower when recalculated as a "final" value in the submission of year y+3. For example, the "final" value for 2016 reported in the 2022 submission is 9 per cent lower than the "projected" value for 2016 reported in the 2021 submission, and 18 per cent lower than the "projected" value for 2016 reported in the 2019 submission. Similarly, the "final" value for 2014 reported in the 2020 submission is 4 per cent lower than the "projected" value for 2014 reported in the 2019 submission, and 8 per cent lower than the "projected" value for 2014 reported in the 2016 submission. During the review, the Party clarified that this was likely to be caused by the effect of the gradual incorporation of estimates covering 2018 which was a particularly dry year. It also noted that the comparison of submissions was only relevant back to the 2017 submission because the extrapolation method was implemented for the first time in the 2016 submission. However, the ERT notes that the "final" value for 2011 reported in the 2017 submission is also 9 per cent lower than the "projected" value for 2011 reported in the 2016 submission. As confirmed by the Party, the 2018 drought cannot influence estimates before 2014. The ERT therefore concludes that the magnitude of the deviation between extrapolated and final values does not seem to be primarily related to the 2018 drought. The ERT recommends that the Party examine the reason for the systematic overestimation of "projected" net removals (reported values for years y–4 to y) compared with "actual" net removals when the NFI is complete, and investigate whether the extrapolation of not yet remeasured plots can be improved, and report its findings in its NIR.	Yes. Accuracy
L.27	4.A.1 Forest land remaining forest land – CO_2	Annual fellings are generally the first-order driver of CSCs in forest land remaining forest land in the short to medium term (one to five years, approximately). The Party did not provide the time series for harvest in the NIR but the ERT downloaded it from FAOSTAT. Comparing FAOSTAT data with overall removals in forest land reported in NIR figure 2.38 (p.106), the ERT noted three major inconsistencies: (a) The minimum removals occurred in 1993, whereas the corresponding maximum removals reported in the harvest statistics occurred in 1995. The two other local maximum removals corresponding to the 2005 and 2007 storms are consistent in both time series;	Yes. Transparency

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		(b) Except for the temporary decrease in removals in 1993, there is no obvious trend in removals between 1990 and 2002, whereas the annual harvest steadily increased by 15 million m^3 (i.e. by around 25 per cent). Removals would be expected to fall steadily by a comparable percentage; (c) After the big 2005 and 2007 storms, the annual harvest resumed a steady increase between 2009 and 2020 from 65 to 76 million m^3/year. The time series of removals also increased until 2016 when it levelled off, creating a divergence between annual harvest and removals between 2017 and 2020. During the review, Sweden explained that: issue (a) could be due to a difference between FAOSTAT data and national data on harvest; issue (b) could be due to the 10-year averaging in the reported estimates or a correspondingly high increase in gross increment between 1998 and 2002; issue (c) could be due to the 2018 drought. The ERT considers that these apparent inconsistencies in the reported values for CSCs in living biomass with harvested volumes should be further investigated and interpreted. In particular, 10-year averaging should smooth extremes but not a medium-term trend. The procedure for estimating "projected" values (see ID# L.26 above) is also a possible explanation for the divergence between annual harvest and removals between 2017 and 2020 (issue (c)). The ERT recommends that Sweden report harvest statistics in its NIR, for example using the same figure as NIR figure 2.38 (displaying total emissions/removals for, inter alia, living biomass). The ERT also recommends that the Party validate reported numbers of changes in living biomass by, for example, using the default biomass gain-loss method from the 2006 IPCC Guidelines (vol. 4, chap. 4.2.1.1).	
L.28	4.A.1 Forest land remaining forest land – CO_2	The Party reported in its NIR (p.395) substantial recalculations for deadwood, litter and mineral soils in forest land and for mineral soils in grassland. These recalculations result in substantial changes for the entire time series (e.g. –0.97 Mt CO_2 and +0.85 Mt CO_2 for deadwood and litter, respectively, in forest land for 1990; and –0.47 for mineral soils in grassland for 2000), except for mineral soils in forest land where the recalculations result in substantial changes from 2012 onward. The Party explained in its NIR that the main reason for the recalculations was the incorporation of new data following the completion of another NFI cycle. The ERT noted that this explanation is appropriate for mineral soils in forest land but not for the other substantial recalculations over the entire time series. During the review, the Party clarified that there has been a change in the "underlying data" for 1989 and 1990 and that for grassland, the small size of the sample could result in substantial recalculations as some land-use changes are recategorized if they revert back to their initial category (e.g. forest land converted to grassland which is then converted back to forest land is recategorized as forest land remaining forest land for the entire sequence). The ERT recommends that the Party clarify in its NIR that the NFI cycle is five years for living biomass but 10 years for the other pools. The ERT also recommends that the Party clarify the reason for the recalculations for deadwood and litter in forest land performed between the 2020 and 2022 submissions in its next NIR and demonstrate that recategorized land-use changes are the reason for the recalculations in grassland, e.g. by reporting the share of "requalified" grassland plots between two annual submissions when substantial recalculations are performed for years of the time series that are more than 12 years before the respective submission year.	Yes. Transparency
L.29	4.A.2 Cropland converted to forest land – CO_2	The Party reported in its NIR (annex 3, p.144) a very useful table synthesizing the EFs for litter and soils by subcategory. The ERT noted that some of these EFs were very different from the default EFs in the 2006 IPCC Guidelines (vol. 4, tables 5.5 and 5.10) and values from the scientific literature (e.g. Poeplau et al., 2011, 2013). For	Yes. Accuracy

