United Nations FCCC/ETF/TERR.1/2024/BRA/Add.1

Framework Convention on Climate Change

Distr.: General
12 January 2026

English only

Report on the technical expert review of the first biennial transparency report of Brazil*

Addendum

Summary

This addendum to the report on the technical expert review of the first biennial transparency report of Brazil, conducted by a technical expert review team in accordance with the modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement, contains the results of the review of the consistency of the information submitted by the Party with those modalities, procedures and guidelines, and presents capacity-building needs identified by the Party and by the technical expert review team in consultation with the Party during the review. The review took place from 5 to 9 May 2025 in Bonn.

* In the symbol for this document, 2024 refers to the year in which the biennial transparency report was submitted, not to the year of publication.

Abbreviations and acronyms

2006 IPCC Guidelines	*2006 IPCC Guidelines for National Greenhouse Gas Inventories*
AD	activity data
BOD	biochemical oxygen demand
BTR	biennial transparency report
CaO	calcium oxide
CDM	clean development mechanism
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
CRT	common reporting table
CSI	Cement Sustainability Initiative
CTF	common tabular format
DOC	degradable organic carbon
DOM	dead organic matter
EF	emission factor
ETF	enhanced transparency framework (under the Paris Agreement)
FAOSTAT	statistical database of the Food and Agriculture Organization of the United Nations
$Frac_{GASF}$	fraction of synthetic fertilizer nitrogen that volatizes as ammonia and nitrogen oxides
$Frac_{LEACH–(H)}$	fraction of nitrogen input to managed soils that is lost through leaching and run-off
GHG	greenhouse gas
HFC	hydrofluorocarbon
HWP	harvested wood products
IE	included elsewhere
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
LULUCF	land use, land-use change and forestry
MCF	methane correction factor
MgO	magnesium oxide
MMS	manure management system(s)
MPGs	modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement
MSW	municipal solid waste
N	nitrogen
N_2O	nitrous oxide
NA	not applicable
NC	national communication
NDC	nationally determined contribution
NE	not estimated
NID	national inventory document
NIR	national inventory report
NMVOC	non-methane volatile organic compound
NO	not occurring
PaMs	policies and measures
PRODES	Program for the Calculation of Deforestation in the Legal Amazon

QA/QC	quality assurance/quality control
SOC	soil organic carbon
SOM	soil organic matter
SWDS	solid waste disposal site(s)
TERT	technical expert review team

I. Areas of improvement[1] identified during the technical expert review of the Party's first biennial transparency report

1. Tables 1–14 present the results of the review of the consistency with the MPGs[2] of the information submitted by Brazil in its BTR1. All recommendations and encouragements contained in the tables are for the next BTR or NIR, unless otherwise specified.

A. General reporting provisions

Table 1
Areas of improvement relating to general reporting provisions

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
NA	NA	No areas of improvement identified

B. Greenhouse gas emissions and removals

Table 2
Areas of improvement relating to general findings on greenhouse gas emissions and removals

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
2.G.1	Specified in paragraph 19 of the MPGs Institutional arrangements	The Party reported in the NID that the Ministry of Foreign Affairs is the national focal point for the GHG inventory. However, the Ministry is not included in figure 2.1, which presents the national institutional arrangements for preparing the GHG inventory submitted as part of the NC4 and was not updated for the BTR1. During the review, Brazil explained that, even though the Ministry of Foreign Affairs plays a crucial role as the national focal point for the GHG inventory, it was not specifically mentioned in figure 2.1, which presents the institutional structure established for preparing the inventory, but should be included under "Federal Government Focal Points". The TERT recommends that the Party update the title and explanation for figure 2.1 showing the national institutional arrangements for preparing the GHG inventory.
2.G.2	Specified in paragraphs 25 and 41 of the MPGs Key category analysis	The Party reported results of the key category analysis performed using approach 1 for both level and trend including and excluding LULUCF for the latest reporting year (2022). However, results of the key category analysis were not reported for the starting year (1990) of the inventory time series for the level assessment. During the review, the Party acknowledged the need to improve the key category analysis by prioritizing performing the level key category analysis for the starting year (1990). The TERT recommends that the Party perform and report the results of the level key category analysis for the starting year of the inventory time series.
2.G.3	Specified in paragraphs 29 and 44 of the MPGs Uncertainty analysis	The Party reported level and trend uncertainty for the emission and removal estimates for all source and sink categories, including inventory totals, for the latest reporting year (2022). However, the Party did not report the uncertainty of the emission and removal estimates for all source and sink categories, including inventory totals, for the starting year (1990) of the inventory time series. Further, the Party did not provide in the NID a qualitative description of the uncertainty assessment, including input parameters, assumptions and methodological approach used. During the review, the Party explained that it could not perform an uncertainty assessment for the starting year owing to lack of systematization of relevant data for the key categories of the inventory due to fragmentation of information on

[1] As referred to in paras. 7, 8, 146(d) and 162(d) of the MPGs, contained in the annex to decision 18/CMA.1.

[2] Decision 18/CMA.1, annex.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		source and sink categories, and that the assessment will be included in the improvement plan for future BTRs. The Party provided a detailed description of the uncertainty assessment for the latest reporting year, including input parameters, assumptions and methodological approach used. The TERT recommends that the Party quantitatively estimate and report in the NID the uncertainty of the emission and removal estimates for all source and sink categories, including inventory totals, for the starting year of the inventory time series and qualitatively discuss the uncertainty assessment performed, including methods used and underlying assumptions.
2.G.4	Specified in paragraph 52 of the MPGs Completeness	The Party did not report indirect CO_2 emissions from the atmospheric oxidation of CH_4, CO or NMVOCs or indirect N_2O emissions from sources other than those in the agriculture and LULUCF sectors as a memo item. During the review, the Party explained that it did not estimate such emissions for the industrial processes and product use, LULUCF and waste sectors owing to lack of methodologies and lack of applicable data for quantifying the formation of secondary gases in the atmosphere for the energy sector. The TERT encourages the Party to either estimate and report indirect CO_2 emissions from the atmospheric oxidation of CH_4, CO and NMVOCs or explain why those emissions were not reported. The TERT also encourages the Party to either report indirect N_2O emissions from sources other than those in the agriculture and LULUCF sectors as a memo item or explain why those emissions were not reported.

Table 3
Areas of improvement of the reporting on greenhouse gas emissions and removals – energy sector

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
3.E.1	Specified in paragraph 36 of the MPGs Fuel combustion – reference approach – all fuels – CO_2	The Party reported that the difference in total emissions from fuel combustion estimated using the reference and sectoral approaches is 1.30 per cent for 2022. However, the TERT noted much larger differences in the estimates of emissions calculated using the two approaches for individual fuels (e.g. liquid fuels (40.8 per cent), solid fuels (78.3 per cent), gaseous fuels (87.4 per cent) and other fuels (20.2 per cent)), which were not explained in the NID. During the review, the Party explained that the large differences in estimated emissions calculated using the reference and sectoral approaches for individual fuels are due to national capacity constraints, as it cannot accurately allocate fuel combustion to relevant fuel types for the reference approach, but all emissions reported by category in the sectoral approach were accurately estimated. The TERT encourages the Party to report transparent and accurate information on the emissions estimated using the reference approach when comparing the reference and sectoral approaches (e.g. by reallocating fuel combustion to relevant fuel types for the reference approach in the CRTs) in the NID and in the CRTs.
3.E.2	Specified in paragraph 39 of the MPGs 1.A.2 Manufacturing industries and construction – biomass – CO_2	The Party reported that biomass fuels were used in some manufacturing processes. However, the TERT noted that there are large differences in the CO_2 IEFs reported for different processes, such as under subcategories 1.A.2.a iron and steel (219.00 t CO_2/TJ), 1.A.2.b non-ferrous metals (68.23 t CO_2/TJ) and 1.A.2.c chemicals (109.93 t CO_2/TJ). During the review, the Party explained that the large differences between the IEFs used for subcategories 1.A.2.a, 1.A.2.b and 1.A.2.c relate to the variety of biomass fuels used in each manufacturing process, namely firewood, charcoal, sugar cane bagasse, biomass and biodiesel, for which IEFs of 95.30, 106.50, 100.00, 100.00 and 70.80 t CO_2/TJ were reported respectively. The TERT noted that the differences in the CO_2 IEFs reported for different manufacturing processes cannot be explained solely on the basis of the differences in the IEFs of the various biomass fuels used in each manufacturing process because these differences lie outside the range of the IEFs of the biomass fuels. The TERT recommends that the Party explain in the NID the large differences in the CO_2 IEFs reported for different manufacturing processes (e.g. for categories

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		1.A.2.a iron and steel, 1.A.2.b non-ferrous metals and 1.A.2.c chemicals), including the types of biomass fuel used in each manufacturing process.
3.E.3	Specified in paragraph 39 of the MPGs 1.A.2.f Non-metallic minerals – other fossil fuels – CO_2	The TERT noted that the IEF reported for CO_2 emissions for subcategory 1.A.2.f non-metallic minerals (143.00 t CO_2/TJ) is much higher than the default EF for stationary combustion of municipal waste (non-biomass fraction) (91.70 t CO_2/TJ) provided in the 2006 IPCC Guidelines (vol. 2, chap. 2.3.2.1, table 2.3). The Party reported in the CRTs that other fossil fuels were reported under subcategory 1.A.2.f only. During the review, the Party explained that it used the default EF (143.00 t CO_2/TJ) for stationary combustion of industrial waste from the 2006 IPCC Guidelines (vol. 2, chap. 2.3.2.1, table 2.3). However, the TERT noted that the NID does not provide the value or source of the EF used nor an explanation for using it. The TERT recommends that the Party include in the NID an explanation for using the default EF for industrial waste for estimating emissions for subcategory 1.A.2.f.
3.E.4	Specified in paragraph 35 of the MPGs 1.A.3 Transport – liquid fuels – CH_4 and N_2O	The Party reported in the NID that the bottom-up and top-down approaches used for estimating CH_4 and N_2O emissions from road transportation and domestic aviation under category 1.A.3 transport are based on methods in the 2006 IPCC Guidelines (vol. 2, chap. 3). However, the Party did not include the result of the comparison of the bottom-up and top-down approaches in the NID as a category-specific QC procedure in accordance with the 2006 IPCC Guidelines (vol. 2, chaps. 3.2.3 and 3.6.2). During the review, the Party provided the file showing the calculations performed using the bottom-up and top-down approaches for estimating CH_4 and N_2O emissions from road transportation and domestic aviation. The TERT encourages the Party to include in the NID the result of the comparison of the bottom-up and top-down approaches used for estimating CH_4 and N_2O emissions from road transportation and domestic aviation.
3.E.5	Specified in paragraph 40 of the MPGs 1.A.3.a Domestic aviation – liquid fuels – CH_4 and N_2O	The Party reported that the National Civil Aviation Agency used a bottom-up approach for estimating emissions for subcategory 1.A.3.a domestic aviation. However, the Party did not include in the NID detailed information on the AD used, covering landing and take-off, cruise, auxiliary power unit, destination and aircraft type. During the review, the Party provided a Microsoft Excel file containing detailed calculations for the bottom-up approach used. The TERT recommends that the Party include in the NID more detailed information on the AD used for estimating emissions for subcategory 1.A.3.a, covering landing and take-off, cruise, auxiliary power unit, destination and aircraft type.
3.E.6	Specified in paragraph 39 of the MPGs 1.A.3.b Road transportation – liquid fuels – CO_2	Brazil reported a CO_2 IEF for diesel oil for subcategory 1.A.3.b.ii light-duty trucks (304.76 t CO_2/TJ) that is much higher than the default EF (74.10 t CO_2/TJ) provided in the 2006 IPCC Guidelines (vol. 2, chap. 3.2.1.2, table 3.2.1). During the review, the Party explained that the high IEF is due to the different types of AD entered in CRT 1.A(a)s3 given that the calculation spreadsheets used to prepare the BTR1 followed a different structure than the CRTs. As such, an intermediary interface was developed to convert physical units from the calculation spreadsheets into energy units for the CRTs and to align the structure of the inventory data with the CRTs. The TERT recommends that the Party investigate and explain in the NID the significant difference between the IEF for diesel oil reported for subcategory 1.A.3.b.ii and the default EF from the 2006 IPCC Guidelines.
3.E.7	Specified in paragraph 40 of the MPGs 1.A.3.b Road transportation – liquid fuels – CH_4 and N_2O	The Party reported in the NID that the CH_4 and N_2O EFs by technology or energy source for liquid fuels for subcategory 1.A.3.b road transportation were obtained from a series of vehicle emission reports for the state of São Paulo. However, the Party did not report the EFs by technology or energy source in the NID.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		During the review, the Party provided the TERT with detailed information on the EFs used for subcategory 1.A.3.b road transportation. The TERT recommends that the Party report the CH_4 and N_2O EFs for liquid fuels used for subcategory 1.A.3.b road transportation by technology or energy source in the NID.
3.E.8	Specified in paragraph 39 of the MPGs 1.A.3.b Road transportation – liquid fuels – CH_4 and N_2O	The Party reported that a sectoral, bottom-up approach was used for calculating CH_4 and N_2O emissions from the mobile emissions sources present in the national vehicle fleet. However, the Party did not include detailed information on the national vehicle fleet, such as vehicle kilometres travelled. During the review, the Party provided a calculation file with detailed information on the national vehicle fleet, including vehicle kilometres travelled. The TERT recommends that the Party include in the NID detailed information on the national vehicle fleet (e.g. vehicle kilometres travelled).
3.E.9	Specified in paragraph 39 of the MPGs 1.A.4 Other sectors – biomass – CH_4	The Party reported a CH_4 IEF for biomass fuels for category 1.A.4 other sectors (650.70 kg CH_4/TJ) that is much higher than the range of default EFs for biomass fuels (5.00–300.00 kg CH_4/TJ) provided in the 2006 IPCC Guidelines (vol. 2, chap. 2, table 2.5). The Party did not explain the significant difference between these values in the NID. During the review, the Party explained that the high CH_4 IEF is due to the predominance of fuelwood combustion for direct heating in the residential and commercial/institutional and the agriculture/forestry/fishing sectors in Brazil. For example, in those sectors, 94.4 and 74.0 per cent respectively of CH_4 emissions are from fuelwood use, which were estimated applying the default EF for conventional wood stoves (932.00 kg CH_4/TJ) provided in the 2006 IPCC Guidelines (vol. 2, chap. 2, table 2.9). In agriculture/forestry/fishing, 99.4 per cent of CH_4 emissions result from fuelwood combustion for heating, which were also estimated using the default EF for wood/wood waste (300.00 kg CH_4/TJ) provided in the 2006 IPCC Guidelines (vol. 2, chap. 2, table 2.5). The TERT recommends that the Party explain in the NID the significant difference between the CH_4 IEF for biomass fuels reported for category 1.A.4 other sectors and the default EFs for biomass fuels provided in the 2006 IPCC Guidelines, and provide detailed information on the type of biomass fuels used in the country.
3.E.10	Specified in paragraph 54 of the MPGs Feedstocks, reductants and other non-energy use of fuels – all fuels – CO_2	The Party reported CO_2 emissions from feedstocks, reductants and other non-energy use of fuels in CRT 1.A(d), but did not specify the categories under which such emissions for each fuel were reported (in column J). The TERT noted several errors in the estimates of CO_2 emissions reported in CRT 1.A(d) (e.g. for lubricants, petroleum coke and asphalt). During the review, the Party provided the correct estimates of CO_2 emissions from feedstocks, reductants and other non-energy use of fuels and specified the categories under which they should be reported in CRT 1.A(d). The TERT encourages the Party to report in CRT 1.A(d) correct estimates of CO_2 emissions from feedstocks, reductants and other non-energy use of fuels and specify under which categories those emissions are reported.
3.E.11	Specified in paragraph 40 of the MPGs 1.B Fugitive emissions from fuels – CO_2	The Party did not report AD for category 1.B fugitive emissions from fuels in the CRTs. During the review, the Party explained that fugitive emissions from fuels were estimated using data provided primarily by Petrobras, which is the main company operating in the oil and gas sector in Brazil. The information reported by Petrobras did not include the AD used. The TERT recommends that the Party collect and report AD for category 1.B fugitive emissions from fuels in the CRTs.
3.E.12	Specified in paragraphs 32 and 47 of the MPGs 1.B.1.a Coal mining and handling – CO_2 and CH_4	The Party reported GHG emissions for subcategory 1.B.1.a.i.3 abandoned underground mines as "NE". The Party explained in CRT 9 that it did not estimate these emissions owing to lack of data. During the review, the Party further explained that, as corroborated by expert judgment from the Brazilian Mining Association, Brazilian coal mines are not considered to be gassy, with low potential for CH_4 emissions owing to the

