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

Addendum

Summary

This addendum to the report on the technical expert review of the first biennial transparency report of Singapore, 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. The review took place from 5 to 9 May 2025 in Singapore City.

* 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*
2019 Refinement to the 2006 IPCC Guidelines	*2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*
AD	activity data
BTR	biennial transparency report
C	confidential
C_3F_8	octafluoropropane
CDM	clean development mechanism
CF_4	tetrafluoromethane
CH_4	methane
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
CRT	common reporting table
CTF	common tabular format
EF	emission factor
ETF	enhanced transparency framework under the Paris Agreement
GHG	greenhouse gas
HFC	hydrofluorocarbon
IE	included elsewhere
IPCC	Intergovernmental Panel on Climate Change
IPPU	industrial processes and product use
ITMO	internationally transferred mitigation outcome
LULUCF	land use, land-use change and forestry
MCF	methane correction factor
MPGs	modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement
MRV	measurement, reporting and verification
N_2O	nitrous oxide
NA	not applicable
NDC	nationally determined contribution
NE	not estimated
NF_3	nitrogen trifluoride
NFI	national forest inventory
NID	national inventory document
NIR	national inventory report
NO	not occurring
QA/QC	quality assurance/quality control
SF_6	sulfur hexafluoride
TERT	technical expert review team
TIW	toxic and industrial waste
Wetlands Supplement	*2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*

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 Singapore 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*
1.1	Specified in paragraphs 104–117 of the MPGs	Singapore's BTR1 does not include a chapter on climate change impacts and adaptation as per the MPGs and chapter III of the BTR outline, contained in annex IV to decision 5/CMA.3. During the review, Singapore explained that its fifth national communication, submitted in 2022, also as its first adaptation communication, includes information in its chapter 4 on vulnerability and adaptation measures, and that its preference is to include information pertaining to climate change impacts and adaptation just as part of its national communication, rather than also in other reports, such as in its BTR. The TERT noted that Article 13, paragraph 8, of the Paris Agreement and paragraph 104 of the MPGs indicate that Parties should report information related to climate change impacts and adaptation in their BTR. Recognizing that this is a non-mandatory reporting requirement, the TERT encourages Singapore to report information on climate change impacts and adaptation in its BTR.

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(a–d) of the MPGs Institutional arrangements	Singapore described its national inventory arrangements in the NID (section 1.2), including for the preparation of the inventory, archiving of information and the official consideration and approval of the inventory. The TERT considered that there was insufficient detail in Singapore's reporting on the functions related to inventory planning, preparation and management for the TERT to fully understand Singapore's national inventory arrangements; in particular, the NID does not include: (a) Clear information on which agency has been designated as Singapore's national entity or national focal point with overall responsibility for the national inventory; (b) A sufficiently detailed description of its inventory preparation process, specifying which agencies are members of the inter-agency working group that prepared the BTR, and the agencies involved in inventory preparation and what their roles are, including how, as part of the inventory preparation and management processes, decisions are made regarding choice of methods and changes to EFs for each sector; (c) Details on whether the archiving system includes the archiving of QA/QC documentation, NIR review results and planned inventory improvements; (d) Clear information on the entity responsible for submitting the approved inventory to the UNFCCC as part of the processes for official consideration and approval of the inventory.

[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*
		During the review, Singapore provided more detail on the national inventory arrangements. As the national focal point to the UNFCCC, the National Climate Change Secretariat is responsible for submitting the NIR. The National Environment Agency compiles the NIR under the supervision of the MRV Task Force, co-chaired by the National Climate Change Secretariat and the Ministry for Sustainability and the Environment. The MRV Task Force is also responsible for seeking approval of the inventory from the Executive Committee and the Chair of the Inter-Ministerial Committee on Climate Change, and the Cabinet before submitting the NIR to the UNFCCC. This information will be included in future NIDs. Singapore also provided during the review more information on the inventory preparation process, including on the members and role of the inter-agency working group, clarifying that its members are primarily the agencies listed in NID table 6. The MRV Task Force, co-chaired by the National Climate Change Secretariat and the Ministry for Sustainability and the Environment, comprises other ministries under the Inter-Ministerial Committee on Climate Change such as the Ministries of Foreign Affairs, Transport, National Development, and Trade and Industry. The Ministries generally oversee the agencies listed in NID table 6, which provide data and information for the GHG inventory. Singapore clarified that the MRV Task Force is responsible for making decisions, based on information provided at the sector level, on choice of estimation methods and changes to EFs. Further, Singapore clarified during the review that the archiving system includes the archiving of QA/QC documentation, NIR review results and planned inventory improvements. The TERT recommends that Singapore include in the NID more detailed information on (1) the national inventory arrangements, including on which agency has been designated as Singapore's national entity or national focal point responsible for the inventory; (2) the inventory preparation and management process, including on how decisions are made regarding choice of estimation methods and changes to EFs for each sector; and (3) the entity responsible for submitting the approved inventory to the UNFCCC as part of the official consideration and approval of the inventory. The TERT also recommends that Singapore report in the NID, in addition to the information on the data management functions covered in the NID (section 1.2.3), that the archiving system includes archiving of QA/QC documentation, review results and planned inventory improvements.