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		example, the reported EF for cropland converted to forest land for mineral soils is 0.26 t C/ha/year and the reported EF for cropland converted to grassland is 0.07 t C/ha/year, whereas both conversions are documented to result in substantial net removals in the three aforementioned references. During the review, the Party clarified that conversions from cropland to forest land could result in net emissions in the first 10 to 20 years and provided an article (Karhu et al., 2011) supporting this view based on six sites, four of which are clearly losing soil carbon. The ERT acknowledges that this evidence provides some ground for a substantial deviation from the default values in the 2006 IPCC Guidelines, although four sites is a small number which should be carefully weighted against the hundreds of sites used to establish the default values and their relevance to the Swedish conditions. The ERT also notes that these carbon losses could be a temporary feature (e.g. in the simulated boreal afforestation by Gaboury et al. (2009), soil carbon starts growing only after 20–30 years) before reverting to carbon gains. As explained by the Party, this could be consistent with the direct measurements used to estimate litter and soil carbon changes in forest land remaining forest land. However, the ERT notes that in that case, the method used to derive the EF should explicitly aim at the CSCs occurring during the first 20 years after conversion rather than the difference at equilibrium classically aimed at in tier 2 methods (see ID# L.20 above). The ERT recommends that the Party either reconsider the EFs used for litter and soils on cropland converted to forest land and cropland converted to grassland or transparently document a plausible reason for the deviation from the default values in the 2006 IPCC Guidelines.	
L.30	4.B.1 Cropland remaining cropland – CO_2	Sweden used a tier 3 model (ICBM) to estimate SOC changes in cropland remaining cropland (NIR annex 3, pp.135–137). The only verification information reported in the NIR is a statement that the reported values "are represented typical values of stock change rates for different management practices observed in mineral cropland soils" (NIR annex 3, p.137). The ERT asked the Party to provide at least one peer-reviewed paper presenting evidence that the ICBM model has been verified at the national level. During the review, the Party explained that there are several studies in which the ICBM model and its subcomponents were evaluated for cropping systems common in Sweden and representative of Swedish soil and climatic conditions but did not share them with the ERT. The ERT recommends that Sweden demonstrate in its NIR that the ICBM model has been verified against independent measurements of CSCs in cropland over a sufficient number of sites and is representative of the heterogeneity in soils, climatic conditions and cropping practices in Sweden. The ERT notes that one of several options that Sweden could consider to address this recommendation is including in the NIR several graphs (e.g. measured versus simulated CSCs) or figures containing numerical data in order to support this verification.	Yes. Transparency
L.31	4.B.2 Grassland converted to cropland – CO_2	The Party reported in its NIR (annex 3, p.141) that several EFs for CSCs in mineral soils for land conversions were based on the difference in average soil carbon stocks as measured in the NFI (e.g. grassland converted to cropland). Some EFs were also complemented by an ad hoc assumption (e.g. cropland converted to forest land becomes a subcategory with a much higher reference carbon stock). The ERT noted that this deviates from the 2006 IPCC Guidelines (vol. 4, chap. 2, p.2.38), which recommends comparing plots with similar characteristics, such as histories and management, as well as similar topographic position and geographical proximity. In many countries, national averages for each land category may exhibit a difference between soil carbon in grassland and forest land (for example), which is very likely due to the fact that forests tend to be located on poorer soils (historically, areas	Yes. Accuracy