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		characteristics of the coal seams and the geological conditions under which extraction occurs. The TERT recommends that the Party report GHG emissions for subcategory 1.B.1.a.i.3 abandoned underground mines or derive a likely level of these emissions using approximated AD and default EFs from the 2006 IPCC Guidelines to demonstrate their insignificance as per paragraph 32 of the MPGs.
3.E.13	Specified in paragraphs 39–40 of the MPGs 1.B.2 Oil, natural gas and other emissions from energy production – CO_2, CH_4 and N_2O	The Party reported GHG emissions for subcategories 1.B.2.a.ii production and upgrading, 1.B.2.a.iii transport, 1.B.2.a.v distribution of oil products and 1.B.2.c venting and flaring, but not the AD used for estimating the emissions. During the review, the Party explained that it estimated GHG emissions for subcategories 1.B.2.a.ii, 1.B.2.a.iii and 1.B.2.a.v on the basis of AD and parameters derived from Petrobras's internal data systems. As Petrobras has a robust internal inventory and monitoring system, Brazil extrapolated national estimates of GHG emissions for the above-mentioned subcategories for other companies using correlations between Petrobras's reported emissions for each of its activities (production, refining and transport) and total national production volumes, as outlined in the NID. The TERT recommends that the Party report the AD used for estimating GHG emissions for subcategories 1.B.2.a.ii production and upgrading, 1.B.2.a.iii transport, 1.B.2.a.v distribution of oil products and 1.B.2.c venting and flaring in CRT 1.B.2 and provide information in the NID on how the AD were derived.
3.E.14	Specified in paragraphs 39–40 of the MPGs 1.B.2.a Oil – CO_2	The Party reported fugitive CO_2 emissions from oil production for subcategory 1.B.2.a.iv refining/storage, but did not include information on the EF used for estimating those emissions and why they were reported separately from the emissions for subcategory 1.A.1.b petroleum refining. During the review, the Party explained that CO_2 emissions reported under subcategory 1.B.2.a.iv are based on consolidated estimates of CO_2 emissions derived from Petrobras's internal monitoring system. However, Petrobras does not disaggregate the AD or EFs used for calculating these estimates. The TERT recommends that the Party include in the NID information on the EF used for estimating fugitive CO_2 emissions from oil production for subcategory 1.B.2.a.iv, explaining why they were reported separately from the emissions for subcategory 1.A.1.b petroleum refining.
3.E.15	Specified in paragraph 47 of the MPGs 1.B.2.b Natural gas – CO_2	The Party reported CO_2 emissions for subcategory 1.B.2.b.iii processing of natural gas as "NE". The TERT noted that the 2006 IPCC Guidelines (vol. 2, chap. 4.2.2.1) provide a tier 1 method and default EF for estimating these emissions. During the review, the Party explained that it reported the CO_2 emissions as "NE" because they were not accounted for in the emission estimates provided by Petrobras. The TERT recommends that the Party estimate and report CO_2 emissions for subcategory 1.B.2.b.iii.
3.E.16	Specified in paragraph 47 of the MPGs 1.B.2.b Natural gas – CO_2 and CH_4	The Party reported emissions from natural gas for subcategories 1.B.2.b.i exploration, 1.B.2.b.ii production and gathering, 1.B.2.b.iv transmission and storage and 1.B.2.b.v distribution as "NE". However, the TERT noted that Brazil reported emissions for subcategory 1.B.2.b.iii processing but not for other subcategories related to processing (e.g. distributing natural gas to facilities in Brazil). During the review, the Party explained that it reported emissions for the above-mentioned natural gas subcategories as "NE" owing to lack of disaggregated information because Petrobras provides consolidated estimates for certain activities but does not disaggregate emissions or provide AD and EFs by subcategory. The TERT recommends that the Party collect disaggregated AD in order to report emissions for subcategories 1.B.2.b.i exploration, 1.B.2.b.ii production and gathering, 1.B.2.b.iv transmission and storage and 1.B.2.b.v distribution.
3.E.17	Specified in paragraph 47 of the MPGs 1.C.2.a Injection – CO_2	The Party reported in the NID that CO_2 emissions for category 1.C CO_2 transport and storage were not estimated owing to unavailability of records on national CO_2 storage activities despite the use of CO_2 in enhanced oil recovery operations.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		During the review, the Party explained that it does not have access to detailed operational data because CO_2 reinjection operations in Brazil are concentrated in the pre-salt reservoirs of the Santos Basin, located offshore of the south-east region of the country, and are carried out by Petrobras. The TERT noted that the Party could estimate the CO_2 emissions for category 1.C by collecting AD on enhanced oil recovery operations (e.g. by using the number of wells and the oil extraction amount for each well). The TERT recommends that the Party collect AD, for example on enhanced oil recovery operations, such as the number of wells and the oil extraction amount for each well, to enable it to estimate and report in the NID CO_2 emissions for category 1.C.

Table 4
Areas of improvement of the reporting on greenhouse gas emissions and removals – industrial processes and product use sector

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
4.I.1	Specified in paragraph 39 of the MPGs 2.A.1 Cement production – CO_2	The Party reported that, for cement production plants for which there were no data on the CaO and MgO content of the clinker, it used the EF recommended in the CSI methodology (0.53 t CO_2/t clinker). The CSI methodology focuses on reducing the cement industry's environmental footprint through technological innovation, alternative fuels and raw materials, and collaboration. However, the Party did not provide detailed information on which plants it used the EF from CSI for and which plants it used plant-specific EFs for. It also did not provide information on whether different EFs were used for the same plants across the time series. In addition, the Party reported the ratio of tonnes of clinker to tonnes of cement production in the NID (p.138). The TERT noted a downward trend in the values for this ratio across the time series that was not explained in the NID. During the review, the Party explained that emissions for category 2.A.1 cement production were estimated through a partnership with the National Cement Industry Union, which provided AD and EFs as per the CSI methodology. In cases where plant-specific data on CaO and MgO content of clinker were not available, the CSI-recommended EF (0.53 t CO_2/t clinker) was used. However, the National Cement Industry Union did not provide a breakdown of how many plants report plant-specific CaO and MgO data. Brazil confirmed that the CSI-recommended EF was consistently applied over the entire time series for the same plants. Brazil acknowledged the need to enhance transparency regarding the proportion of cement production covered by plant-specific data and the use of the EF from the CSI for future BTRs. The Party explained that the cement industry has accelerated production in Brazil using additives in clinker, particularly with materials such as steel slag, fly ash and limestone filler. Thus, while emissions from calcination remain relatively constant in the production of clinker, as the average CaO and MgO contents do not change substantially over time, a decrease in the clinker content in cement has been observed, given the increase in the use of additives. Brazil also explained that it did not have any foreign trade flows (imports and exports) related to clinker for cement production between 1990 and 2022. The TERT recommends that Brazil explain in the NID the use of EFs for different plants, including the CSI-recommended EF and plant-specific EFs. The TERT also recommends that the Party explain the downward trend in the ratio of tonnes of clinker to tonnes of cement production in the NID by clarifying that it is linked to the increase in the use of additives in the cement produced in Brazil.
4.I.2	Specified in paragraphs 21, 27 and 47 of the MPGs 2.A.2 Lime production – CO_2	The Party reported that, when updating its national inventory, it revised the time series of AD for subcategory 2.A.2 lime production following the publication of updated documents covering production, export and import of products in the mineral industry. However, the Party did not provide information on specific changes in the AD and their implications for the emission estimates for the category. During the review, the Party explained that, in its previous GHG inventory, for 1990–2020, a lime production estimate from the 2019 Statistical Yearbook of the Non-Metallic Transformation Sector of 8,400 kt for 2018, 2019 and 2020 was

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		reported. Because that Yearbook includes production data for up to 2018 only, the 2018 production value was used for 2019 and 2020. Brazil also explained that for the 2024 NIR it used updated data from the 2020 Statistical Yearbook of the Non-Metallic Transformation Sector, which includes revised estimates of lime production for 2018 (8,300 kt) and 2019 and 2020 (8,100 kt), which were used to recalculate the emissions for the category. Because that Yearbook covers lime production up to 2020 only, the 2020 production value was used for 2021 and 2022. The Party explained that it will include information on the revised AD in the next BTR. The TERT noted that the Party did not include in the NID an explanation for using the 2020 data on lime production for 2021 and 2022. The TERT recommends that the Party collect AD on lime production for after 2020 in order to estimate the associated emissions or justify its use of 2020 AD to fill data gaps for 2021 and 2022; otherwise, the TERT encourages the Party to use appropriate splicing techniques provided in the 2006 IPCC Guidelines (vol. 1, chap. 5.3.3) for calculating AD for the years after 2020.
4.I.3	Specified in paragraphs 21 and 40 of the MPGs 2.A.2 Lime production – CO_2	The Party did not report in the NID data on lime produced for use in relevant industrial processes in Brazil, such as the sugar cane and pulp and paper industries. The TERT noted that not including the associated emissions might lead to a significant underestimation of emissions for category 2.A.2 lime production, which is a key category, given the size of the sugar cane industry in Brazil. During the review, the Party acknowledged that lime is used in some industrial processes in Brazil, particularly for clarification of sugar cane juice, but national statistics on lime production do not usually capture lime produced for use in industrial processes in the country. Brazil explained that it ceased using the Statistical Yearbook of the Non-Metallic Transformation Sector as a source of data for estimating emissions for the category in 2021, and discussions of the Interministerial Committee on Climate Change are ongoing regarding the improvement and collection of national statistics on lime production and consumption. The TERT recommends that the Party collect AD on lime produced for use in relevant industries in the country, particularly the sugar cane industry, estimate the associated CO_2 emissions and report detailed information in the NID on lime produced for use in relevant industrial processes in Brazil.
4.I.4	Specified in paragraphs 39 and 43 of the MPGs 2.C.1 Iron and steel production – CO_2	The Party reported in the NID that it revised the time series of AD on iron and steel production but did not provide further information explaining those revisions and the resulting recalculation of the CO_2 emission estimates for category 2.C.1 iron and steel production. During the review, Brazil explained that detailed information is provided in the NID (section 5.5.3). AD on iron and steel production were revised for 2019–2020 as a result of the availability of updated information in the Brazil Steel Databook 2023, published by the Brazil Steel Institute, namely revised crude steel production values for 2019 and 2020 from 32,560 and 34,102 kt to 32,569 and 31,415 kt respectively. The crude steel production values for 2021 and 2022 from the publication were also used in the NID (36,071 and 34,089 kt respectively). The TERT recommends that the Party provide information in the NID on the recalculation of the CO_2 emission estimates for category 2.C.1, including the revised and previous AD, and a detailed explanation for the changes in AD.
4.I.5	Specified in paragraphs 39–40 of the MPGs 2.F.1 Refrigeration and air conditioning – HFCs	The Party reported that, for commercial freezers, the average refrigerant charge used for mixtures of HFC-134a and R-404A is 150 g/unit; for display cases and cold rooms, the average refrigerant charge used for HFC-134a is 360 g/unit; and for cooling units for water, juice and drinking fountains, the average refrigerant charge used for HFC-134a is 50 g/unit. The Party did not provide sources of information or explain how the AD, average refrigerant charges per unit and EFs were obtained. During the review, the Party explained that, owing to lack of data, the fluorinated gas load estimates were obtained through expert judgment, in consultation with specialists in air conditioning and refrigeration, using the expert elicitation methods provided in the 2006 IPCC Guidelines (vol. 1, chap. 2.2 and annex 2A.1). While Brazil intends to broaden the range of stakeholders and data sources

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		consulted to improve these estimates, the national knowledge on HFC emission accounting methods is limited. The TERT recommends that the Party provide detailed descriptions in the NID of the methods used for estimating the number of refrigeration units in the country and the average refrigerant charges per unit, as well as the EFs.