2.G.2	Specified in paragraph 20 of the MPGs NID	The NID (section 1.3) states that Singapore estimated emissions using the 2006 IPCC Guidelines and the Wetlands Supplement. In the NID (section 1.6) Singapore reported that it used the 2019 Refinement to the 2006 IPCC Guidelines in developing its uncertainty analysis, but there is no mention thereof in the overview presented in the NID (section 1.3) on methodologies and data sources used. During the review, Singapore noted the finding of the TERT. The TERT recommends that Singapore, to increase transparency, mention that the 2019 Refinement to the 2006 IPCC Guidelines is among the methodological guidance that it uses in developing its quantitative uncertainty analysis.
2.G.3	Specified in paragraph 29 of the MPGs Uncertainty analysis	Singapore reported in its NID (section 1.6 and annex II) on the uncertainty of the emission and removal estimates for all source and sink categories, level and trend assessment, for both the starting year and the latest reporting year of the inventory time series, using approach 1 (and approach 2 for category 2.F and its subcategories). The NID mentions that the quantitative uncertainty analysis is used to prioritize national efforts to reduce inventory uncertainties and guide decisions on methodological choice. However, reporting more detailed information on how the quantitative uncertainty analysis is used to prioritize national efforts could increase transparency. During the review, Singapore informed the TERT that, on the basis of both the quantitative uncertainty analysis and the key category analysis, it is undertaking efforts to develop country-specific EFs for the energy sector to reduce inventory uncertainties as the energy sector contributes the majority of the country's emissions. The TERT suggests that, to provide more transparency, Singapore include in its BTR or NID examples of how the uncertainty analysis is used to prioritize national

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		efforts to reduce inventory uncertainties and guide decisions on methodological choice.
2.G.4	Specified in paragraphs 30–31 of the MPGs Notation keys	Singapore reported estimates of emissions or removals for all categories for which methods are included in the 2006 IPCC Guidelines and used notation keys in completing the CRTs for categories and subcategories of gases that are not reported. In some cases notation keys were not used consistently with the MPGs. For example, "NO" was used in some instances where "NA" would be more appropriate (e.g. for CO_2, CH_4 and N_2O emissions for subcategory 1.A.3.c railways) and "0.00" was reported where a notation key should have been used (e.g. for CO_2 emissions for subcategory 4.D.1 wetlands remaining wetlands). During the review, Singapore acknowledged the findings of the TERT on the inappropriate use of notation keys and confirmed that it will correct its use of notation keys for the next BTR and NID. The sector-specific recommendations of the TERT concerning use of notation keys are provided in the tables below.
2.G.5	Specified in paragraphs 31 and 47 of the MPGs CRTs	Singapore reported emissions and removals for all categories, gases and carbon pools considered in the GHG inventory for the whole time series on a gas-by-gas basis in units of mass at the most disaggregated level with emissions by sources listed separately from removals by sinks, using the CRTs, including a descriptive summary and figures illustrating underlying emission trends. The TERT noted that Singapore needed to apply a minimum level of aggregation to protect confidential information, particularly in the energy, IPPU and agriculture sectors, and that it used "IE" to indicate that emissions for some of the categories were aggregated and reported under another category. However, Singapore did not also use "C" to indicate that reporting those emissions would involve the disclosure of confidential information. During the review, Singapore indicated that, to improve transparency, it will consider reporting, in the next BTR, "C" in conjunction with "IE" for categories whose emissions are reported under another category to preserve confidential information. The TERT notes that using "C" in conjunction with "IE" would increase the transparency of the reporting in cases where reporting would involve the disclosure of confidential information. The sector-specific recommendations of the TERT concerning use of "C" in conjunction with "IE" are provided in the tables below.