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		with better soils were deforested for farming). Therefore, the ERT notes that a difference between two land uses resulting from a soil inventory may not always be representative of actual transitions to and from forest land (for example). The ERT recommends that the Party justify how differences in national averages for different land categories to estimate the soil CSCs in land conversions compares plots with similar characteristics as recommended by the 2006 IPCC Guidelines (vol. 4, chap. 2, p.2.38), or update CSCs for land conversions, in particular if any substantial differences compared with the default EFs (e.g. F_{LU} parameters; vol. 4, chap. 5, p.5.17) cannot be adequately justified (see ID# L.32 below).	
L.32	4.C.2 Cropland converted to grassland – CO_2	The Party reported in its NIR (annex 3, p.144) that the EF used to estimate CSCs in mineral soils in cropland converted to grassland was the same as the EF for cropland remaining cropland. The ERT noted that this is likely to be a typographical error and that Sweden meant to state that it used the EF for grassland remaining grassland. However, even if that is the case, it is likely to be inaccurate as cropland converted to grassland generally stores much more carbon than grassland remaining grassland. During the review, the Party pointed to a report by Karltun et al. (2015) to justify the EF to estimate CSCs in mineral soils in cropland converted to grassland but the ERT did not identify which part of the report justified the reported EF of –0.07 t C/ha/year or the use of the same EF as grassland remaining grassland (0.09 t C/ha/year). The ERT recommends that the Party reconsider the EF used for CSCs in mineral soils in cropland converted to grassland and revise the information in the NIR that the EF used to estimate CSCs in mineral soils in cropland converted to grassland is the same as the EF for cropland remaining cropland or transparently justify in its NIR why the EF for cropland remaining cropland is appropriate.	Yes. Accuracy
L.33	4.E.2 Land converted to settlements – CO_2	The Party reported in its NIR (annex 3, p.143) that "for SOC on cropland or grassland converted to settlement the remaining SOC after 20 years was assumed to be 30 per cent and 90 per cent respectively". During the review, the Party clarified that these percentage losses were not related to an intrinsic feature of the initial land use, but rather that it had been able to quantify the share of the converted area that had been severely disturbed (e.g. with roads and car parks representing severe disturbances, and gardens representing minor disturbances) on the basis of satellite images. The ERT recommends that the Party explain in its NIR that the percentage losses for SOC on cropland or grassland converted to settlements reported in the NIR (annex 3, p.143) were not related to an intrinsic feature of the initial land use, but rather that the Party had been able to quantify the share of the converted area that had severely been disturbed (e.g. with roads and car parks representing severe disturbances, and gardens representing minor disturbances) on the basis of satellite images. The ERT also recommends that the Party provide information on the share of the area that has been severely disturbed for each subcategory under land converted to settlements.	Yes. Transparency
L.34	4.F.2 Land converted to other land – CO_2	The Party did not report in its NIR the method used to derive the EFs for the subcategories under land converted to other land. During the review, the Party acknowledged this issue. The ERT recommends that the Party document in its NIR the method used to derive the EFs for the subcategories under land converted to other land. In particular, because under "Other land" as defined by Sweden, subcategories with heterogeneous carbon stocks (e.g. "high mountains with grass", "bare rock", "ice" and "quarries") are	Yes. Transparency

ID#	*Finding classification*	*Description of finding with recommendation or encouragement*	*Is finding an issue/problem?*[a]
		aggregated, the ERT also recommends that Sweden document the different types of conversions from "Other land" to other land-use categories and how the EFs accurately reflect those conversions.	
L.35	4.G.2 Paper and paperboard – CO_2	In its NIR (p.384), Sweden described the inflow to the paper pool which includes paper made from pulp and from recovered paper. The ERT noted that this is not in line with the 2006 IPCC Guidelines where, for the production approach, inflow only includes matter "transported from harvest sites" (see the definition of "H" in equation 12A.3 (vol. 4, chap. 12, p.12.28)). During the review, the Party confirmed that the ERT had correctly understood how the inflow to the paper pool was calculated. The ERT recommends that Sweden investigate the possibilities for adjusting the two-year IPCC default half-life for paper instead of including recycling in the inflow. The ERT notes that the effect on the net estimate is, however, likely to be minor.	Yes. Comparability
Waste			
W.11	5.B Biological treatment of solid waste – CH_4 and N_2O	The ERT noted that dm of municipal solid waste reported as AD in CRF table 5.B is estimated from wet-weight values, as reported in NIR table 7.21, applying an assumption of 65 per cent moisture content. The moisture content value used differs from the value (60 per cent) provided in table 4.1 of the 2006 IPCC Guidelines (vol. 5, chap. 4, p.4.6). In addition, the waste amounts reported in NIR table 7.21 are in t, whereas the column headings of the table indicate that these amounts are in kt. During the review, the Party confirmed that the column headings were incorrect. During the review, the Party explained that the 2023 NIR will include the information on the moisture content and the correct column heading. The ERT recommends that the Party include in the NIR information on the value of moisture content (65 per cent). The ERT also recommends that the Party correct NIR table 7.21 so that the values reported and amounts indicated in the column headings are in the same units (kt or t).	Yes. Transparency
W.12	5.D.1 Domestic wastewater – CH_4	The Party reported in its NIR (p.435) that AD for domestic wastewater treatment were estimated on the basis of population data for two categories: (A) population connected to wastewater treatment facilities >25 PE; and (B) population connected to wastewater treatment facilities <25 PE. Although no further details were found in the NIR, the ERT was able to replicate the BOD data reported in CRF table 5.D using the following parameters: a BOD value of 60 g/person/day, and a correction factor for additional industrial BOD discharged into sewers (I = 1.15) for category (A). The ERT noted that table 6.4 of the 2006 IPCC Guidelines (vol. 5, chap. 6, p.614) contains a higher per capita BOD estimate specifically for Sweden (75 g/person/day), and the default value for additional industrial load is 1.25 for collected wastewater. Furthermore, the ERT noted that when estimating N in the effluent, the Party applied the default value of 1.25 for industrial and commercial co-discharged protein, which seemed to contradict the value of 1.15 used for co-discharged industrial DC. During the review, the Party confirmed that the above-mentioned parameters (a BOD value of 60 g/person/day, and a correction factor for additional industrial BOD discharged into sewers (I = 1.15) for category (A)) were used in the calculations. Moreover, as an example, the Party provided the measured BOD_7 value of the influent in large wastewater treatment plants (>2,000 PE) for 2018, which was 224,553 t, similar to the calculated BOD value for all centralized wastewater treatment plants for the same year (224,906 t), which seemed to justify the parameters selected by the Party (noting also that the BOD_7 value might be greater than the BOD_5 value referred to as "BOD" in the 2006 IPCC Guidelines).	Yes. Transparency