Table 5
Areas of improvement of the reporting on greenhouse gas emissions and removals – agriculture sector

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
5.A.1	Specified in paragraphs 38–39 of the MPGs 3.B Manure management – CH_4 and N_2O	Brazil reported in CRT 3.B(a) the fraction of total annual N excretion for each livestock species and category subject to MMS. The TERT noted that the sum of the fractions of N excretion for each livestock species and category per climate region for each MMS is equal to 1 (i.e. 100 per cent). The TERT also noted that reporting these data in CRT 3.B(a) in this manner does not enable it to be verified that the sum of the fractions of N excretion for each livestock species and category considering the fractions managed in all MMS and climate regions is equal to 1 (i.e. 100 per cent), as it should be. During the review, Brazil acknowledged that the presentation of the allocation of N excretion fractions in CRT 3.B(a) could be improved in future submissions to enhance clarity. For clarification purposes, the Party provided a document that includes detailed data on MMS usage by animal category, MMS and climate region corresponding to the federative units of the country. The TERT recommends that Brazil present the allocation of N excretion fractions in CRT 3.B(a) by ensuring that the sum of the fractions of N excretion for each livestock species and category considering all MMS and climate regions is equal to 1 (i.e. 100 per cent).
5.A.2	Specified in paragraph 38 of the MPGs 3.B Manure management – N_2O	The TERT noted the following inconsistencies between the data reported in CRTs 3.B(a) and 3.B(b): (a) Manure from poultry is reported in CRT 3.B(a) as managed only under MMS "Other", while in CRT 3.B(b) it is reported as managed under MMS "Deep bedding and other"; (b) Manure from mules and asses, buffalo, horses and goats is reported as managed under MMS "Pasture, range and paddock" according to CRT 3.B(a) but under MMS "Deep bedding and other" according to CRT 3.B(b); (c) Manure from swine managed under MMS "Pasture, range and paddock" is reported as "NO" in CRT 3.B(a), while N excretion is reported for this MMS in CRT 3.B(b). During the review, Brazil acknowledged the errors in reporting and provided the correct MMS classification for the relevant animals as follows: (a) The MMS for poultry should be "Deep bedding and other"; (b) The MMS for mules and asses, buffalo, horses and goats should be "Pasture, range and paddock"; (c) The MMS for swine should be "Anaerobic lagoon", "Liquid slurry", "Anaerobic digester" and "Composting". The TERT recommends that Brazil ensure consistency between CRTs 3.B(a) and 3.B(b) in the information reported on MMS for mules and asses, buffalo, horses, and goats, poultry and swine.
5.A.3	Specified in paragraph 32 of the MPGs 3.B.5 Indirect N_2O emissions – N_2O	For category 3.B.5 indirect N_2O emissions, Brazil explained in CRT 9 that indirect N_2O emissions from N leaching from manure management were reported as "NE" because the emissions were considered negligible. However, Brazil did not provide in the NID a likely level of these emissions derived from approximated AD and default EFs from the 2006 IPCC Guidelines to demonstrate that they are below 0.05 per cent of the national total GHG emissions, excluding LULUCF, or 500 kt CO_2 eq, whichever is lower.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		During the review, the Party explained that it used approximated AD and default EFs from the 2006 IPCC Guidelines to derive a likely level of indirect N_2O emissions from N leaching from manure management and found that they are insignificant over the reporting period. On the basis of the information provided during the review, the TERT determined that indirect N_2O emissions from N leaching from manure management are insignificant as per the threshold defined in the MPGs.
		The TERT encourages Brazil to justify in the NID reporting indirect N_2O emissions from N leaching from manure management as "NE", if the level is considered insignificant, by reporting in the NID the information demonstrating its insignificance by deriving a likely level of emissions for the category using approximated AD and default EFs from the 2006 IPCC Guidelines.
5.A.4	Specified in paragraphs 21, 27 and 47 of the MPGs	Brazil reported the harvested area of intermittently flooded rice cultivation as "NE" but reported CH_4 emissions for subcategory 3.C.1 irrigated rice cultivation in CRT 3.C.
	3.C.1 Irrigated rice cultivation – CH_4	Brazil explained in the NID and during the review that AD on the harvested area of intermittently flooded rice cultivation with single and multiple aerations were available for 1990–2016 and were thus used for estimating CH_4 emissions for the subcategory. However, for 2017–2022 AD on the areas of intermittently flooded rice cultivation were not available in the official databases related to rice cultivation of Embrapa, the Brazilian Agricultural Research Corporation, and, as such, were reported as "NE" in CRT 3.C. Brazil added that, following a conservative approach, the emissions for this subcategory were estimated by replicating the most recent available data on emissions for the intermittently flooded rice systems, which are emissions for 2017 replicated for 2018–2022 for single aeration and emissions for 2016 replicated for 2017–2022 for multiple aerations.
		However, the Party did not provide any evidence to substantiate using this approach. The TERT noted that it is not consistent with the 2006 IPCC Guidelines to replicate the emissions reported for the last year for which AD are available for all succeeding years unless there is evidence to substantiate this approach.
		The TERT recommends that Brazil estimate CH_4 emissions from intermittently flooded rice cultivation for the entire time series by collecting AD on the harvested area for the years for which they are not available or provide evidence to substantiate replicating the emissions reported for the last year for which AD are available for all succeeding years.
		If the Party is unable to collect the AD required to estimate emissions for some years or provide evidence to substantiate its approach, the TERT encourages Brazil to use the appropriate splicing techniques contained in the 2006 IPCC Guidelines (vol. 1, chap. 5.3.3) for estimating the missing AD on the harvested area for intermittently flooded rice cultivation.
5.A.5	Specified in paragraphs 21 and 31 of the MPGs	Brazil reported the N input from sewage sludge applied to soils as "NE" in CRT 3.D for the agriculture sector. However, in the waste sector, the Party reported that, for the generation of domestic wastewater sludge (Mg BOD $year^{-1}$), it considered that the entire mass of wastewater sludge from domestic wastewater treatment generated was disposed of in SWDS.
	3.D.1.b.ii Sewage sludge applied to soils – N_2O	During the review, Brazil explained that the sludge applied to soils was reported as "NE" in the light of its national circumstances, given that it was not possible to disaggregate the amounts of sewage sludge applied to soils and disposed of in landfills. Therefore, all sludge generated was assumed to be disposed of in landfills. The TERT noted that, in that case, emissions from N input from sewage sludge applied to soils should be reported as "IE" in CRT 3.D.
		The TERT recommends that Brazil collect data on the amount of sewage sludge applied to soils in order to separately estimate and report the emissions from N input from sewage sludge applied to soils in CRT 3.D.
		If it is not possible to disaggregate the amount of sewage sludge applied to soils, the TERT recommends that Brazil report the emissions from N input from sewage sludge applied to soils as "IE" in CRT 3.D.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
5.A.6	Specified in paragraph 47 of the MPGs 3.D.1.b.iii Other organic fertilizers applied to soils – N_2O	Brazil reported in the NID (pp.378–379) that it produces compost from solid waste. However, it did not clarify whether the compost produced is included in the organic fertilizers applied to soils in the agriculture sector. During the review, Brazil explained that the compost produced in the waste sector was not considered under organic fertilizers applied to soils as there were no data for tracking the uses of the compost produced in the waste sector. The TERT recommends that Brazil collect data on the compost produced from solid waste applied to managed soils in order to estimate and report the associated emissions.
5.A.7	Specified in paragraphs 21 and 23 of the MPGs 3.D.2 Indirect N_2O emissions from managed soils – N_2O	Brazil reported in its NID and CRTs 7 and summary 3 that it used tier 1 and 2 methods with default EFs (EF_4 and EF_5) from the 2006 IPCC Guidelines (vol. 4, chap. 11.2.2, table 11.3) for estimating N_2O emissions for category 3.D.2 indirect N_2O emissions from managed soils, which is a key category. The TERT noted that, on the basis of the information reported in the NID and CRTs, it is not clear which tier method Brazil applied for estimating the different components of emissions under this category, nor is it clear which AD and EFs were used. During the review, Brazil explained that it used the tier 1 method for estimating indirect N_2O emissions from N leaching and run-off and default $Frac_{LEACH–(H)}$ and EF_5 values from the 2006 IPCC Guidelines, and that it used the tier 2 method for estimating indirect N_2O emissions from volatilization and atmospheric N deposition and default $Frac_{GASF}$ and EF_4 values from the 2006 IPCC Guidelines. The TERT noted that indirect N_2O emissions from N leaching and run-off is a significant subcategory of key category 3.D.2 and, given that it accounts for 63 per cent of the indirect N_2O emissions from managed soils, according to the methodological tier recommended in the corresponding decision tree of the 2006 IPCC Guidelines (vol. 4, chap. 11.2.2.1, figure 11.3) higher-tier methods and country-specific EF_4 and $Frac_{GASF}$ values should be used for estimating the emissions. The TERT recommends that Brazil explain in the NID which tier method was applied for estimating each component of emissions under category 3.D.2, the AD and EFs used and how the tier 2 method was selected for estimating indirect N_2O emissions from volatilization and atmospheric N deposition on the basis of the corresponding decision tree of the 2006 IPCC Guidelines. The TERT encourages the Party to make every effort to use higher-tier methods for estimating indirect N_2O emissions from N leaching and run-off in line with the corresponding decision tree of the 2006 IPCC Guidelines and prioritize developing country-specific EFs (EF_4 and EF_5) and partitioning fractions ($Frac_{GASF}$ and $Frac_{LEACH–(H)}$) for category 3.D.2 in its future improvement plan. In case the Party uses a tier 1 method owing to lack of resources, the TERT recommends that Brazil clearly document in the NID why the methodological choice is not in line with the corresponding decision tree of the 2006 IPCC Guidelines.
5.A.8	Specified in paragraph 47 of the MPGs 3.E Prescribed burning of savannahs – CH_4 and N_2O	Brazil reported in the NID emissions for category 3.E prescribed burning of savannahs as “NE” while noting that burning of savannahs occurs in the country. The Party explained in the NID that emissions were not estimated because differentiating the burning of savannahs due to anthropogenic causes from burning due to natural causes and monitoring the dynamics of these fires over time across the national territory requires developing a methodology for ensuring that fires are linked to the correct causes. The Party also explained that, in order to account for these emissions in the future, it will assess the possibility of conducting studies to develop methodologies that enable differentiation between the causes of fires. The TERT noted that Brazil did not report in the NID any capacity constraints in this regard. During the review, Brazil explained the constraint on its capacity to collect data related to prescribed burning of savannahs for until 2021, and that a single data point of burned areas, with traceability of burned areas in conservation units, was provided by the Chico Mendes Institute for Biodiversity Conservation (the main national institute that manages conservation units). The Party further explained that, although monitoring has been ongoing since 2007, burned areas have been segregated into prescribed burning of savannahs and other types of burning only since 2021, and it will explore the possibility of strengthening institutional

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		arrangements to ensure that these data on burned areas are collected annually and used to calculate emissions for category 3.E for future GHG inventories. The TERT recommends that Brazil estimate and report emissions for category 3.E by continuing efforts to estimate the areas of prescribed burning of savannahs by segregating burned areas of savannahs into areas of prescribed burning and other types of burning (e.g. by strengthening institutional arrangements to ensure that the data on burned areas are collected annually).
5.A.9	Specified in paragraphs 21 and 23 of the MPGs 3.G Liming – CO_2	Brazil used the tier 1 method from the 2006 IPCC Guidelines (vol. 4, chap. 11.3.1) for estimating CO_2 emissions for category 3.G liming. The TERT noted that this is not in accordance with the relevant decision tree of the 2006 IPCC Guidelines (vol. 4, chap. 11.3.1, figure 11.3) because it is a key category and, as such, higher-tier methods should be used for estimating emissions. Brazil documented in the NID why the methodological choice was not in line with the corresponding decision tree of the 2006 IPCC Guidelines and a plan to develop country-specific EFs for this key category. Brazil does not have a robust database on lime application that allows country-specific information to be used for estimating EFs, as is required for the tier 2 method. During the review, the Party explained that the tier 1 method was used for estimating CO_2 emissions for category 3.G because the emissions did not meet the threshold for the category to be considered a key category in the previous GHG inventory and owing to constraints on national capacity to prepare the BTR1 (e.g. limited time to mobilize the technical team for compiling data and preparing the submission). Brazil also explained that a national technical cooperation agreement has been established with Embrapa, the Brazilian Agricultural Research Corporation, aiming to support methodological improvements for the agriculture sector of the GHG inventory. The TERT encourages Brazil to make every effort to use higher-tier methods for estimating CO_2 emissions for category 3.G liming and prioritize developing country-specific EFs for this key category in its future improvement plan.
5.A.10	Specified in paragraphs 21 and 23 of the MPGs 3.H Urea application – CO_2	Brazil used the tier 1 method from the 2006 IPCC Guidelines (vol. 4, chap. 11.4.1) for estimating CO_2 emissions for category 3.H urea application. The TERT noted that this is not in accordance with the relevant decision tree of the 2006 IPCC Guidelines (vol. 4, chap. 11.4.1, figure 11.5) because it is a key category and, as such, higher-tier methods should be used for estimating emissions. Brazil clearly documented in the NID why the methodological choice was not in line with the corresponding decision tree of the 2006 IPCC Guidelines and a plan to develop country-specific EFs for this key category. Brazil does not have a robust database on urea application that allows country-specific information to be used for estimating EFs as is required for the tier 2 method. During the review, the Party explained that the tier 1 method was used for estimating CO_2 emissions for category 3.H because the emissions did not meet the threshold for the category to be considered a key category in the previous GHG inventory and owing to constraints on national capacity to prepare the BTR1 (e.g. limited time to mobilize the technical team for compiling data and preparing the submission). Brazil also explained that a national technical cooperation agreement has been established with Embrapa, aiming to support methodological improvements for the agriculture sector of the GHG inventory. The TERT encourages Brazil to make every effort to use higher-tier methods for estimating CO_2 emissions for category 3.H and prioritize developing country-specific EFs for this key category in its future improvement plan.

Table 6

Areas of improvement of the reporting on greenhouse gas emissions and removals – land use, land-use change and forestry sector

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
6.L.1	Specified in paragraph 39 of the MPGs	The Party reported in its NID (p.522) that, to establish an average value for above-ground woody biomass carbon stock in the areas of the Amazon biome where there is no natural vegetation, values for the original vegetation (i.e. the natural vegetation before the land-use change) were obtained on the basis of the seventy-fifth

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
	4. General (LULUCF) – biomass – CO_2, CH_4 and N_2O	percentile of the above-ground woody biomass values in the phytophysiognomies of this vegetation. During the review, the Party explained that this approach allowed for consistency with the carbon stock map produced for the NC3 and also performed better than when using the average above-ground woody biomass values. The assessment involved a comparative analysis with the carbon stock map produced for the NC3, which is based on ground-truth data from the Radar in the Amazon Project, with expert judgment from the Scientific Validation Committee (see NID p.48). The TERT acknowledges that the use of the most accurate data available is consistent with the good practice provided in IPCC guidelines but notes that the use of different approaches for deriving above-ground woody biomass values (e.g. seventy-fifth percentile and average values) across the time series could potentially result in a lack of time-series consistency, as evidenced by a decreasing trend in per hectare losses from deforestation from 2016. The TERT recommends that the Party select the data set on above-ground woody biomass values (seventy-fifth percentile or average values) that has higher accuracy and use it to derive a consistent time series of emission and removal estimates for relevant land-use categories as per the good practice provided in IPCC guidelines. If, instead of using average values for areas subsequently deforested, the Party elects to use the seventy-fifth percentile of the above-ground woody biomass values, the TERT recommends that the Party provide transparent information in the NID justifying the methodological choices underpinning the use of these values for estimating past carbon stocks for areas where natural vegetation had already been removed. This justification could, for example, be provided by comparing the above-ground woody biomass values with measurements taken in areas with similar vegetation. Furthermore, if the Party continues to use data sets derived using two different approaches (seventy-fifth percentile and average values) across the time series, the TERT recommends that the Party clearly demonstrate how the use of two such data sets across the time series does not lead to a lack of time-series consistency.
6.L.2	Specified in paragraphs 21, 32, 40 and 47 of the MPGs 4. General (LULUCF) – organic soils – CO_2	Brazil reported in its NID (p.315) that emissions and removals from mineral and organic soils in the LULUCF sector were not estimated or reported separately from each other. The TERT noted that this is not in accordance with the 2006 IPCC Guidelines (vol. 4, chap. 2.3.3) or the CRTs because estimates of SOC in mineral soils and CO_2 emissions from organic soils are to be estimated using different methods and reported separately from each other. During the review, Brazil explained that, according to national data compiled by Embrapa, organic soils, including organosols and other soils with organic horizons, occupy approximately 0.1 per cent of Brazil's territory, equivalent to about 937,000 ha, of which organosols represent around 789,000 ha. Given this very limited spatial dimension, organic soils are not considered a key category in terms of GHG emissions or removals in the LULUCF sector in accordance with the 2006 IPCC Guidelines. As such, there are no plans to map or monitor drainage and rewetting of organic soils for reporting purposes, but potential inclusion of organic soils in the inventory may be reassessed as part of future methodological improvements. The TERT noted that Brazil reported 176,376.87 ha cultivated organic soils under category 3.D direct and indirect N_2O emissions from agricultural soils in the agriculture sector but did not report information on the significance of the emissions from organic soils on the basis of the likely level of emissions derived using approximated AD and default EFs from the 2006 IPCC Guidelines as per the MPGs. The TERT recommends that Brazil estimate CO_2 emissions from drained organic soils and report them separately from CO_2 emissions from mineral soils under the land-use category they occur in, if significant, or demonstrate their insignificance on the basis of the likely level of emissions derived using approximated AD and default IPCC EFs.
6.L.3	Specified in paragraphs 21 and 39 of the MPGs 4. General (LULUCF) – biomass and HWP – CO_2, CH_4 and N_2O	The Party used data on harvest collected from the Brazilian Institute of Geography and Statistics to derive the amount of biomass left on deforested land, which was used to estimate CH_4 and N_2O emissions from biomass burning. However, the Party used data on harvest collected from FAOSTAT to estimate the HWP contribution. The TERT noted that Brazil did not report data on harvested woody biomass