2.G.6	Specified in paragraph 32 of the MPGs Other	Singapore reported in its NID (e.g. section 1.7) that it used "NE" to indicate categories for which AD and emissions have not been estimated, including some instances where emissions were considered insignificant. However, for category 3.I other carbon-containing fertilizers in the agriculture sector (see ID# 5.A.3), the Party reported that emissions were likely to be insignificant, but Singapore did not provide a quantitative estimate of the insignificant emissions to show that they are either below 0.05 per cent of the national GHG emissions, excluding LULUCF, or 500 kt CO_2 eq, whichever is lower. The lack of numerical estimates for all categories considered insignificant renders it impossible to check whether the total national aggregate of estimated emissions for all gases for categories considered insignificant is below 0.1 per cent of the national total GHG emissions, excluding LULUCF. During the review, Singapore indicated that it will provide numerical estimates of emissions for categories considered insignificant in the next BTR or NID to justify reporting them as "NE". The Party also explained that it sometimes referred to emissions as insignificant in the NID but not in accordance with the definition in paragraph 32 of the MPGs. In the case of category 3.I, the Party explained that it had intended to provide a qualitative indication of the magnitude of the estimation gap and did not intend to imply that emissions were in fact insignificant as per paragraph 32 of the MPGs. Singapore indicated that it will amend the text of future NIDs to avoid confusion. The TERT recommends that Singapore, in its NID, refer to emissions as insignificant only in accordance with the definition in paragraph 32 of the MPGs and demonstrate that the total national aggregate of estimated emissions for all gases for categories considered insignificant is below 0.1 per cent of the national total GHG emissions, excluding LULUCF.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
2.G.7	Specified in paragraphs 34–35 of the MPGs QA/QC and verification	Singapore provided a brief general description of its QA/QC plan and its implementation in the NID (section 1.5), but the description is insufficient for the TERT to understand the extent to which the QA/QC plan is in accordance with the 2006 IPCC Guidelines, in particular the extent to which the plan includes the general inventory QC procedures set out in the 2006 IPCC Guidelines (vol. 1, chap. 6, table 6.1) as well as the extent to which Singapore applies category-specific QC procedures in accordance with the 2006 IPCC Guidelines for key categories and for individual categories for which significant methodological changes and/or data revisions have occurred. During the review, Singapore clarified that the aforementioned QC procedures set out in the 2006 IPCC Guidelines are included as part of the QC checklists for various subcategories under the purview of the relevant data owners at the agency level. The process involves the QC checklists being endorsed by the agency management and then sent to the inventory compiler for archival. The TERT recommends that Singapore provide a more detailed description of its QA/QC plan to demonstrate that it was elaborated in accordance with the 2006 IPCC Guidelines using the general inventory QC procedures set out therein (vol. 1, chap. 6, table 6.1) as a reference, in particular concerning the review of internal documentation and archiving, as well as documenting in the NID how other organizations involved in the preparation of the inventory are following applicable QA/QC procedures and that appropriate documentation of these activities is available (as per the 2006 IPCC Guidelines, vol. 1, section 6.4). The TERT encourages the Party to include information on the extent to which category-specific QC procedures are applied for key categories and for individual categories for which significant methodological changes and/or data revisions have occurred.
2.G.8	Specified in paragraph 43 of the MPGs Recalculations	Singapore explained category-specific recalculations in its NID (e.g. in sections 3.2.5.6, 3.2.8.6, 4.3.6 and 4.7.6), but the TERT identified a couple of recalculations for which the explanations and justifications were not complete (see ID#s 6.L.9 and 7.W.3). The TERT recommends that Singapore provide in its NID explanatory information on and justification for each recalculation, including the relevant changes in methods, AD and EFs, and the impact of each recalculation on emission trends.