ID#	*Finding classification*	*Description of finding with recommendation or encouragement*	*Is finding an issue/problem?*[a]
		The ERT recommends that the Party include the parameters used for estimating BOD in the NIR, especially the values for per capita BOD and additional industrial load, and provide justification in cases where those values differ from the default values in the 2006 IPCC Guidelines. The ERT also recommends that the Party justify the use of different EFs for industrial load for organic matter and N. The ERT encourages the Party to collect measured BOD values for the influent of large wastewater treatment plants to verify (or change, where necessary) the calculated BOD values reported in CRF table 5.D.	
W.13	5.D.1 Domestic wastewater – CH_4	The Party reported in its NIR (pp.434–435) that it used an EF of 0.175 kg CH_4/kg BOD for CH_4 generation. This EF is a product of the B_o for which the Party applied a value of 0.25 kg CH_4/kg BOD and a CH_4 correction factor value of 0.7 for anaerobic stabilization. The ERT noted that both parameters are country-specific. Using the country-specific EF for CH_4 generation with the AD for sludge removed reported in CRF table 5.D (140.40 kt BOD for 2020), the ERT calculated 24.57 kt CH_4 generated for 2020. However, the ERT identified a relatively large difference between the calculated estimate and the "observed" value of CH_4 generation (without considering losses), that is, the amount of CH_4 flared plus the amount of CH_4 for energy recovery (6.82 kt plus 45.20 kt, amounting to 52.02 kt CH_4 for 2020 as reported in CRF table 5.D). The ERT considers that this large difference between the calculated and observed values for CH_4 generation might indicate an underestimation of either the BOD in wastewater (and sludge) or the B_o value used by Sweden, or both. During the review, the Party clarified that BOD in wastewater and sludge is not underestimated (see ID# W.12 above). The Party also acknowledged that its interpretation of B_o might be the reason for the difference between the calculated and observed CH_4 generation reported in the inventory. The Party stated that it is currently analysing the methodologies described in the 2019 Refinement to the 2006 IPCC Guidelines and early conclusions suggest that there may be some errors both in the 2019 Refinement to the 2006 IPCC Guidelines and in the 2006 IPCC Guidelines. The ERT noted that there are alternative methodologies to calculate CH_4 emissions from anaerobic treatment of sludge. For example, a different methodology is provided for anaerobic digestion of organic waste in chap. 4.1 of the 2006 IPCC Guidelines (vol. 5), and emissions could also be estimated on the basis of produced biogas assuming a certain percentage loss. This latter approach is already followed by the Party for estimating industrial wastewater treatment. On the basis of the calculations of the ERT, all the above methodologies lead to different estimates than those reported by the Party (some higher and some lower results). The ERT also noted that, on the basis of data reported on CH_4 recovery in CRF table 5.D, over 10 per cent of recovered CH_4 is flared. The 2006 IPCC Guidelines state that "Where technical standards for biogas plants ensure that unintentional CH_4 emissions are flared, CH_4 emissions are likely to be close to zero" (vol. 5, chap. 4, p.4.4). Considering the above, it is not possible to determine with certainty whether the emissions reported by the Party are over- or underestimated. However, actual observations would appear to clearly refute the Party's statement in the NIR (p.434) that 0.25 kg CH_4/kg BOD is the absolute maximum theoretical value of the parameter B_o. The ERT recommends that the Party revise its country-specific B_o value using either a new country-specific value that corresponds to the observed CH_4 generation or the IPCC default value and recalculate its emission estimates accordingly. As the theoretical maximum B_o value is under discussion, the ERT encourages the Party to engage in discussions with the authors of the 2006 IPCC Guidelines and the 2019 Refinement to the 2006 IPCC Guidelines to reach a common understanding on the methodologies and parameters included in the guidelines.	Yes. Accuracy