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		extracted from logging on forest land (e.g. forest plantations and selectively logged forests and from deforestation events), perennial crops or other wooded land, which could be used to apply the default gain–loss method from the 2006 IPCC Guidelines (vol. 4, chap. 2.3.1.1), for estimating carbon stock losses and could also be used for verification when applying the stock-difference method from the 2006 IPCC Guidelines (vol. 4, chap. 2.3.1.1). The Party did not provide transparent information in the NID on why it did not use the harvest data for estimating biomass carbon stock changes or how consistency between the two data sets on harvest was ensured when using them for estimating emissions for two different categories (biomass burning and HWP). During the review, the Party clarified that statistical data on harvest are collected by the Brazilian Institute of Geography and Statistics for wood extracted from deforestation and natural forest, although data are not disaggregated into components for deforestation and selective logging, and from forest plantations. The Party also clarified that, even though the Institute publishes data for forest plantations, the forest harvest data used to estimate the HWP contribution were obtained from FAOSTAT, which publishes data provided by the Brazilian Forest Service. The TERT recommends that the Party report in the NID the data on harvested wood obtained from the Brazilian Institute of Geography and Statistics used to estimate non-CO_2 emissions from biomass burning and information on how data sourced from the Institute are consistent with the harvest data from FAOSTAT used to estimate the HWP contribution.
6.L.4	Specified in paragraphs 21 and 39 of the MPGs 4. General (LULUCF) – all carbon pools – CO_2	The Party presented the equations used to calculate annual carbon stock gains and losses for all carbon pools in the NID (table A.VII.14). The TERT noted that the equations are used to calculate the carbon stock changes by assuming that the entire land area is converted in the middle year of the period between two successive land-use maps, rather than deriving AD as per the good practice provided in IPCC guidelines, and limiting the period of land-use conversion to the period between the two successive land-use maps for which the conversion was identified, rather than to the transition period to be applied for land-use conversions as per the good practice provided in IPCC guidelines. During the review, the Party provided a revised version of table A.VII.14, which includes its explanation and corrections for the typographical errors identified during the review. The Party explained that variable t in the equations is the time period between successive land-use mapping years; and that, with the exception of managed forest land and grassland (i.e. conservation units and Indigenous lands) and forest land subject to selective logging, carbon stock changes are only estimated for conversions of one land stratum to another land stratum (see NID dataframe 7.4), as identified by comparing successive land-use maps. The TERT recommends that the Party calculate annual carbon stock gains and losses for all carbon pools for the entire time series for all land-use conversions by revising the equations used for estimating perennial biomass for each year of the inventory time series, including the years in which a land-use category and/or stratum conversion occurs, and DOM and SOM for each year of the transition period of each category and/or stratum conversion.
6.L.5	Specified in paragraphs 27 and 47 of the MPGs 4. General (LULUCF) – all carbon pools – CO_2	As stated in the NID (pp.318 and 339), for gross CO_2 removals and CO_2 emissions from the biomass and SOC pools for 2017–2022 Brazil reported the values estimated for 2016. During the review, Brazil explained that, given national capacity constraints in preparing the BTR1, including the short time frame available to mobilize the technical team for compiling data and preparing the submission, the Party did not collect AD for years subsequent to 2016 (see ID# 6.L.14) and thus it replicated the 2016 values in the inventory time series for 2017–2022. Acknowledging the importance of improving the representation of the changes in biomass and SOC pools for 2017–2022, Brazil noted that it is exploring methodological alternatives to enhance its estimates in the future. In addition, Brazil is planning capacity-building for the inventory team to facilitate it using splicing techniques provided in the 2006 IPCC Guidelines (vol. 1, chap. 5.3.3) to fill data gaps.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		The TERT recommends that Brazil collect the AD necessary for it to estimate and report CO_2 emissions and removals for 2017–2022 for all land-use categories. In case the Party is unable to do so, the TERT encourages it to fill the gaps in the AD using data splicing techniques provided in the 2006 IPCC Guidelines (vol. 1, chap. 5.3.3) for estimating and reporting these emissions and removals.
6.L.6	Specified in paragraphs 29 and 39 of the MPGs 4. General (LULUCF) – all carbon pools – CO_2, CH_4 and N_2O	The Party reported limited information on the uncertainty assessment for the LULUCF sector in the NID (annex, table A.II.2), reporting only the aggregate uncertainty of AD and EFs for the six land-use categories without providing information on how the uncertainty assessment was performed. The Party did not provide annual AD for any of the land-use categories in the NID or CRTs. On the basis of the information presented and owing to lack of annual AD for the LULUCF sector (see ID# 6.L.5), the TERT could not assess the uncertainty analysis for the LULUCF sector. During the review, the Party provided relevant explanations (see ID#s 6.L.8 and 6.L.15). The TERT recommends that Brazil provide complete information, including uncertainties of AD and EFs, to enable the TERT to assess the uncertainty analysis performed for the LULUCF sector.
6.L.7	Specified in paragraphs 35 and 39 of the MPGs 4. General (LULUCF) – SOM – CO_2	The Party reported in its NID (p.331) country-specific stock change factors used to calculate changes in SOC in mineral soils, although the description of how they were derived is largely incomplete and includes a reference to a single peer-reviewed publication on a study involving zero and conventional tillage in rotations of annual crops in a single soil type (oxisol) in the state of Rio Grande do Sul. The NID does not include an assessment of the accuracy of the country-specific stock change factors used to calculate SOC changes. The TERT noted that the reporting is not in accordance with the 2006 IPCC Guidelines (vol. 1, chap. 4), according to which sufficient and clear documentation is required to assess whether the information reported meets the good practice requirements, including for using unbiased, and as precise as practicable, country-specific values, and to demonstrate that the stock change factors enable estimating SOC changes associated with a change in land use, land management and/or input of organic matter. During the review, the Party clarified that conversions from native vegetation to conventional tillage, no-tillage systems and pastures with different management conditions were usually consistently considered in the land-use analysis. The methodology for calculating SOC changes is based on analysing the integrated effect of land-use or management change on the top 30 cm of soil over a 20-year period (as proposed by Ogle et al. (2004)). The Party provided a list of additional relevant sources and a description of the general QA process applied to the inventory. Owing to limited time, the TERT could not fully assess whether the Party followed the good practice provided in IPCC guidelines when estimating the changes in SOC in mineral soils. The TERT recommends that the Party report complete information on how the stock change factors used for calculating changes in SOC in mineral soils are derived to enable assessment of whether these factors can be used to produce estimates of SOC changes consistently with the good practice methodology in the 2006 IPCC Guidelines. The TERT encourages the Party to verify the accuracy of the reported estimates of changes in SOC in mineral soils by comparing them with alternative independent estimates, or with available annually collected measurements.
6.L.8	Specified in paragraphs 38 and 40 of the MPGs 4. General (LULUCF) – all carbon pools – CO_2	Brazil did not report AD for any years of the time series in CRTs 4.A, 4.B, 4.C, 4.D, 4.E, 4.F or 4(IV). Given that no AD are reported in these CRTs, the reporting on CO_2 emissions and removals for categories 4.A forest land, 4.B cropland, 4.C grassland, 4.D wetlands, 4.E settlements and 4.F other land and GHG emissions for category 4(IV) biomass burning did not allow the TERT to understand how the estimations were calculated. During the review, Brazil acknowledged the missing information and clarified that it is due to lack of capacity for completing the CRTs and applying splicing techniques from the 2006 IPCC Guidelines for producing the annual time series of AD from periodically collected data.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		The TERT recommends that Brazil report the AD associated with emissions for categories 4.A, 4.B, 4.C, 4.D, 4.E, 4.F and 4(IV) in the relevant rows of the CRTs.
6.L.9	Specified in paragraph 39 of the MPGs 4. General (LULUCF) – all carbon pools – CO_2, CH_4 and N_2O	Brazil reported in its NID (dataframe 7.4) that the subcategory "Areas not observed", which comprises areas not observed owing to the occurrence of persistent clouds and/or cloud shadows or relief in the images from 2016 onward, is classified under other land, which is not expected to have significant resident carbon stocks in carbon pools. However, Brazil did not report information on how carbon stock changes associated with land conversion to and from "Areas not observed" are calculated. During the review, Brazil explained that no carbon stock changes were estimated for conversion of land to and from "Areas not observed", and that a change in land use of "Areas not observed" was identified on the basis of the previous land-use category of the area. The TERT recommends that Brazil report in the NID all methodological information (e.g. AD, EFs and methods) relevant to estimating carbon stock changes in land under conversion to and from "Areas not observed".
6.L.10	Specified in paragraphs 21 and 47 of the MPGs 4. General (LULUCF) – biomass – CO_2	Brazil reported in CRTs 4.A, 4.B and 4.C a single value for net biomass carbon stock change, even for categories for which an initial loss of biomass and subsequent regrowth (although the regrowth calculation was limited to the period between two successive maps) were estimated (e.g. conversion to secondary forest). The single value for net biomass carbon stock change in each CRT is reported in the column for gains or losses, depending on whether it is a net gain or loss, and the corresponding loss or gain is reported as "IE". The TERT noted that the CRTs require reporting values for biomass carbon stock gains and losses and reporting a single value is not transparent given that, as per the MPGs (para. 47), reporting is to be implemented at the most disaggregated level, including by reporting carbon stock gains and losses separately, unless the stock-difference method is applied to calculate a single net change in carbon stock. During the review, Brazil acknowledged the missing information and clarified that it is due to lack of capacity for completing the CRTs. The TERT recommends that Brazil report estimated biomass carbon stock gains separately from biomass carbon stock losses in CRTs 4.A, 4.B and 4.C.
6.L.11	Specified in paragraph 47 of the MPGs 4. General (LULUCF) – DOM – CO_2	Brazil did not report deadwood and litter carbon stock changes in CRT 4.A or DOM carbon stock changes in CRTs 4.B, 4.C, 4.D, 4.E and 4.F, instead reporting DOM carbon stock changes as "IE", "NA" or "NE". The Party reported in the NID (tables A.VII.2–A.VII.7) that deadwood and litter carbon stocks are reported for each phytophysiognomy in forest land and grassland and used them to calculate carbon stock changes in those carbon pools. The carbon stock changes in DOM were included in the estimates reported for carbon stock changes in the biomass pool. The TERT noted that the reporting is not in accordance with the MPGs because carbon stock changes should be reported by carbon pool at the most disaggregated level. During the review, Brazil acknowledged the missing information and clarified that it is due to lack of capacity for completing the CRTs. The TERT recommends that Brazil report the carbon stock changes in DOM in CRTs 4.A, 4.B, 4.C, 4.D, 4.E and 4.F, wherever estimated, instead of including them with the carbon stock changes for other carbon pools.
6.L.12	Specified in paragraph 47 of the MPGs 4. General (LULUCF) – SOM – CO_2	Brazil did not report any values for SOC stock changes in CRTs 4.A, 4.B, 4.C, 4.D, 4.E and 4.F, instead reporting SOC stock changes as "IE", "NE", "NA" and "NO". The Party reported in the NID (section 7.2.2.1) that SOC stock changes were estimated by applying the method provided in the 2006 IPCC Guidelines (vol. 4, chap. 2, equation 2.25), but the TERT noted that the reporting is not in accordance with the MPGs because carbon stock changes should be reported by carbon pool at the most disaggregated level. During the review, Brazil acknowledged the missing information and clarified that it is due to lack of capacity for completing the CRTs. The TERT recommends that Brazil report estimated SOC stock changes in CRTs 4.A, 4.B, 4.C, 4.D, 4.E and 4.F, wherever estimated, instead of including them with the carbon stock changes for other carbon pools.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
6.L.13	Specified in paragraph 47 of the MPGs 4. General (LULUCF) – biomass and DOM – CO_2, CH_4 and N_2O	Brazil did not report emissions from fires on managed land other than from biomass burning on cleared (deforested) land. The Party reported in its NID (dataframe 7.20) that it plans to estimate and report the emissions. In this context, the TERT noted the availability of data for burned areas from national sources, such as the National Institute for Space Research. During the review, Brazil explained that it established an important fire monitoring system (see https://terrabrasilis.dpi.inpe.br/queimadas/portal/) with great potential for helping to estimate emissions from forest fires. Estimating emissions from fire degradation poses challenges owing to the significant heterogeneity of vegetation and environmental conditions, which affects the immediate and subsequent impacts on carbon stock losses and tree mortality, and carbon stock recovery dynamics. As mentioned in the LULUCF improvement plan (see NID dataframe 7.20), Brazil is planning to expand the development of national studies and methodologies for estimating emissions from fire degradation. The TERT recommends that Brazil report carbon stock losses and non-CO_2 emissions from biomass burning on managed land other than biomass burning on cleared (deforested) land, including by prioritizing efforts to develop country-specific data and, if not immediately available, by using available national and/or international data sets on the burned areas and data on biomass and DOM carbon stocks as reported in the NID.
6.L.14	Specified in paragraphs 18–19 of the MPGs Land representation – all carbon pools – CO_2, CH_4 and N_2O	Brazil reported in its NID that land representation was established using land-use maps for 1994, 2002, 2005 (for the Amazon biome only), 2010 and 2016. However, the Party did not report information on the institutional arrangements that ensure that the Party, on the basis of its available resources, continuously collects the necessary AD, and applies them consistently with the good practice provided in IPCC guidelines, to prepare a complete and consistent land representation across the entire time series of the national GHG inventory, in particular for years for which no data are available. During the review, the Party explained that it has a long history of mapping land use and land cover. Maps were produced for the whole country for 1994, 2002, 2005 (for the Amazon biome only), 2010 and 2016 on the basis of the visual interpretation of satellite images obtained through remote sensing. However, owing to limited technical and institutional capacities, it has not been feasible to update the land-cover mapping since 2016. Recognizing the importance of updating land-use and land-cover mapping for future reporting, Brazil plans to increase the frequency of land-use mapping and expand the use of official national monitoring systems established by the National Institute for Space Research. The TERT encourages the Party to implement and maintain national inventory arrangements, including institutional, legal and procedural arrangements, for producing a consistent and complete land representation for each inventory cycle as per the relevant IPCC guidelines. The TERT recommends that the Party report information on such institutional, legal and procedural arrangements in the NID.
6.L.15	Specified in paragraph 21 of the MPGs Land representation – all carbon pools – CO_2, CH_4 and N_2O	Brazil reported in its NID that data on land use and land-use change are derived from an analysis, through overlapping, of a time series of five maps derived from satellite images obtained through remote sensing, that is for 1994, 2002, 2005 (limited to the Amazon biome), 2010 and 2016. However, the Party did not report the results of the verification of land use and land-use change data resulting from the analysis of the following pairs of land-use maps: 1994 and 2002, 2002 and 2005, 2005 and 2010 (both limited to the Amazon biome), 2002 and 2010, and 2010 and 2016, with ground-truth data consistent with the 2006 IPCC Guidelines (vol. 4, chap. 3, annex 3A.2, chap. 3A.2.4). During the review, the Party explained that verification of land use and land-use change data was undertaken by an independent scientific validation committee that evaluated intermediate products, reviewed past land-use maps and those for 2016, and recommended corrections and updates to land use and land-use change data that were duly implemented. Validation statistics on land use and land-use change data were based on the confusion matrix and commission and omission errors. The global accuracy of land-use maps for the different biomes ranged from 64.9 to 99.3 per cent. The TERT noted that the information on the validation of maps does not enable