2.G.9	Specified in paragraph 51 of the MPGs Completeness	Singapore did not provide information on the precursor gases carbon monoxide, nitrogen oxides, non-methane volatile organic compounds or sulfur oxides, reporting emissions thereof as “NE” in CRT 6 and sectoral CRTs 1, 2(I), 3 and 5. However, the NID (section ES.4) indicates that the levels of precursor gases are monitored by a network of ambient air quality monitoring stations. During the review, Singapore explained that it is building its technical capacity to include data on precursor gases in its inventory but needs more time to acquire and review the data and finalize estimates for the inventory. The TERT welcomes the Party’s implemented and planned efforts in this area and encourages Singapore to provide information on the precursor gases carbon monoxide, nitrogen oxides, non-methane volatile organic compounds and sulfur oxides in its NIR.
2.G.10	Specified in paragraph 52 of the MPGs Completeness	Singapore did not report indirect N_2O emissions from sources other than those in the agriculture and LULUCF sectors. During the review, Singapore explained that it is building its technical capacity to report indirect N_2O emissions from sources other than those in the agriculture and LULUCF sectors, but needs more time to acquire and review data and incorporate estimates into the inventory. The TERT welcomes the Party’s implemented and planned efforts in this area and encourages Singapore to report indirect N_2O emissions from sources other than those in the agriculture and LULUCF sectors as a memo item in its NIR.
2.G.11	Specified in paragraph 57 in conjunction with paragraph 6 of the MPGs Time series	Singapore applied flexibility with respect to the time series reported in its GHG inventory, which starts in 2000 rather than 1990. The NID (section 1.9) indicates that the Party needs time to acquire more data and identify an appropriate methodology for projecting emissions back to 1990. Singapore did not provide an estimated time frame for extending the inventory time series back to 1990.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		During the review, Singapore explained that it is building its technical capacity to estimate emissions since 1990. The TERT recommends that Singapore provide a self-determined estimated time frame for extending the inventory time series back to 1990.

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 paragraphs 21 and 23 of the MPGs 1. General (energy sector)	Singapore estimated emissions from fuel combustion for key categories such as 1.A.1 energy industries, 1.A.2 manufacturing industries and construction, 1.A.3.b road transportation and 1.A.3.d domestic navigation using tier 1 methodologies and default EFs, except for estimating emissions from some facilities using plant-specific EFs. The TERT noted that the decision trees in the 2006 IPCC Guidelines (vol. 2, chap. 2, figure 2.1 and chap. 3, figures 3.2.2 and 3.5.1) recommend using higher-tier methodology for estimating emissions for key categories. The TERT also noted that the energy sector contributed 83.8 per cent of total national emissions in 2022, so any improvement to the accuracy of the estimates for this sector will make a large impact on the overall accuracy of the national inventory. During the review, Singapore indicated that it will make efforts to use higher-tier methodology for estimating emissions for key categories in the energy sector, depending on the availability of resources. The TERT recommends that Singapore include the explanation in the NID for not using higher-tier methodology for the key categories 1.A.1 energy industries, 1.A.2 manufacturing industries and construction, 1.A.3.b road transportation and 1.A.3.d domestic navigation. The TERT, in line with IPCC good practice, encourages the Party to make every effort to use the tier-level methodology for estimating emissions for key categories recommended in the 2006 IPCC Guidelines (vol. 2, chap. 2, figure 2.1 and chap. 3, figures 3.2.2 and 3.5.1), including for categories 1.A.1 energy industries, 1.A.2 manufacturing industries and construction, 1.A.3.b road transportation and 1.A.3.d domestic navigation, and to report information on how it is addressing or intends to address the issue.
3.E.2	Specified in paragraph 23 of the MPGs 1. General (energy sector)	Singapore reported using tier 1 methodology for estimating emissions for key categories but did not clearly document why the choice of methodology was not in line with the corresponding decision trees of the 2006 IPCC Guidelines (vol. 2, chaps. 2–3). However, Singapore reported that it is working on developing country-specific EFs for fuels to enable it to use tier 2 estimation methodology for key categories in line with the 2006 IPCC Guidelines. During the review, Singapore explained the technical and resource constraints it is facing and stated that for key categories it will make efforts to use higher-tier estimation methodology in future, depending on the availability of resources. For key categories estimated using tier 1 methodology, the TERT recommends that Singapore improve the transparency of its reporting by clearly documenting in its NID why the (lower-tier) methodology used is not in line with the corresponding decision trees of the 2006 IPCC Guidelines.