ID#	*Finding classification*	*Description of finding with recommendation or encouragement*	*Is finding an issue/problem?*[a]
KP-LULUCF			
KL.4	FM – CO_2, CH_4 and N_2O	Information on the main factors used for calculating the accounting quantity for FM was not provided in the NIR. During the review, Sweden provided this information, noting that, after technical correction, the FMRL is –32.4 Mt CO_2 eq/year; therefore, the difference compared with the reported quantity is even larger than the calculation by the ERT (i.e. –11.8 Mt CO_2 eq/year of additional sinks, although the accounted quantity is heavily limited by the cap). For the simulation of living biomass, the Party assumed the highest sustainable harvest in accordance with 'business as usual' forestry practice at that point in time. Therefore, the reason for the difference is mainly because the harvest level has been lower than the level expected in the projections. Consequently, the largest difference is observed in the living biomass pool, where the reported average for 2013–2020 is –31.4 Mt CO_2 eq/year and the average for the FMRL for living biomass for 2013–2020 is –23.6 Mt CO_2 eq/year. The difference of 7.8 Mt CO_2 eq/year corresponds to a harvest level that is approximately 10 per cent lower than the level expected in the 'business as usual' projections. The Party also noted that there is a relatively large difference for the litter pool (a larger loss compared with the reference period) which is more difficult to assess as the FMRL calculation is based on the historical value in combination with the effect of extraction of harvest residues and stumps rather than a simulation. The Party further noted that the loss of carbon from the litter pool has decreased compared with the reference period, which could be due to several issues (e.g. a lower degree of extraction of harvest residues, higher mortality). 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.	Yes. KP reporting adherence

[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 Sweden.

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 Sweden 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 Sweden in its 2022 annual submission

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

Table I.1
Total greenhouse gas emissions and removals for Sweden, 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								–41 336.10
Base year[d]	34 976.78	71 567.85	NA	NA	NA		NA	
1990	34 850.48	71 441.55	NA	NA				
1995	36 887.13	73 363.50	NA	NA				
2000	26 597.73	68 337.64	NA	NA				
2010	21 670.73	64 713.64	NA	NA				
2011	17 354.07	60 371.63	NA	NA				
2012	14 044.81	57 508.57	NA	NA				
2013	14 522.34	55 842.98	NA	NA		1 785.18	NA	–47 739.54
2014	12 796.14	53 944.02	NA	NA		2 059.63	NA	–46 918.69
2015	15 639.77	54 106.00	NA	NA		3 308.52	NA	–45 493.91
2016	14 827.88	53 701.68	NA	NA		1 916.02	NA	–44 640.42
2017	18 334.96	53 100.52	NA	NA		1 681.63	NA	–41 097.11
2018	17 634.76	52 149.83	NA	NA		1 806.87	NA	–41 181.59
2019	14 074.24	50 810.59	NA	NA		1 909.41	NA	–42 101.25
2020	6 520.21	46 284.75	NA	NA		1 281.78	NA	–44 160.50

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 second 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. Sweden 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 Sweden, 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	57 580.09	7 414.81	5 769.66	6.49	568.78	NO	101.73	NO
1995	59 605.07	7 351.69	5 603.45	135.76	532.35	NO	135.19	NO
2000	54 890.66	6 836.36	5 346.26	769.64	375.93	NO	118.78	NO
2010	53 287.35	5 211.99	4 829.25	1 133.81	187.79	NO	63.46	NO
2011	49 405.18	5 055.33	4 534.66	1 105.94	215.08	NO	55.44	NO
2012	46 918.58	4 874.59	4 495.67	1 087.92	78.68	NO	53.13	NO
2013	45 351.34	4 783.49	4 538.13	1 076.73	51.22	NO	42.06	NO
2014	43 477.93	4 635.90	4 599.20	1 103.09	82.02	NO	45.88	NO
2015	43 741.73	4 518.76	4 635.54	1 121.70	35.13	NO	53.14	NO
2016	43 415.99	4 441.12	4 617.42	1 138.52	31.18	NO	57.46	NO
2017	42 704.24	4 407.10	4 806.37	1 100.43	36.58	NO	45.81	NO
2018	42 094.91	4 320.83	4 596.05	1 043.18	61.87	NO	32.98	NO
2019	40 982.49	4 179.64	4 573.86	991.08	49.39	NO	34.13	NO
2020	36 515.10	4 110.20	4 616.69	938.61	65.22	NO	38.93	NO
Percentage change 1990–2020	**–36.6**	**–44.6**	**–20.0**	**14 368.1**	**–88.5**	**NA**	**–61.7**	**NA**

Note: Emissions and removals reported for the sector other (sector 6) are not included in this table.