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		an assessment of the quality of the land-use data derived from overlapping those maps. The TERT recommends that the Party report verification statistics on the land-use changes derived by overlapping maps by reporting the confusion matrix and commission and omission errors for each pair of maps, and accordingly adjust statistical data on areas of land use and land-use change and quantify the uncertainty of such data.
6.L.16	Specified in paragraphs 21 and 39 of the MPGs Land representation – all carbon pools – CO_2, CH_4 and N_2O	Brazil reported in its NID that forest land is defined as having a minimum area of 0.5 ha and the minimum mapping area of the land-use maps is 6.25 ha. However, the Party did not report information on how areas of land-use change from and to forest smaller than 6.25 ha were identified or estimated. During the review, Brazil explained that wall-to-wall mapping was based on the visual interpretation of medium-resolution satellite images from the Landsat 5 and Landsat 8 satellites, which have a minimum mapping area of 6.25 ha. This minimum mapping area was the same as the one used by PRODES (Brazil's official deforestation monitoring system) at the time of the mapping. This means that land-cover changes in polygons smaller than 6.25 ha may not be detected through the interpretation of satellite images. The Party also explained that the uncertainty of land identification related to this technical limitation is applicable to all land-cover classes. However, the Party stated that it is open to improving its methodology and may address this limitation as part of future inventory updates. The TERT noted that Brazil might consider using various approaches consistent with the good practice provided in the 2006 IPCC Guidelines for deriving areas of land converted to and from forest land. For instance, it could conduct studies with high-resolution data, where two data sets of land-cover change and/or land-use change are estimated, the first with a minimum area of 6.25 ha and the second with a minimum area of 0.5 ha. The comparison of the two sets of results provides a correction factor for deriving the second set of results from the first. A stratification of such studies according to the fragmentation of the landscape enhances the accuracy of the results. The TERT recommends that Brazil estimate land conversion areas involving forest land consistently with the threshold used to define forest land using approaches consistent with the good practice provided in the 2006 IPCC Guidelines for identifying areas larger than the threshold and smaller than the minimum mapping area. The TERT also recommends that the Party report in the NID transparent information on technical limitations in identifying such areas.
6.L.17	Specified in paragraphs 21 and 39 of the MPGs Land representation – all carbon pools – CO_2, CH_4 and N_2O	The Party reported in its NID (p.334) that the annual gross CO_2 emissions for the years in which there were no annual deforestation data were obtained from the arithmetic average of the emissions for each assessed period using relevant equations (equations 7.3 and 7.4 in the NID). However, the Party did not provide transparent information on how data on deforestation specifically collected to monitor deforestation are used, together with data obtained from the time series of land-use maps from which land representation is derived, to calculate areas of land use and land-use change. During the review, the Party explained that in equation 7.3 in the NID both variables (the annual area deforested in year i and the arithmetic average of the area deforested in period j) were derived from deforestation monitoring systems such as PRODES; they were not based on the land-use maps prepared for the national GHG inventory. The sum of the areas of annual deforestation estimated using data from deforestation monitoring systems (data set A) does not equal exactly the areas of deforestation estimated using land-use maps (data set B). The differences between the two data sets relate to the fact that the annual deforestation monitoring systems were developed for different purposes compared with land-use maps and thus have their own methodological specificities. For example, PRODES was initially developed for monitoring deforestation in primary forests in the Amazon, excluding deforestation of secondary forests and other wooded land vegetation. The Party acknowledged the importance of improving the representation of deforestation dynamics in its national inventory and explained that it is exploring possibilities for increasing the consistency and harmonization of available databases, and efforts are ongoing to harmonize and strengthen synergies with other national actors involved

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		in land-use monitoring with a view to improving temporal resolution and methodological robustness in future land-use maps. The TERT noted that the use of two different data sets to derive areas of land use and land-use change caused discrepancies in the estimated areas of land categories and land representation because areas of land conversion that are estimated with data set B (e.g. forest land converted to cropland) are not matched by corresponding changes in the area of the original category (e.g. forest land) or in the area of the final category at the end of the transition period (e.g. cropland), which are both estimated using data set A. As a result, the use of two different data sets requires area corrections to ensure that the total area reported in the land representation corresponds to the total area of the country across the entire time series. The TERT noted that annual changes in area for every land-use category (e.g. forest land) should be based on corresponding changes in the areas of associated land-use subcategories in the same year (e.g. a decrease in the area of forest land remaining forest land should be matched by an equivalent area of deforestation, such as forest land converted to cropland, and conversely a new area of deforestation should be paired with an equivalent decrease in the area of forest land remaining forest land) and at the end of the transition period (e.g. an increase in the area of cropland remaining cropland should be paired with an equivalent decrease in the area of land converted to cropland). The TERT recommends that the Party estimate annual carbon stock changes for forest land converted to other land-use categories for the entire time series by using the most accurate land-use data set, ensuring that annual changes in area for every land-use category are based on corresponding changes in the areas of associated land-use subcategories in the same year and at the end of the transition period.
6.L.18	Specified in paragraphs 20, 27, 38 and 40 of the MPGs Land representation	Brazil in CRT 4.1 reported areas of land use and land-use change as "NE" for all inventory years for which a pair of land-use maps was not available, namely all years apart from 2002, 2010 and 2016. Brazil also reported, for 2002, 2010 and 2016, land use and land-use change areas across time periods, namely 1994–2002, 2002–2010 and 2010–2016. The TERT noted that the reporting is not in accordance with the requirements of CRT 4.1 because Parties are required to report areas and changes in areas between the previous and the current inventory year. During the review, Brazil acknowledged the missing information and clarified that it is due to lack of capacity for completing the CRTs and applying splicing techniques from the 2006 IPCC Guidelines for producing annual time series of AD from periodically collected data. The TERT recommends that Brazil compile a consistent land representation with, for each land category, the entire inventory time series of areas and changes in areas between the previous and the current inventory year and report them in CRT 4.1. The TERT encourages the Party to use the splicing techniques (e.g. linear interpolation) provided in the 2006 IPCC Guidelines for calculating annual area changes on the basis of data on area changes collected over longer time periods.
6.L.19	Specified in paragraph 21 of the MPGs 4.A Forest land and 4.C Grassland – biomass carbon pool – CO_2	Brazil reported in its NID (table A.VII.8) that, in order to estimate carbon stock changes in forest land and grassland within conservation units and Indigenous lands (i.e. managed forest land, managed grassland or other managed wooded land), it used constant rates of net accumulation of carbon in biomass or, for rates derived from eddy covariance techniques, aggregate carbon accumulation rates considering all carbon pools together. These rates were derived from a limited number of research studies conducted in a few areas of forest land and grassland that are not subject to disturbances, and were either calculated from measured biomass increments subtracted by natural mortality or as net CO_2 flux using eddy covariance techniques. In some cases, expert judgment was also applied for deriving them. The TERT noted that the reporting is not in accordance with the 2006 IPCC Guidelines (vol. 4, chap. 2) as net removals have been systematically overestimated because only net increment is estimated, while carbon stock losses, in particular from forest fires, were not estimated. In addition, the net CO_2 flux estimated using eddy covariance techniques does not correspond to actual net accumulation of carbon in land because the eddy covariance techniques do not account for lateral losses of carbon occurring through water run-off and may underestimate CO_2 emissions from soil respiration in non-turbulent atmospheric conditions.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		During the review, Brazil provided additional information clarifying the data used from each of the research studies and on the expert judgment applied. The TERT recommends that Brazil estimate carbon stock changes in biomass in forest land within conservation units and Indigenous lands by using unbiased values of perennial biomass increment rates, including by periodically collecting ground-based measurements of biomass carbon stock gains and losses, accounting for biomass losses (e.g. from forest fires), verifying the accuracy of the net removals reported using independent data sets (e.g. data collected through Brazil's national forest inventory) and using data collected through eddy covariance techniques of appropriate quality only for verifying ground-based measurements. The TERT also recommends that Brazil provide transparent information (e.g. in an annex to the NID) on the derivation of the biomass accumulation rates for managed forest land and managed grassland.
6.L.20	Specified in paragraphs 21 and 35 of the MPGs 4.A Forest land – biomass – CO_2	The Party reported in its NID (p.347) that carbon stock gains in biomass in forest plantations are reported for a 7-year cultivation cycle for the eucalyptus and black wattle plantations and for a 15-year cultivation cycle for pine plantations. The TERT noted that this approach is applied to new plantations only for their first cultivation cycle and, as such, carbon stock gains or losses are not reported thereafter, including for forest plantations remaining under the same land-use subcategory. In addition, Brazil did not report carbon stock losses due to harvesting at the end of the cultivation period. The TERT noted that the reporting is not in accordance with the 2006 IPCC Guidelines (vol. 4, chaps. 2.3.1 and 4.2.1), which require estimation of annual carbon stock gains and losses in the perennial biomass pool for each year of the inventory time series given that, in forest land, carbon stocks in perennial biomass are not assumed to reach equilibrium levels in the long term. During the review, the Party explained that the net change in biomass carbon stocks was calculated on the basis of mean annual increment curves, without distinguishing between intra-cycle gains and losses. In the case of forest plantations remaining forest plantations, no carbon stock changes are reported, owing to lack of consistent data over time on plantation age, harvest cycles and management practices. Under current assumptions and consistent with the tier 1 methodology in the 2006 IPCC Guidelines, carbon stocks in these areas are considered to be in equilibrium, where periodic harvesting is balanced by regrowth. The TERT recommends that the Party calculate and report annual gains and losses of biomass carbon stocks in forest plantations, accounting for all gains (i.e. net biomass increment during the cultivation cycle) and losses (e.g. harvested biomass at the end of the cultivation cycle) for all cultivation cycles. The TERT encourages the Party to verify total net biomass accumulation across the cultivation cycle using data on harvested biomass, in cases where growth curves are used to model annual net increment, given that the harvested quantity at the end of the cultivation cycle corresponds to the actual total net accumulation of biomass across the cycle.
6.L.21	Specified in paragraph 21 of the MPGs 4.A Forest land – biomass and DOM – CO_2	The Party reported in its NID (table A.VII.12) that for estimating carbon stock changes in selectively logged forests it applied a different rate of net change in carbon stocks in biomass and coarse woody debris (which is considered DOM) than the original rate of change in average carbon stocks (i.e. at conversion of primary forest to selective logging) to each subsequent logging phase. This rate of net change was calculated on the basis of the sequence of successive logging phases and the period between two successive logging phases, as identified using the land-use maps. Following a tier 3 approach provided in the 2006 IPCC Guidelines, these rates were modelled from a single study that uses remotely sensed data. The TERT noted that the reporting is not in accordance with the 2006 IPCC Guidelines (vol. 1, chap. 3; vol. 4, chap. 2), which prescribe using data on annual harvest and regrowth (i.e. gain–loss method) or forest inventory data (i.e. stock-difference method). Furthermore, for both methods, rates of change in biomass and DOM should be representative of the variability of forest types, climate conditions and management practices in the area and, as such, values for these parameters based on a single study may pose limitations to accuracy and precision of carbon stock change estimates. The TERT also noted that, consistently with the 2006 IPCC Guidelines (vol. 4, chap. 2), models for implementing tier 3 approaches should be developed and

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		applied as per the good practice provided in the 2006 IPCC Guidelines, including by verifying across time the outputs of models with independent measurements. Where such verification is not possible, the default method provided in the 2006 IPCC Guidelines (vol. 4, chaps. 2 and 4) should be used for calculating and reporting biomass carbon stock losses in the year of harvesting and subsequent annual carbon stock gains and losses across the entire inventory time series. The TERT noted that data sets for implementing the IPCC default method are available in Brazil, such as statistics on harvest and regrowth from the Brazilian Institute of Geography and Statistics, the Brazilian Forest Service and the national forest inventory, as well as data from the monitoring systems of the National Institute for Space Research (harvested areas and areas subject to forest fires). During the review, the Party provided additional information specifying that the values used to estimate carbon stock changes in selectively logged forests were derived from Huang and Asner (2010), which quantifies carbon stock losses from live biomass and gains in coarse woody debris over a 60-year recovery period. These trajectories describe the temporal dynamics of carbon redistribution following logging and underpin the rates applied in the national GHG inventory. The study uses remote sensing products to identify disturbance and a process-based model (CASA-3D) to simulate carbon dynamics over time. The model was applied to 24 structural canopy classes corresponding to different levels of pre-disturbance gap fraction, ensuring computational feasibility while maintaining spatial representativeness across a 48,150 km^2 region of the Brazilian Amazon where logging has been most significant in the 2000s. The model results were compared with multiple field and remote sensing studies in the region, showing general consistency within expected biophysical ranges. The TERT recommends that the Party verify estimates of carbon stock changes in selectively logged forests across the entire inventory time series by comparing modelled results with national data sources, in particular with harvest data, or otherwise apply the IPCC default method (gain–loss method) using national data sets.
6.L.22	Specified in paragraphs 21, 32, 39 and 47 of the MPGs 4.B Cropland – biomass – CO_2	Brazil did not estimate carbon stock changes for cropland remaining cropland. During the review, the Party explained that carbon stock changes for cropland remaining cropland were not estimated using the tier 1 method provided in the 2006 IPCC Guidelines (vol. 4, chap. 3) owing to the unavailability of spatially disaggregated data on crop types for most of the time series, given that land-use and land-cover maps distinguishing annual, semi-perennial and perennial crops are only available for 2016 onward. Further, the Party considered carbon stock changes in biomass on cropland remaining cropland to be negligible. However, for future inventory cycles, if a new land-use and land-cover map becomes available that enables identifying perennial cropland remaining perennial cropland, it will be possible to report associated biomass carbon stock changes for this subcategory, as per the good practice provided in the 2006 IPCC Guidelines. The TERT noted that the tier 1 method in the 2006 IPCC Guidelines (vol. 4, chap. 3) requires reporting annual gains and losses of perennial biomass in each year of the entire inventory time series regardless of the status of conversion of the land for perennial crops. The TERT noted that available statistical data on areas cultivated under perennial and semi-perennial crops can be used to apportion the total area of cropland identified in land-use maps to these crops, following the approach used to apportion the total area of forest plantations to the various tree species. The TERT recommends that Brazil calculate a complete and consistent time series of annual carbon stock changes in perennial biomass on cropland by calculating annual carbon stock gains and losses, or demonstrate their insignificance by deriving the likely level of emissions using approximated AD and default EFs from the 2006 IPCC Guidelines.
6.L.23	Specified in paragraph 21 of the MPGs 4.B Cropland – biomass – CO_2	The Party reported in its NID (tables 7.11 and 7.12) average values of biomass carbon stocks and carbon stock gains used to calculate carbon stock changes in land converted to cropland. These values are weighted averages of biomass carbon stocks for every crop type under cropland, comprising a mix of annual, semi-perennial and perennial crops. The Party did not provide information on how those values were derived nor whether they are average values of carbon stocks across an entire year or for a shorter cultivation period, nor in the latter case whether the average value is