3.E.3	Specified in paragraphs 20 and 36 of the MPGs Fuel combustion – reference approach – liquid, solid, gaseous and other fossil fuels – CO_2	Singapore reported the AD and estimated CO_2 emissions for all fuels combusted except for peat as "NE" in CRT 1.A(c) (using the reference approach). In the NID (section 3.2.1) Singapore indicated that it is building its capacity for estimating emissions using the reference approach. During the review, Singapore explained that it is assessing and building its internal capacity to report AD and CO_2 emissions for fuel combustion estimated using the reference approach in the next BTR. The TERT encourages Singapore to improve the completeness of its reporting by estimating and reporting AD and estimated CO_2 emissions for fuel combustion for the reference approach in CRT 1.A(c). The TERT also encourages Singapore to compare its estimates of CO_2 emissions from fuel combustion calculated using the sectoral approach with those obtained using the reference approach and report the results of this comparison in its NID.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
3.E.4	Specified in paragraphs 31, 40 and 47 of the MPGs 1.A.2 Manufacturing industries and construction – liquid and solid fuels – CO_2, CH_4 and N_2O	Singapore reported CO_2, CH_4 and N_2O emissions from solid fuel use under subcategories 1.A.2.a–1.A.2.g as "IE" in CRT 1.A(a)s2 and explained that they are reported under subcategory 1.A.2.c chemicals (liquid fuels) owing to a lack of disaggregated data at the subcategory level, and that data are collected at the national level. In the NID (p.55), Singapore reported that emission estimates for liquid fuel use under subcategories 1.A.2.g.ii manufacturing of transport equipment, 1.A.2.g.iii mining (excluding fuels) and quarrying, 1.A.2.g.iv wood and wood products, 1.A.2.g.vi textiles and leather and 1.A.2.g.vii off-road vehicles and other machinery are included under subcategory 1.A.2.g other. During the review, Singapore clarified that disaggregated AD for category 1.A.2 manufacturing industries and construction (i.e. on fuel use for non-ferrous metals, pulp, paper and print, machinery manufacturing, textiles and leather, iron and steel, construction, non-metallic minerals, manufacturing of transport equipment, food processing, beverages and tobacco, wood and wood products, and others) are not available and liquid fuel data at the national level were used to estimate the aggregated emissions. Furthermore, for confidentiality reasons, the AD and emission estimates from use of industrial town gas and petroleum coke were included under subcategory 1.A.2.c chemicals (liquid fuels). The TERT and Singapore agreed that there could be a significant overestimation of the reported emissions under category 1.A.2.c chemicals (liquid fuels) owing to the aggregation of the emissions with those for several other categories that could not be disaggregated. The TERT recommends that Singapore report, to the extent possible, disaggregated estimates of emissions from solid fuel use under subcategories 1.A.2.a–1.A.2.g in CRT 1.A(a)s2, using expert judgment if needed, and explain the methodologies, EFs and AD used in the estimations for each subcategory. The TERT also recommends that Singapore, where the reporting would involve the disclosure of confidential information, report emissions from use of solid fuels in manufacturing industries and construction as "C" in addition to "IE", with information on where the data are reported and appropriate explanations in the NID and CRT 9.
3.E.5	Specified in paragraphs 32 and 47 of the MPGs 1.B.2.b Natural gas – CO_2 and CH_4	Singapore did not estimate fugitive CO_2 and CH_4 emissions from natural gas systems (specifically for subcategories 1.B.2.b.iv transmission and storage and 1.B.2.b.v distribution), reporting them as "NE" in CRT 1.B.2. During the review, Singapore explained that it is assessing possible fugitive emissions from natural gas systems and will report estimates of the emissions in the next BTR. The TERT recommends that Singapore estimate and report fugitive CO_2 and CH_4 emissions for categories 1.B.2.b.iv transmission and storage (natural gas) and 1.B.2.b.v distribution (natural gas) in CRT 1.B.2 using the methodologies and EFs included in the 2006 IPCC Guidelines (vol. 2, chap. 4, section 4.2.2) or a consistent methodology. If Singapore considers any of these emissions to be insignificant and reports them as "NE", the TERT encourages Singapore to explain the exclusion and demonstrate that the likely level of emissions for each category is below 0.05 per cent of the national total GHG emissions, excluding LULUCF, or 500 kt CO_2 eq, whichever is lower.