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

Table I.3

Greenhouse gas emissions and removals by sector for Sweden, 1990–2020

(kt CO_2 eq)

	Energy	*IPPU*	*Agriculture*	*LULUCF*	*Waste*	*Other*
1990	52 367.56	7 667.77	7 664.29	–36 591.07	3 741.94	–
1995	54 262.67	7 949.40	7 589.82	–36 476.38	3 561.61	–
2000	49 285.74	8 395.78	7 433.97	–41 739.91	3 222.15	–

	Energy	*IPPU*	*Agriculture*	*LULUCF*	*Waste*	*Other*
2010	47 480.57	8 417.59	6 844.91	–43 042.91	1 970.58	–
2011	43 740.36	7 916.97	6 838.35	–43 017.56	1 875.96	–
2012	41 435.26	7 562.45	6 764.65	–43 463.76	1 746.21	–
2013	39 858.22	7 506.55	6 840.93	–41 320.64	1 637.28	–
2014	38 145.96	7 392.44	6 898.71	–41 147.88	1 506.91	–
2015	38 436.60	7 347.93	6 923.32	–38 466.23	1 398.15	–
2016	37 598.67	7 889.41	6 890.27	–38 873.80	1 323.33	–
2017	37 139.32	7 639.07	7 053.90	–34 765.56	1 268.24	–
2018	36 750.84	7 327.72	6 878.85	–34 515.06	1 192.42	–
2019	34 995.89	7 909.90	6 823.64	–36 736.35	1 081.17	–
2020	31 763.34	6 573.86	6 930.49	–39 764.54	1 017.06	–
Percentage change 1990–2020	**–39.3**	**–14.3**	**–9.6**	**8.7**	**–72.8**	**NA**

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

(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				–41 336.10				
Technical correction				8 942.64				
Base year	NA				NA	NA	NA	NA
2013		–1 155.97	2 941.15	–47 739.54	NA	NA	NA	NA
2014		–1 099.99	3 159.62	–46 918.69	NA	NA	NA	NA
2015		–977.98	4 286.49	–45 493.91	NA	NA	NA	NA
2016		–1 037.52	2 953.54	–44 640.42	NA	NA	NA	NA
2017		–1 029.49	2 711.12	–41 097.11	NA	NA	NA	NA
2018		–1 044.02	2 850.89	–41 181.59	NA	NA	NA	NA
2019		–1 086.97	2 996.38	–42 101.25	NA	NA	NA	NA
2020		–1 111.44	2 393.22	–44 160.50	NA	NA	NA	NA
Percentage change base year–2020					**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.

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 Sweden
(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 quantity*[a]
A.1. AR		–1 155.971	–1 099.991	–977.975	–1 037.519	–1 029.495	–1 044.024	–1 086.966	–1 111.439	–8 543.380		–8 543.380
Excluded emissions from natural disturbances[d]		–	–	–	–	–	–	–	–	–		–
Excluded subsequent removals from land subject to natural disturbances		–	–	–	–	–	–	–	–	–		–
A.2. Deforestation		2 941.149	3 159.623	4 286.492	2 953.537	2 711.125	2 850.893	2 996.376	2 393.222	24 292.417		24 292.418
B.1. FM										–353 333.017		–94 185.350
Net emissions/ removals		–47 739.544	–46 918.694	–45 493.913	–44 640.423	–41 097.107	–41 181.589	–42 101.249	–44 160.498	–353 333.017		
Excluded emissions from natural disturbances[d]		–	–	–	–	–	–	–	–	–		–
Excluded subsequent removals from land subject to natural disturbances		–	–	–	–	–	–	–	–	–		–

GHG source/sink activity	Net emissions/removals										Accounting parameters	Accounting quantity[a]
	Base year[b]	2013	2014	2015	2016	2017	2018	2019	2020	Total[c]		
Any debits from newly established forest		–	–	–	–	–	–	–	–	–		–
FMRL[e]											–41 336.099	
Technical corrections to FMRL											8 942.641	
FM cap											20 175.994	–20 175.994
B.2. CM (if elected)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA
B.3. GM (if elected)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		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 Sweden's reporting under Article 3, paragraphs 3–4, of the Kyoto Protocol.