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		corrected for the months in which the land is not under crop to correctly calculate an average annual value. The TERT noted that the reporting is not in accordance with the 2006 IPCC Guidelines (vol. 4, chap. 5.2.1.1) because, for woody biomass in perennial cropland, it is good practice to estimate annual carbon stock gains and losses, including for years beyond the year of conversion, while this is not the case for annual biomass, for which annual gains and losses in biomass carbon stocks are assumed to be in equilibrium after the year of conversion. During the review, the Party explained that the method followed is consistent with the guidance provided in the 2006 IPCC Guidelines (vol. 4, chap. 5.2.1.1) because at the end of the crop cycle the net change in biomass carbon is considered zero, as all accumulated carbon is assumed to be released at harvest. Consequently, measuring biomass at harvest reflects the peak carbon accumulation during the cycle and can be used as a reasonable approximation for the average annual carbon stock, particularly when considered over successive cropping cycles where gains and losses tend to balance out. The Party also explained that by using nationally derived data and literature, and applying estimates based on biomass at harvest or maturity, the method provides a practical and technically sound basis for estimating carbon stocks in cropland. However, the TERT noted that the justification provided by the Party relates to annual biomass only, while values in the NID (tables 7.11 and 7.12) provide data on a mix of annual biomass and perennial biomass. Further, using peak biomass results in a biased assessment of the total net CO_2 removals across the cultivation period. The TERT recommends that the Party calculate carbon stocks and carbon stock changes for annual crops, semi-perennial crops and perennial crops separately and use them to estimate biomass carbon stock gains and losses in land converted to cropland, cropland converted to another land category and cropland remaining cropland, applying the relevant IPCC methodological guidance.
6.L.24	Specified in paragraph 21 of the MPGs 4.E.2 Land converted to settlements, 4.A.2.4 Settlements converted to forest land, 4.C.2.4 Settlements converted to grassland and 4.D.2 Land converted to wetlands – SOM – CO_2	The Party reported in its NID (table A.VII.16) that carbon stocks in settlements are considered to be zero. However, the Party did not provide evidence to support the assumption in the NID. The TERT noted that areas in settlements where the soil has not been completely excavated contain SOC stocks. The TERT also noted that the reporting is not in accordance with the 2006 IPCC Guidelines (vol. 4, chap. 8.2.3) because in settlements SOM may be a source or a sink of CO_2 depending on previous land use, soil burial or collection during development, and current management. During the review, Brazil confirmed that any transition from other land-use categories (with a stock change factor for land use greater than zero) to settlements leads to a loss of the entire SOC, as the carbon stock is reduced to zero in the new land-use category. The TERT recommends that the Party recalculate the stock changes in SOC in mineral soils on land converted to settlements and settlements converted to other land-use categories using the default method in the 2006 IPCC Guidelines (vol. 4, chap. 8.2.3.1) or a country-specific method considering SOC stocks present in settlements, as appropriate.

Table 7
Areas of improvement of the reporting on greenhouse gas emissions and removals – waste sector

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
7.W.1	Specified in paragraphs 21, 39 and 47 of the MPGs 5. General (waste) – CH_4	Brazil reported in its NID (table 8.2) that data from national sanitation surveys were used to estimate the distribution of disposal practices for collected MSW, including dumps, controlled landfills, sanitary landfills and composting. However, waste burial, referred to elsewhere in the NID (p.398), is not included among the disposal methods presented in the table and emissions from waste burial are not included in the inventory. The TERT noted that the exclusion of burial from waste disposal fractions, despite it being mentioned as a known practice in the country, may affect the accuracy of the reported waste allocation. As the fractions are normalized to add up to 1.0, the omission of burial may lead to an overestimation of the shares of the disposal practices included in the estimation of emissions. In addition, if burial remains relevant in certain regions or time periods, its exclusion may lead to an

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		underestimation of total CH_4 emissions from solid waste disposal on land under category 5.A.1 managed waste disposal sites. During the review, Brazil clarified that the disposal fractions presented in the NID (table 8.2) refer only to waste collected through formal municipal services. For the population not served by waste collection, disposal practices such as open burning and burial are considered separately using data from census and household surveys. While emissions from open burning are estimated under category 5.C.2 open burning of waste, emissions from burial are not estimated owing to lack of sufficient data. Brazil noted that the prevalence of waste burial is low and decreasing over time in the country. The TERT noted that, even if emissions are not estimated, excluding burial from the disposal fractions may lead to an incorrect estimation of the waste disposal fractions presented, thus affecting the accuracy of the estimates of emissions from waste disposal. The TERT recommends that Brazil account for the emissions from waste burial in the emission estimates for the waste sector (e.g. by monitoring and collecting AD on waste burial). The TERT recommends that Brazil clearly state in the NID that waste burial is not included in the disposal fractions presented and describe how this practice is addressed in the inventory, including its measures for ensuring the accuracy of waste allocation.
7.W.2	Specified in paragraphs 38–40 of the MPGs 5. General (waste) – CH_4 and N_2O	Brazil reported in its NID that the AD used for categories 5.A solid waste disposal on land and 5.B biological treatment of solid waste are based on waste generation rates and the proportion of the population covered by each waste management system. The Party did not specify whether the AD used for categories 5.A and 5.B were compiled on a wet or dry weight basis or provide information on the moisture content or conversion factors used to derive the dry weight values reported in the CRTs for the amount of waste. During the review, Brazil explained that the waste generation data used in the inventory were reported on a wet weight basis, as obtained from the National System of Information on Basic Sanitation. Emissions were estimated using default values for DOC expressed as a percentage of wet waste presented in the 2006 IPCC Guidelines (vol. 5, chap. 2, table 2.4). Consequently, the AD submitted in the CRTs were also reported on a wet weight basis. Brazil indicated that, for future BTRs, the methodology will be updated to use default values from the 2006 IPCC Guidelines for dry matter content, enabling consistent reporting and estimation of emissions on a dry weight basis. The TERT recommends that Brazil transparently document the methodology applied for estimating emissions for categories 5.A and 5.B in the NID, clarifying whether the AD on waste generation used were originally compiled on a wet weight basis, and describe the moisture content or conversion factors used to derive dry weight values. The TERT also recommends that the Party report the AD on waste generation in CRTs 5.A and 5.C on a dry weight basis.
7.W.3	Specified in paragraph 39 of the MPGs 5. General (waste) – CH_4	Brazil reported in its NID that clinical waste generation was estimated by assuming it is proportional to the population served by the municipal waste collection services, using the total municipal population as the generating population. This approach was applied for estimating clinical waste generation annually at the state level for 1990–2022. The TERT noted that the Party did not provide a transparent explanation of the rationale or data sources supporting the use of total municipal population as a proxy for clinical waste generation. During the review, Brazil explained that, owing to direct data on the population generating clinical waste not being collected in the National Basic Sanitation Survey, clinical waste generation was estimated on the basis of the ratio of the population served by waste collection. Per capita clinical waste generation rates were derived from data from the National Survey of Basic Sanitation or estimated using interpolation or fixed-year assumptions. These rates were then used to estimate the annual mass of clinical waste collected per state. The TERT recommends that Brazil clearly explain the basis for using the municipal population as a proxy for clinical waste generation, including any supporting data, literature or expert judgment.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
7.W.4	Specified in paragraphs 21 and 39 of the MPGs 5.A Solid waste disposal on land – CH_4	Brazil reported in its NID that it applied the first-order decay method for estimating CH_4 emissions from disposal of MSW, clinical waste and sludge under category 5.A solid waste disposal on land. The time series of AD on MSW begins from 1970. For clinical waste and sludge originating from domestic wastewater treatment, annual estimates of generation and disposal are reported for 1990–2022 and based on state-level data. The TERT noted that, as per the 2006 IPCC Guidelines (vol. 5, chap. 3.2.1.1), estimating emissions from SWDS using the first-order decay method requires historical data on the quantities and types of waste deposited for at least 50 years from the latest reporting year (i.e. equivalent to three to five half-lives of the degradable waste fractions) to properly account for the time-distributed generation of CH_4. If a shorter historical period is used, the inventory compiler should demonstrate that this does not result in a significant underestimation of emissions. The TERT noted that none of the time series of data reported for MSW, clinical waste or sludge fully meets this requirement, which may affect the accuracy of the CH_4 emission estimates, particularly in the initial years. During the review, Brazil explained that the time series of AD on MSW starts from 1970 to reflect national waste management conditions, and the decay parameters applied were selected to capture the dynamics associated with degradation over time. The Party also explained that, for clinical waste and sludge, the systematization of robust national databases is still in the early stages, and historical data for prior to 1990 are unavailable. Despite these limitations, efforts to improve the MSW time series have been prioritized given that this waste type accounts for the largest share of CH_4 emissions from solid waste disposal on land. The TERT recommends that Brazil, when applying the first-order decay method for estimating and reporting CH_4 emissions for category 5.A, use a historical time series of AD for clinical waste and sludge extending at least 50 years from the latest reporting year (i.e. equivalent to three to five half-lives of the degradable waste fractions) as per the 2006 IPCC Guidelines, including by using the relevant splicing techniques provided in the 2006 IPCC Guidelines (vol. 1, chap. 5.3.3) where national data are unavailable. If shorter time frames are maintained, the TERT recommends that the Party demonstrate in the NID that this approach does not result in a significant underestimation of emissions.
7.W.5	Specified in paragraphs 21 and 39 of the MPGs 5.A Solid waste disposal on land – CH_4	Brazil reported in its NID (p.378) that, owing to lack of official national data, per capita MSW generation was estimated using a proxy approach involving dividing the amount of waste collected by the number of people in the urban population served by waste collection services. The data sources for the population include the Demographic Census, public cleaning and waste removal surveys and the National System of Information on Basic Sanitation for 2003–2024. The TERT noted that, while this proxy approach enables the estimation of emissions in the absence of direct data on MSW generation, it may also lead to an underestimation of emissions if the amount of waste collected does not reflect the total MSW generated. In addition, as the calculation is based only on the urban population, applying the same per capita generation rate to non-urban populations could introduce bias unless adjusted accordingly. The TERT also noted that the Party did not clearly specify whether commercial solid waste was included in the MSW estimates. These aspects could affect the representativeness and completeness of the AD used for estimating CH_4 emissions from MSW disposal. During the review, Brazil confirmed that whether commercial solid waste was taken into account in these estimates is not specified in the NID, but this aspect will be evaluated for possible refinement in future inventory cycles. The Party also confirmed that the per capita generation rate was applied only to the urban population served by waste collection services and not extrapolated to non-urban areas. The TERT recommends that Brazil explain the representativeness of the amount of collected waste as a proxy for total MSW generation, including the treatment of non-urban populations and whether commercial waste is included in the estimates, and assess the implications of using this approach for the accuracy of the associated estimates of CH_4 emissions.
7.W.6	Specified in paragraphs 21 and 39 of the MPGs	Brazil reported in its NID that estimates of CH_4 recovered from landfill gas flaring were based on monitoring reports from CDM projects. The Party identified 51

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
	5.A Solid waste disposal on land – CH_4	projects as active between 2003 and 2022, with 37 providing CH_4 recovery values that were incorporated into the inventory. The Party did not clarify whether all CH_4 recovery systems included in the inventory are limited to projects registered for the CDM or whether additional biogas capture systems exist outside the CDM framework. If recovery systems outside the CDM framework exist and are not included, an incomplete estimation of CH_4 recovery would result. In addition, the Party did not clarify how flaring emissions were reported, particularly how such emissions were distinguished from those related to energy generation. During the review, Brazil explained that all CH_4 recovery systems included in the inventory correspond to projects registered for the CDM, as no information is available on other sites undertaking biogas capture. This choice to include only CDM-registered projects in the inventory was made to ensure the reliability of the estimates. Brazil also clarified that CO_2 emissions from biogas flaring were treated as biogenic and excluded from total GHG emissions, while CH_4 and N_2O emissions from flaring were not estimated owing to their expected low magnitude. To avoid double counting, CH_4 recovered for energy is reported under the energy sector and subtracted from gross CH_4 generation in the waste sector. The TERT recommends that Brazil estimate CH_4 emissions for category 5.A solid waste disposal on land accounting for all CH_4 recovered by CH_4 recovery systems, including systems not covered by projects registered for the CDM. The TERT recommends that the Party transparently report the amounts of CH_4 recovered and flared.
7.W.7	Specified in paragraphs 21, 39 and 47 of the MPGs 5.A Solid waste disposal on land – CH_4	Brazil reported in its NID that estimates of CH_4 emissions under category 5.A solid waste disposal on land include MSW, clinical waste and sludge from domestic wastewater treatment. However, the TERT noted that the Party did not address the disposal of other types of industrial solid waste, nor did it specify whether such waste streams are managed in facilities covered by the inventory or whether associated CH_4 emissions were estimated. During the review, Brazil explained that emissions from other types of industrial solid waste are not estimated owing to lack of systematized and up-to-date national data on their generation and disposal. Information is not available from a single data source and there are no dedicated data collection tools. Brazil acknowledged the relevance of this emissions source and indicated that institutional efforts are under way to address this gap, including the establishment of the Technical Group on the National Inventory of Greenhouse Gas Emissions and Removals under the Interministerial Committee on Climate Change. The TERT recommends that Brazil provide transparent information in the NID clarifying whether industrial solid waste is disposed of in facilities already covered by the inventory and whether the associated CH_4 emissions are estimated, and collect data on the generation and disposal of industrial solid waste in order to estimate CH_4 emissions from disposal of industrial solid waste.
7.W.8	Specified in paragraphs 21, 39 and 47 of the MPGs 5.A Solid waste disposal on land – CH_4	Brazil reported in its NID that it estimated CH_4 emissions from disposal of MSW, clinical waste and sludge from domestic wastewater treatment under category 5.A solid waste disposal on land using the first-order decay method. The Party classified SWDS into “managed landfills” (anaerobic landfills) and “uncategorized sites”. In the inventory, uncategorized sites are controlled landfills and open dumps that could not be assigned to specific categories in the 2006 IPCC Guidelines owing to insufficient technical information on their structural and operational characteristics. An MCF of 1.0 is applied for managed landfills and a value of 0.6 is applied for uncategorized sites. The TERT noted that, according to a reference cited in the NID from Brazil’s third (2015) national GHG inventory (p.26), the classification approach used in the previous inventory was based on urban population size, with categories defined as “managed anaerobic”, “unmanaged deep” and “unmanaged shallow”. This classification approach was subsequently changed to the current approach. The Party did not clearly explain the criteria used to distinguish different types of SWDS, such as applicable legal or technical definitions, nor did it provide detailed information on how the classification and distribution of these SWDS evolved over the time series for each type of waste, including the rationale for the change in the methodology for estimating emissions, nor the potential impact of this change on emission trends across the time series.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		During the review, Brazil explained that the classification of SWDS was based on the availability of technical information for each site. Controlled landfills and dumpsites were grouped under "uncategorized sites" owing to lack of data necessary for assigning them to specific categories in the 2006 IPCC Guidelines. For clinical waste and sludge, in the absence of specific national data on SWDS characteristics, the current classification applied for MSW was extended to them. Although Brazil has national legal and technical regulations for solid waste management, such as the National Solid Waste Policy, these instruments do not provide sufficient technical detail for classifying these SWDS consistently with the definitions in the 2006 IPCC Guidelines. As a result, the system for classifying SWDS primarily uses the type of disposal unit declared by municipalities in national information systems, which replaced the previous classification approach based on population size. This change was intended to reflect the information that is available through standardized and systematically collected administrative sources. Brazil acknowledged the need for improved data collection to support a more accurate classification of SWDS that is consistent with the definitions in the 2006 IPCC Guidelines and indicated plans for advancing this work in future inventory cycles. The TERT recommends that Brazil transparently characterize the types of SWDS used for MSW, clinical waste, sludge and other relevant waste types and justify the application of MCFs over the time series, including by clearly documenting the basis for site classification, ensuring consistency with the categories in the 2006 IPCC Guidelines, providing complete coverage of SWDS distribution across the time series, explaining any changes in the site classification approach compared with the previous inventory and clarifying its impact on emission trends across the time series.
7.W.9	Specified in paragraphs 26 and 39 of the MPGs 5.A Solid waste disposal on land – CH_4	Brazil reported in its NID that different sources of AD were used throughout the time series for solid waste disposal on land. The Party outlined the methodological approaches applied for estimating emissions by gas and provided references for each AD source used. It also described the techniques employed for addressing data gaps and supplementing missing information. The TERT noted that, while these techniques are helpful in addressing incomplete data, the use of varying AD sources over time can affect time-series consistency. Brazil did not clearly describe how it ensured time-series consistency. During the review, Brazil explained that, to ensure consistency across the time series, adjustments and harmonization techniques were applied to the methodology for estimating emissions. These include using a consistent modelling approach based on the first-order decay method, using harmonized parameters such as region-specific decay rates (CH_4 generation rate values) and waste composition, and systematically using statistical methods, such as quadratic regression and linear interpolation, for filling data gaps and ensuring smooth transitions between data sources. Brazil highlighted that official data sources (e.g. the Brazilian Institute of Geography and Statistics) are subject to strict statistical QC procedures. Once inventory databases are consolidated, any discrepancies identified are evaluated on the basis of their impact on the time series. In such cases, the value from the official source is retained and the discrepancy is documented in the inventory database. Brazil acknowledged that the formal assessment of statistical time-series consistency needs to be improved and has included this in the inventory improvement plan for future BTRs. The TERT recommends that Brazil transparently explain how consistency is maintained when multiple AD sources are used for estimating CH_4 emissions from SWDS, including any adjustments or harmonization techniques applied.
7.W.10	Specified in paragraphs 39–40 of the MPGs 5.A Solid waste disposal on land – CH_4	Brazil reported in its NID (dataframe 2.1) that a country-specific EF and country-specific AD were used to estimate CH_4 emissions for category 5.A solid waste disposal on land in the tier 2 method used. However, the TERT noted that key parameters used for estimating emissions (fraction of DOC in waste, fraction of DOC that decomposes, fraction of CH_4 in landfill gas, MCF, CH_4 generation rate and oxidation factor) were default values from the 2006 IPCC Guidelines (vol. 5, chap. 2), rather than being country-specific. During the review, Brazil explained that DOC was estimated using country-specific waste composition data from gravimetric analyses across Brazilian states, combined with default DOC values (percentage of wet waste) provided in the 2006 IPCC

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		Guidelines (vol. 5, chap. 3, equation 3.7). The TERT noted that this estimation is consistent with a tier 2 method as per the decision tree for CH_4 emissions from SWDS in the 2006 IPCC Guidelines (vol. 5, chap. 3.2.1, figure 3.1), as it applies the IPCC first-order decay method with default parameters and country-specific AD. The TERT recommends that Brazil report transparent information in the NID on the tier 2 method used for estimating CH_4 emissions for category 5.A, correctly specifying the parameters used as default values from the 2006 IPCC Guidelines instead of country-specific ones.
7.W.11	Specified in paragraphs 21, 31, 39 and 47 of the MPGs 5.B.1 Composting – CH_4 and N_2O	Brazil reported estimates in CRT 5.B of CH_4 and N_2O emissions for subcategory 5.B.1.a composting of MSW, while reporting those for subcategory 5.B.1.b other composting as "NA". The TERT noted that it was not specified in the NID whether activities (e.g. composting of agricultural residues and industrial and green waste or other organic material) under subcategory 5.B.1.b occur in the country and those activities were not included in the inventory estimates. During the review, Brazil explained that only subcategory 5.B.1.a was included in the inventory owing to lack of official, systematized data on other types of composting activities. Brazil indicated that historical estimates of the composted organic fraction (1 per cent of food and garden and park waste) were based on national surveys. Brazil acknowledged that, given the lack of data confirming the non-occurrence of other composting types, emissions for subcategory 5.B.1.b should have been reported instead as "NE". The Party mentioned plans to coordinate with state regulatory agencies and industry associations to verify whether other composting practices occur in the country and to update the inventory accordingly for future submissions. The TERT recommends that Brazil collect AD for estimating CH_4 and N_2O emissions from activities under subcategory 5.B.1.b in addition to those under subcategory 5.B.1.a. The TERT also recommends that the Party explain in the NID whether such activities occur and how they are treated in or excluded from the inventory, and report the appropriate notation key ("NE") when emissions are not estimated owing to lack of data.
7.W.12	Specified in paragraphs 31 and 38–39 of the MPGs 5.B.2 Anaerobic digestion at biogas facilities – CH_4 and N_2O	Brazil reported in its NID that biogas flaring for energy generation is included in the national energy balance, and the associated CH_4 and N_2O emissions are allocated to the energy sector. However, the TERT noted that in CRT 5.B the amount of CH_4 used for energy recovery is reported as "NO". Additionally, biogas sources are not disaggregated in the national energy balance, making it difficult to identify whether the biogas originates from anaerobic digestion at biogas facilities (subcategory 5.B.2) or another source. During the review, Brazil explained that biogas combustion data reported in the national energy balance do not distinguish between sources, making it impossible to identify whether biogas originates from anaerobic digestion facilities. Brazil clarified that CH_4 emissions from anaerobic digestion of MSW were reported as "IE" and N_2O emissions as "NO" in the CRTs for the entire time series. For energy recovery, "NO" was reported across the time series, which the TERT noted may not be appropriate because the reporting of biogas combustion in the energy balance implies that energy recovery is occurring. The TERT recommends that Brazil transparently report the methodological choices and assumptions applied in estimating and reporting CH_4 and N_2O emissions for category 5.B.2 across the time series, including in relation to the treatment of CH_4 for energy recovery, and report the appropriate notation keys in CRT 5.B consistently with the MPGs.
7.W.13	Specified in paragraphs 26, 28 and 39 of the MPGs 5.C Incineration and open burning of waste – CO_2, CH_4 and N_2O	The estimated GHG emissions reported by Brazil for category 5.C incineration and open burning of waste decreased by approximately 40 per cent, from 2,192.89 kt CO_2 eq in 2015 to 1,272.29 kt CO_2 eq in 2016. The TERT noted that the NID does not explain the national circumstances or methodological factors that may have contributed to this change. During the review, Brazil attributed the decrease in estimated emissions for category 5.C in 2015–2016 to a reduction in the fossil carbon content of incinerated waste, particularly plastics, due to improved recycling practices.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		The TERT recommends that Brazil include in the NID transparent information on national circumstances or methodological changes to explain annual changes in GHG emissions across the time series, particularly for category 5.C in 2015–2016. If there is a lack of consistency in the methods, EFs and AD used across the time series, the TERT also recommends that Brazil recalculate emissions in accordance with the 2006 IPCC Guidelines with a view to ensuring the time-series consistency of the estimates of emissions reported for category 5.C.
7.W.14	Specified in paragraphs 21, 39 and 47 of the MPGs 5.C.1 Waste incineration – CO_2, CH_4 and N_2O	Brazil indicated in its NID that, for estimating emissions for category 5.C.1 waste incineration, all parameters and EFs used for estimating the clinical waste fraction are default values from the 2006 IPCC Guidelines (vol. 5, chap. 5). The Party did not indicate whether other waste types (e.g. industrial waste, animal cremation or human cremation) are incinerated in the country and, if so, whether the associated emissions are included in the inventory. During the review, Brazil explained that, as a developing country, it faces limitations in systematizing data to account for all possible types of waste incineration activities, with the exception of clinical waste. Currently, there are no robust national databases covering the incineration of industrial waste or human and animal cremation, but efforts are under way to improve data collection and explore the possibility of including additional incineration sources for future BTRs. As part of these efforts, the Technical Group on the National Inventory of Greenhouse Gas Emissions and Removals was established under the Interministerial Committee on Climate Change for addressing gaps identified in the BTR1. The Group includes representatives of the Government of Brazil, academia and the private sector and aims to strengthen data systematization and implementation arrangements for future inventory submissions. The TERT recommends that Brazil collect AD for estimating emissions from incineration activities involving other waste types (e.g. industrial waste, animal cremation and human cremation) in addition to clinical waste. The TERT also recommends that Brazil explain in the NID whether such activities occur and how they are treated in the inventory, reporting "NE" in CRT 5.C when emissions are not estimated owing to lack of data.
7.W.15	Specified in paragraphs 21 and 39 of the MPGs 5.D Wastewater treatment and discharge – CH_4	Brazil reported in its NID (p.404) that, owing to lack of data on the share of industrial wastewater discharged into domestic wastewater collection systems, the default correction factor for additional industrial BOD discharged into sewers was set to 1.0, as recommended in the 2006 IPCC Guidelines (vol. 5, chap. 6). This factor is used to account for additional BOD loads from industrial effluents when estimating CH_4 emissions from domestic wastewater treatment. The TERT noted that, according to the 2006 IPCC Guidelines (vol. 5, chap. 6.2.2.3), a default value of 1.25 should be applied where industrial wastewater is co-discharged into domestic wastewater collection systems and 1.0 should be applied in all other cases. While the use of 1.0 is appropriate in the absence of data, if co-discharge occurs its application may lead to an underestimation of emissions. During the review, Brazil explained that the discharge of industrial effluents into domestic wastewater collection systems is strictly regulated, with regulations setting limits on effluent quality and treatment requirements. Industrial wastewater must be pre-treated before entering domestic wastewater collection systems, and emissions from its treatment are reported under subcategory 5.D.2 industrial wastewater. However, Brazil acknowledged that unauthorized co-discharge may occur in practice and that its traceability remains limited. As a result, the estimation of emissions from domestic wastewater assumes no co-discharge of industrial effluents. The TERT recommends that Brazil collect information on the extent of industrial wastewater co-discharged into domestic systems in order to assess the appropriateness of the use of the default correction factor of 1.0 for additional industrial BOD discharged into sewers, or use an appropriate country-specific or default value if co-discharge of industrial effluents into domestic wastewater collection systems occurs.
7.W.16	Specified in paragraph 39 of the MPGs	Brazil reported in its NID (p.405) that, based on expert judgment from the NC3, anaerobic reactors used in both domestic and industrial wastewater treatment systems include burners for biogas combustion, resulting in partial CH_4 destruction.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
	5.D Wastewater treatment and discharge – CH_4	A destruction efficiency of 50 per cent was assumed and the amount of CH_4 recovered was estimated accordingly. The Party did not specify whether any portion of the recovered CH_4 is used for energy purposes or how emissions from flaring, combustion or potential leakage were allocated between the waste and energy sectors. According to the 2006 IPCC Guidelines (vol. 5, chap. 6.2.2.3), if CH_4 is recovered and used or flared it must be deducted from the emissions estimated in the waste sector to avoid overestimation. During the review, Brazil explained that CH_4 recovery from anaerobic reactors is reported under category 5.D wastewater treatment and discharge, while emissions from its combustion are accounted for in the energy sector under category 1.A fuel combustion. However, the national energy balance provides only aggregated biogas data without disaggregation by source or facility, preventing the identification of biogas originating from wastewater treatment. Brazil explained that biogas represents less than 1 per cent of total national natural gas consumption, which limits the availability of a detailed breakdown. In addition, there is no capacity for systematically quantifying recovered CH_4 or emissions from flaring or leakage at the national level. As a result, on the basis of corporate GHG inventories, only the amount of recovered CH_4 is reported in category 5.D. Assuming a 50 per cent CH_4 destruction efficiency, the amount of CH_4 recovered in anaerobic wastewater treatment is estimated and deducted from total emissions for category 5.D. CH_4 and N_2O emissions from combustion are not included in the waste sector and no leakage or flaring emissions are reported. The TERT recommends that Brazil explain in the NID how recovered CH_4 from anaerobic wastewater treatment is treated in the inventory, particularly whether any portion is used for energy purposes, and how associated emissions from combustion, flaring or leakage (if occurring) are allocated between the waste and energy sectors.
7.W.17	Specified in paragraphs 25 and 39 of the MPGs 5.D Wastewater treatment and discharge – CH_4	Brazil identified CH_4 emissions for category 5.D wastewater treatment and discharge as a key category but did not indicate in the NID whether it conducted an assessment to determine whether domestic or industrial wastewater constitutes a significant subcategory under category 5.D to support the appropriate selection of methodological tiers and thus improve the accuracy of estimates consistently with the methodological tier selection approach outlined in the 2006 IPCC Guidelines (vol. 1, chap. 4, table 4.1). During the review, Brazil explained that a subcategory-level significance assessment was not performed, while noting that domestic wastewater accounts for over 80 per cent of the emissions for category 5.D. Brazil indicated that it will conduct a significance analysis of subcategories for future GHG inventory submissions to support its selection of methodological tiers. The TERT recommends that, when category 5.D is identified as a key category, the Party perform a significance assessment of its subcategories (domestic and industrial wastewater) to support the selection of appropriate methodological tiers. The TERT also recommends that Brazil explain in the NID whether such an assessment was performed.
7.W.18	Specified in paragraph 39 of the MPGs 5.D Wastewater treatment and discharge – CH_4	Brazil reported in the NID that a country-specific EF was used to estimate CH_4 emissions for category 5.D wastewater treatment and discharge. However, the Party explained in the NID (p.386) that the estimation was based on default values for maximum CH_4-producing capacity and the MCF provided in the 2006 IPCC Guidelines (vol. 5, chap. 6.2.2.2), combined with country-specific AD. The Party did not specify whether the country-specific EF was developed using national input parameters, or whether only country-specific AD or partially adjusted parameters were used. During the review, Brazil clarified that the value for the maximum CH_4-producing capacity was the default value (0.6) provided in the 2006 IPCC Guidelines (vol. 5, chap. 6, table 6.2), while the classification of the country-specific EF used was based on the derivation of a weighted average MCF using national data from the National Basic Sanitation Survey, which characterizes the types of wastewater treatment systems used in each state for each observation year (1989, 2000, 2008 and 2017), and using linear interpolation to estimate annual values. The MCF for 2017 was applied for 2017–2022.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		The TERT recommends that Brazil explain in the NID whether all the parameters used to estimate CH_4 emissions for category 5.D are country-specific, and, if so, describe how they differ from the default values in the 2006 IPCC Guidelines. If only a few country-specific parameters (e.g. MCF) are used, Brazil should specify which parameters are country-specific and document the data sources and rationale for selecting them.