Table I.6
Key data for Sweden 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	Yes, for AR and FM[a]
3.5% of total base-year GHG emissions, excluding LULUCF	2 521 999 t CO_2 eq (20 175 994 t 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 8 543 380 RMUs
2. Deforestation	Cancel 24 292 418 units
3. FM	Issue 20 175 994 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 annual 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 Sweden. 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 Sweden
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
CPR	283 999 121	–	–	283 999 121
Annex A emissions				
CO_2	36 515 101	–	–	36 515 101
CH_4	4 110 198	–	–	4 110 198
N_2O	4 616 688	–	–	4 616 688
HFCs	938 611	–	–	938 611
PFCs	65 223	–	–	65 223
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	38 931	–	–	38 931
NF_3	NO	–	–	NO
Total Annex A sources[a]	**46 284 753**	–	–	**46 284 753**
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–1 111 439	–	–	–1 111 439
Deforestation	2 393 222	–	–	2 393 222
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–44 160 498	–	–	–44 160 498

[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 Sweden
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	40 982 492	–	–	40 982 492
CH_4	4 179 640	–	–	4 179 640
N_2O	4 573 856	–	–	4 573 856
HFCs	991 084	–	–	991 084
PFCs	49 390	–	–	49 390
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	34 131	–	–	34 131
NF_3	NO	–	–	NO
Total Annex A sources[a]	**50 810 593**	–	–	**50 810 593**
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–1 086 966	–	–	–1 086 966
Deforestation	2 996 376	–	–	2 996 376
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				

	Original submission	*Revised submission*	*Adjustment*	*Final value*
FM	–42 101 249	–	–	–42 101 249

[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 Sweden
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	42 094 909	–	–	42 094 909
CH_4	4 320 833	–	–	4 320 833
N_2O	4 596 055	–	–	4 596 055
HFCs	1 043 179	–	–	1 043 179
PFCs	61 870	–	–	61 870
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	32 983	–	–	32 983
NF_3	NO	–	–	NO
Total Annex A sources[a]	**52 149 828**	–	–	**52 149 828**
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–1 044 024	–	–	–1 044 024
Deforestation	2 850 893	–	–	2 850 893
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–41 181 589	–	–	–41 181 589

[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 Sweden
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	42 704 238	–	–	42 704 238
CH_4	4 407 098	–	–	4 407 098
N_2O	4 806 370	–	–	4 806 370
HFCs	1 100 430	–	–	1 100 430
PFCs	36 578	–	–	36 578
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	45 811	–	–	45 811
NF_3	NO	–	–	NO
Total Annex A sources[a]	**53 100 525**	–	–	**53 100 525**
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–1 029 495	–	–	–1 029 495
Deforestation	2 711 125	–	–	2 711 125
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–41 097 107	–	–	–41 097 107

[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 Sweden
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				

	Original submission	*Revised submission*	*Adjustment*	*Final value*
CO_2	43 415 985	–	–	43 415 985
CH_4	4 441 115	–	–	4 441 115
N_2O	4 617 418	–	–	4 617 418
HFCs	1 138 521	–	–	1 138 521
PFCs	31 177	–	–	31 177
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	57 463	–	–	57 463
NF_3	NO	–	–	NO
Total Annex A sources[a]	**53 701 681**	–	–	**53 701 681**
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–1 037 519	–	–	–1 037 519
Deforestation	2 953 537	–	–	2 953 537
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–44 640 423	–	–	–44 640 423

[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 Sweden
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	43 741 733	–	–	43 741 733
CH_4	4 518 763	–	–	4 518 763
N_2O	4 635 537	–	–	4 635 537
HFCs	1 121 696	–	–	1 121 696
PFCs	35 131	–	–	35 131
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	53 136	–	–	53 136
NF_3	NO	–	–	NO
Total Annex A sources[a]	**54 105 997**	–	–	**54 105 997**
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–977 975	–	–	–977 975
Deforestation	4 286 492	–	–	4 286 492
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–45 493 913	–	–	–45 493 913

[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 Sweden
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	43 477 929	–	–	43 477 929
CH_4	4 635 903	–	–	4 635 903
N_2O	4 599 199	–	–	4 599 199
HFCs	1 103 090	–	–	1 103 090
PFCs	82 024	–	–	82 024
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	45 879	–	–	45 879
NF_3	NO	–	–	NO

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Total Annex A sources[a]	**53 944 024**	**–**	**–**	**53 944 024**
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–1 099 991	–	–	–1 099 991
Deforestation	3 159 623	–	–	3 159 623
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–46 918 694	–	–	–46 918 694

[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 Sweden
(t CO_2 eq)

	Original submission	*Revised submission*	*Adjustment*	*Final value*
Annex A emissions				
CO_2	45 351 341	–	–	45 351 341
CH_4	4 783 492	–	–	4 783 492
N_2O	4 538 135	–	–	4 538 135
HFCs	1 076 727	–	–	1 076 727
PFCs	51 224	–	–	51 224
Unspecified mix of HFCs and PFCs	NO	–	–	NO
SF_6	42 058	–	–	42 058
NF_3	NO	–	–	NO
Total Annex A sources[a]	**55 842 977**	**–**	**–**	**55 842 977**
Activities under Article 3, paragraph 3, of the Kyoto Protocol				
AR	–1 155 971	–	–	–1 155 971
Deforestation	2 941 149	–	–	2 941 149
FM and elected activities under Article 3, paragraph 4, of the Kyoto Protocol				
FM	–47 739 544	–	–	–47 739 544

[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

No mandatory categories from the 2006 IPCC Guidelines were identified as missing.

Annex IV

Reference documents

A. Reports of the Intergovernmental Panel on Climate Change

IPCC. 2003. *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. J Penman, M Gytarsky, T Hiraishi, et al. (eds.). Hayama, Japan: Institute for Global Environmental Strategies. Available at https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html.

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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 2014, 2015, 2016, 2017, 2019 and 2020 annual submissions of Sweden, contained in documents, FCCC/ARR/2014/SWE, FCCC/ARR/2015/SWE, FCCC/ARR/2016/SWE, FCCC/ARR/2017/SWE, FCCC/ARR/2019/SWE and FCCC/ARR/2020/SWE 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 Sweden for 2022. Available at https://unfccc.int/sites/default/files/resource/asr2022_SWE.pdf.

C. Other documents used during the review

Responses to questions during the review were received from Joel Bengtsson and Emma Carlén (Swedish Environmental Protection Agency), 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:

Berg B, Johansson M-B, Tjarve I, Gaitnieks T, Rokjanis B, Beier C, Rothe A, Bolger T, Göttlein A, Gerstberger P (1999a). Needle litterfall in a North European spruce forest transect. Reports in Forest Ecology and Forest Soils – Swedish University of Agricultural Sciences No 80 38pp. Reports in Forest Ecology and Forest Soils – Swedish University of Agricultural Sciences.

Berg B, Albrektson A, Berg M, Cortina J, Johansson M-B, Gallardo A, Madeira M, Pausas J, Vallejo R, McClaugherty C (1999b). Amounts of litter fall in some pine forests in a European transect, in particular Scots pine. Annals of forest science, vol.56, number 8, pp.625-639. Available at https://doi.org/10.1051/forest:19990801.

Bertilsson J (2016). Updating Swedish emission factors for cattle to be used for calculations of greenhouse gases. Report 292. Department of Animal Nutrition and Management. Swedish University of Agricultural Sciences.

Gaboury S, Boucher JF, Villeneuve C, Lord D and Gagnon R (2009). Estimating the net carbon balance of boreal open woodland afforestation: A case-study in Quebec's closed-crown boreal forest. Forest Ecology and Management vol.257, issue 2, pp.483-494. Available at https://doi.org/10.1016/j.foreco.2008.09.037.

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Peacock M, Audet J, Bastviken D, Futter MN, Gauci V, Grinham A, Harrison JA, Kent MS, Kosten S, Lovelock CE, Veraart AJ and Evans CD (2021). Global importance of methane emissions from drainage ditches and canals. Environmental Research Letters, Volume 16, Number 4. Available at https://doi.org/10.1088/1748-9326/abeb36.

Poeplau C, Don A, Vesterdal L, Leifeld J, van Wesemael B, Schumacher J, Gensior A (2011). Temporal dynamics of soil organic carbon after land-use change in the temperate zone – carbon response functions as a model approach. Global Change Biology 17, 2415–2427.

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Remus R, Aguado-Monsonet MA, Roudier S and Delgado-Sancho L (2013). *Best Available Techniques Reference Document for Iron and Steel Production*. Joint research centre reference report EUR 25521 EN. Available at https://eippcb.jrc.ec.europa.eu/reference/iron-and-steel-production.

Tong CHM (2022). The greenhouse gas balance of drained forest landscapes in boreal Sweden. Acta Universitatis Agriculturae Sueciae 2022:43. Doctoral thesis. Faculty of Forest Sciences Swedish University of Agricultural Science. Available at https://pub.epsilon.slu.se/28440/1/tong-chm-220801.pdf.

Wallin M, Bishop K, Fölster J, Löfgren S, Lundblad M (2021). (*In Swedish*) Koncentration och export av TOC från dikad organogen mark. En rumsligt upplöst modell för nationell skattning [Concentration and export of TOC from drained organic soil. A spatially resolved model for national estimation]. Swedish environmental protection agency (SMED) report 17 2021. Available at http://urn.kb.se/resolve?urn=urn%3Anbn%3Ase%3Anaturvardsverket%3Adiva-9002.