C. Information necessary to track progress in implementing and achieving the nationally determined contribution under Article 4 of the Paris Agreement

Table 8
Areas of improvement of the reporting on national circumstances and institutional arrangements

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
8.1	Specified in paragraph 59 of the MPGs	Brazil did not report in its BTR1 on the national circumstances relating to climate profile relevant to progress in implementing and achieving its NDC. During the review, the Party provided information on its climate profile. Brazil encompasses equatorial (semi-arid), tropical and subtropical climate zones, with the tropical and subtropical climates covering 81.4 and 13.7 per cent of the national territory respectively and the remaining 4.9 per cent of the territory having an equatorial climate. The TERT recommends that the Party report in its BTR on the national circumstances relating to climate profile relevant to progress in implementing and achieving its NDC.
8.2	Specified in paragraph 62 of the MPGs	Brazil did not report information on stakeholder engagement related to the implementation and achievement of its NDC. During the review, Brazil provided information on its national process for updating the National Plan on Climate Change, which is informed by robust scientific knowledge and broad intersectoral and government–society dialogue, with comprehensive participation by government agencies at different levels, the private sector, civil society and the scientific community. The TERT recommends that the Party provide information in its BTR on stakeholder engagement related to the implementation and achievement of its NDC.

Table 9
Areas of improvement of the description of the nationally determined contribution under Article 4 of the Paris Agreement, including updates

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
9.1	Specified in paragraph 64(a–c) of the MPGs	Brazil did not clarify whether its NDC targets for 2025 and 2030 are fixed-level targets. Brazil also did not report in its BTR1 whether its NDC targets are single- or multi-year targets. In addition, Brazil reported in its BTR1 a single time frame of implementation (2020–2030) for its NDC target years 2025 and 2030 and did not clarify whether this applies to the targets for both 2025 and 2030. During the review, Brazil explained that the targets for 2025 and 2030 are fixed on the basis of national GHG inventory data for the base year (2005). While the inventory estimates may be subject to recalculations for future submissions owing to methodological improvements, the targets will remain unchanged and will not be affected by potential future revisions of the base-year inventory data. The Party explained that its targets are single-year targets and that the NDC implementation period is 2020–2025 for the 2025 target and 2020–2030 for the 2030 target. The TERT recommends that the Party indicate in the BTR that its targets for 2025 and 2030 are fixed and not dependent on the base-year emission level in 2005 for tracking the achievement of the NDC in 2025 and 2030. The TERT also recommends that the Party clarify in its BTR that its NDC targets are single-year

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		targets and report in its BTR a time frame of implementation specifically for its 2025 NDC target.

Table 10

Areas of improvement of the reporting of the information necessary to track progress in implementing and achieving the nationally determined contribution under Article 4 of the Paris Agreement

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
10.1	Specified in paragraph 65 of the MPGs	Brazil described in CTF table 1 that, for measuring progress in implementing its NDC, it used an indicator that establishes the ratio of total net GHG emissions in 2025 and 2030 respectively to the total net GHG emissions reported for the base year (2005). However, the TERT noted that the values reported for 2020–2022 in CTF tables 4.3 and 4.4 are the percentage reduction in total net GHG emissions in those years compared with the 2005 level. During the review, Brazil clarified that the description of the indicator for measuring progress in implementing its NDC in CTF table 1 should explain that it represents the percentage change between total net GHG emissions in the base year and the target year. The TERT recommends that the Party correct the description of the indicator for tracking progress in implementing the NDC in CTF table 1, explaining that it represents the percentage change between total net GHG emissions in the base year and the target year.
10.2	Specified in paragraph 71 of the MPGs	In CTF table 3, Brazil reported on the accounting approach used for its NDC targets, including how it is consistent with Article 4, paragraphs 13–14, of the Paris Agreement. Brazil intends to use GHG inventory data to measure progress towards the achievement of its NDC. However, Brazil reported "NA" in four rows in CTF table 3 related to information on accounting for its first NDC and its consistency with decision 4/CMA.1. During the review, Brazil explained that, although the reporting of the four specific items in CTF table 3 is optional for its first NDC, it provided information related to this in its BTR1. The TERT encourages the Party to report information in CTF table 3 on how accounting for its first NDC is consistent with decision 4/CMA.1 or explain why it is not possible to do so.
10.3	Specified in paragraph 74(a) of the MPGs	In CTF table 3, Brazil did not report when the NDC target for 2025 will be accounted for in the description of the accounting approach for its NDC targets. During the review, Brazil explained that it will account for its 2025 target in its BTR3, which is expected to be submitted in 2028, along with the NIR, for which 2026 will be the latest reporting year. The TERT recommends that the Party report when the NDC target for 2025 will be accounted for in the description of the accounting approach for its NDC targets in CTF table 3.

Table 11

Areas of improvement of the reporting on mitigation policies and measures, actions and plans, including those with mitigation co-benefits resulting from adaptation actions and economic diversification plans, related to implementing and achieving the nationally determined contribution under Article 4 of the Paris Agreement

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
11.1	Specified in paragraph 83 of the MPGs	Brazil did not report in its BTR1 or CTF table 5 on costs of each action, policy and measure reported or how the mitigation actions interact with each other, as appropriate. During the review, Brazil explained that this information was not included in the BTR1 owing to lack of systematically available data on the costs and a structured national assessment of the interactions between mitigation actions.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		The TERT encourages Brazil to report in its BTR on costs of each action, policy and measure reported and how the mitigation actions interact with each other, as appropriate, or explain why it did not report this information.
11.2	Specified in paragraph 85 of the MPGs	Brazil did not report estimates of expected and achieved GHG emission reductions for any of its actions and PaMs in tabular format, except for achieved GHG emission reductions for Procel, the National Electricity Conservation Program. The Party applied the provided flexibility with respect to reporting this information.
		In the BTR1 and during the review, Brazil indicated the application of the flexibility, clarified its capacity constraints and provided estimated time frames for improvements in relation to those capacity constraints.
		The TERT encourages the Party to estimate, to the extent possible, expected and achieved GHG emission reductions for its actions and PaMs and report them in CTF table 5.
11.3	Specified in paragraph 86 of the MPGs	Brazil did not report a complete description of the methodologies and assumptions used to estimate the achieved GHG emission reductions for the mitigation action Procel.
		During the review, Brazil explained that the emission reductions for the mitigation action Procel were estimated using the average EF for the national electricity grid. The estimates are based on net energy savings and only CO_2 emissions were considered. It also explained that the observed annual variation in GHG emission reductions is due to changes in the hydrological regime, which affects the annual average EFs for the national electricity grid, given its significant reliance on hydroelectric power.
		The TERT recommends that the Party, to the extent available, provide a clear and complete description of the methodologies and assumptions used to estimate the expected and achieved GHG emission reductions or removals due to each action, policy and measure for which the Party has estimated expected or achieved GHG emission reductions.
11.4	Specified in paragraph 88 of the MPGs	Brazil did not identify its actions and PaMs that influence GHG emissions from international transport.
		During the review, Brazil explained that in the BTR1 it could not identify any actions or PaMs that directly influence GHG emissions from international transport and, as such, did not report this information.
		The TERT encourages the Party to identify its actions and PaMs that influence GHG emissions from international transport or explain why it has not done so (e.g. if the Party does not have any policy or action influencing GHG emissions from international transport).
11.5	Specified in paragraph 89 of the MPGs	Brazil did not provide information about how its actions and PaMs are modifying longer-term trends in GHG emissions and removals.
		During the review, Brazil explained that this information was not included in the BTR1 owing to the lack of a consolidated national assessment of the long-term effects of PaMs on GHG emission and removal trends.
		The TERT encourages the Party to provide, to the extent possible, information about how its actions and PaMs are modifying longer-term trends in GHG emissions and removals.
11.6	Specified in paragraph 90 of the MPGs	Brazil did not provide detailed information on the assessment of the economic and social impacts of its response measures.
		During the review, Brazil explained that this assessment was not included in the BTR1 owing to the lack of consolidated national information on the topic.
		The TERT encourages the Party to provide, to the extent possible, detailed information on the assessment of the economic and social impacts of its response measures.

Table 12
Areas of improvement of the summary of greenhouse gas emissions and removals

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
NA	NA	No areas of improvement identified

Table 13
Areas of improvement of the projections of greenhouse gas emissions and removals

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
13.1	Specified in paragraphs 6 and 92 of the MPGs	Brazil did not report projections pursuant to paragraphs 93–101 of the MPGs. The Party applied the provided flexibility with respect to reporting projections in accordance with paragraphs 92, 95 and 102 of the MPGs. The Party indicated in the BTR1 that it applied flexibility with respect to these paragraphs of the MPGs and provided its estimated time frame for improving its reporting. The Party explained in the BTR1 that, at the time of the approval of the BTR1, the Government of Brazil was in the process of analysing and validating the results of the GHG emission projections and the duly completed and validated projections will be submitted in the BTR2. However, the Party did not clarify its capacity constraints in relation to reporting projections. During the review, Brazil identified its lack of technical and institutional capacity to develop projections on the basis of modelling results. The Party explained that it lacked sufficient time to enable a comprehensive and inclusive approval process for the projections that would have required the involvement of multiple stakeholders to properly understand, analyse and validate the results before the BTR1 submission deadline. The TERT encourages the Party to report projections pursuant to paragraphs 93–101 of the MPGs. The TERT recommends that the Party concisely clarify its capacity constraints in relation to reporting projections when it does not report projections because it applies the relevant flexibility.

Table 14
Areas of improvement of other information relevant to tracking progress in implementing and achieving the nationally determined contribution under Article 4 of the Paris Agreement

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
NA	NA	No areas of improvement identified

II. Capacity-building needs[3] identified by the Party and by the technical expert review team in consultation with the Party during the technical expert review of its first biennial transparency report

2. Table 15 presents capacity-building needs identified by the Party and by the TERT in consultation with the Party during the technical expert review of its BTR1.

Table 15
Capacity-building needs identified in consultation with the Party

ID#	*Reporting requirement*	*Area in which capacity-building is needed*
General reporting		
1_CBN.1	Specified in paragraph 35 of the MPGs	Strengthening the QA/QC process in preparing the BTR and NID (medium priority)

[3] As referred to in paras. 7, 8 and 162(d) of the MPGs.

ID#	*Reporting requirement*	*Area in which capacity-building is needed*
1_CBN.2	Specified in paragraphs 31, 38, 47 and 79 of the MPGs	Improving understanding of how to use the tools for reporting under the ETF and enter data in the CRTs and CTF tables (medium priority)
NIR – energy		
3.E_CBN.1	Specified in paragraphs 36, 39 and 54 of the MPGs	Understanding the national parameters needed to convert physical units into energy units for fuel consumption and allocating fuels to relevant sectors (e.g. for the comparison of the reference and sectoral approaches) (medium priority)
3.E_CBN.2	Specified in paragraphs 31, 39–40 and 47 of the MPGs	Identifying sources of AD for estimating emissions for energy sector categories obtained from non-official sources (e.g. corporations) (medium priority)
NIR – industrial processes and product use		
4.I_CBN.1	Specified in paragraphs 39–40 of the MPGs	Estimating emissions of fluorinated gases for subcategory 2.F.1 refrigeration and air conditioning (high priority)
4.I_CBN.2[a]	Specified in paragraphs 31, 38 and 48 of the MPGs	Disaggregating AD for estimating nitrogen trifluoride emissions for subcategory 2.E.3 photovoltaics (high priority)
NIR – agriculture		
5.A_CBN.1	Specified in paragraphs 21 and 31 of the MPGs	Disaggregating sludge from SWDS applied to soils (low priority)
5.A_CBN.2	Specified in paragraph 47 of the MPGs	Collecting AD on compost applied to managed soils (low priority)
NIR – LULUCF		
6.L_CBN.1	Specified in paragraphs 18 and 21 of the MPGs	Completing and updating a consistent time series of annual land use and land-use change area data for land representation (medium priority)
6.L_CBN.2	Specified in paragraphs 21 and 27 of the MPGs	Using splicing techniques from the 2006 IPCC Guidelines for deriving an annual time series of AD for LULUCF categories from AD collected periodically (low priority)
NIR – waste		
7.W_CBN.1	Specified in paragraphs 39 and 47 of the MPGs	Systematizing databases on solid waste generation and treatment to enable accurate classification of SWDS across the time series (high priority)
7.W_CBN.2	Specified in paragraphs 26–28 and 39 of the MPGs	Enhancing the assessment of statistical time-series consistency (low priority)
Information necessary to track progress in implementing and achieving the NDC under Article 4 of the Paris Agreement		
11_CBN.1[a]	Specified in paragraph 85 of the MPGs	Establishing a sustainable system for estimating expected and achieved GHG emission reductions from PaMs to ensure their timely reporting under the ETF (high priority)
11_CBN.2	Specified in paragraphs 83 and 89–90 of the MPGs	Developing technical capacity, data collection systems, methodologies and institutional arrangements for gathering, assessing and reporting information on how mitigation actions interact with each other, costs of each action, policy and measure, how PaMs are modifying longer-term trends in GHG emissions and removals, and the assessment of economic and social impacts of response measures (high priority)

ID#	*Reporting requirement*	*Area in which capacity-building is needed*
13_CBN.1[a]	Specified in paragraph 92 of the MPGs	Establishing a sustainable system for developing GHG emission projections to ensure their timely reporting under the ETF (high priority)

[a] Capacity-building need identified by the TERT in consultation with the Party relating to the flexibilities applied by it as per the MPGs.

Annex

Documents and information used during the review

A. Reference documents

BTR1 of Brazil. Available at https://unfccc.int/first-biennial-transparency-reports.

BTR1 CTF tables of Brazil. Available at https://unfccc.int/first-biennial-transparency-reports.

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Fourth national communication of Brazil. Available at https://unfccc.int/documents/267657.

"Guidance for operationalizing the modalities, procedures and guidelines for the enhanced transparency framework referred to in Article 13 of the Paris Agreement". Decision 5/CMA.3. FCCC/PA/CMA/2021/10/Add.2. Available at https://unfccc.int/documents/460951.

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B. Additional information provided by the Party

Responses to questions during the review were received from Ricardo Vieira Araujo (Ministry of Science, Technology and Innovation of Brazil), including additional material. The following references were provided by Brazil and may not conform to UNFCCC editorial style as some have been reproduced as received:

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IBGE – Brazilian Institute of Geography and Statistics. 2025. *Tabela 289*. Available at https://sidra.ibge.gov.br/tabela/289

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Maia, S. M. F. *et al*. 2009. *Effect of grassland management on soil carbon sequestration in Rondonia and Mato Grosso states, Brazil*. Geoderma, v. 149, n. 1–2, p. 84–91. Available at https://www.sciencedirect.com/science/article/abs/pii/S0016706108003406

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Ministry of Science, Technology and Innovations (MCTI) - Secretariat for Research and Scientific Training. 2021. *Fourth National Communication of Brazil to the United Nations Framework Convention on Climate Change*. Available at https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/sirene/publicacoes/comunicacoes-nacionais-do-brasil-a-unfccc/arquivos/4comunicacao/4_nat_com_brazil_web.pdf

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