3.E.6	Specified in paragraphs 32 and 54 of the MPGs Feedstocks, reductants and other non-energy use of fuels – CO_2	Singapore reported the AD and related information, and the implied CO_2 EFs, for feedstocks, reductants and other non-energy use of fuels as "NE" in CRT 1.A(d), while the NID (pp.47 and 85) indicates that the emissions are included under the IPPU sector. During the review, Singapore clarified that AD and CO_2 emissions for feedstocks, reductants and other non-energy use of fuels were not estimated but it is assessing its capacity to report them. The TERT encourages Singapore to estimate and report AD and emissions for feedstocks, reductants and other non-energy use of fuels in CRT 1.A(d) and clearly indicate how feedstocks, reductants and other non-energy use of fuels have been accounted for in the inventory, under the energy or IPPU sector, in accordance with the 2006 IPCC Guidelines. Alternatively, if they are reported as "NE", the TERT recommends that Singapore explain why.

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 47 of the MPGs 2.B.10 Other (chemical industry) – CH_4 and N_2O	Singapore reported N_2O emissions for subcategory 2.B.10 other in CRTs 2(I) and 2(I).A-H and included a footnote in the NID (p.90) noting that those emissions include N_2O emissions for subcategory 2.B.8 (petrochemical and carbon black production) and that CH_4 emissions are also produced under subcategory 2.B.8 but reported under subcategory 2.B.10. The TERT noted that, according to the 2006 IPCC Guidelines (vol. 3, section 3.9) and the CRTs, N_2O emissions are not expected to be produced or reported for processes under subcategory 2.B.8 (the cell for N_2O emissions for that subcategory is greyed out in CRT 2(I).A-H). The primary emissions for subcategory 2.B.8 are CO_2, with a minor share of CH_4 emissions from only some processes under the subcategory. Additionally, the NID does not specify the process from which the CH_4 emissions (and by extension the N_2O emissions) referred to therein (in the footnote on p.90) that are reported as "IE" under subcategory 2.B.8.g.ii other originate. The two paragraphs under NID table 84 list the processes that are included in these categories but do not identify which are relevant for CO_2 or CH_4 emissions. During the review, Singapore explained that AD and CO_2, CH_4 and N_2O emissions for venting and flaring from petrochemical and chemical production operations were reported under subcategory 1.B.2 (oil and natural gas and other emissions from energy production) in its biennial update reports. However, Singapore also explained that in the BTR those AD and CO_2 and CH_4 emissions are reported under subcategory 2.B.8 for the petrochemical facilities and under subcategory 2.B.10 for the chemical production facilities respectively, and that the N_2O emissions from flaring are reported under subcategory 2.B.10. The TERT noted that this reporting results in N_2O emissions being incorrectly reported for subcategory 2.B.8, where they do not occur. In addition, CH_4 emissions reported for that subcategory are potentially overestimated and potentially underestimated in the same amount for subcategory 1.B.2. The TERT recommends that Singapore review the allocation of AD and emissions for the processes under subcategories 2.B.8.g.ii and 2.B.10.b other and ensure that the reported information is representative of the category under which it is reported.
4.I.2	Specified in paragraph 35 of the MPGs 2.E Electronics industry – HFC-41, C_3F_8, CF_4, SF_6 and NF_3	Singapore is one of few Parties reporting emissions for category 2.E electronics industry. Owing to the small number of relevant companies, Singapore reported the emissions as "IE" for confidentiality. For example, for 2022 Singapore reported in CRT 2(II).B-Hs1: (a) For subcategory 2.E.1 integrated circuit or semiconductor, AD and HFC-41 and C_3F_8 emissions as "IE"; (b) For subcategory 2.E.2 thin-film transistor flat panel display, AD for CF_4, SF_6 and NF_3 emissions as "C" and the related emissions as "IE"; (c) For subcategory 2.E.3 photovoltaics, AD and CF_4, SF_6 and NF_3 emissions as "IE". The TERT recommends that Singapore report confidential emissions under category 2.E as "C" and "IE" in CRT 2(II).B-Hs1 and indicate where the confidential emissions have been reported. The TERT considers that undertaking a high-level comparative analysis of other reporting Parties' methods and estimates for category 2.E and providing a summary of the results in the NID could be included as a QA/QC measure for this category.
4.I.3	Specified in paragraphs 32 and 47 of the MPGs 2.G.3 N_2O from product uses – N_2O	Singapore reported N_2O emissions for subcategory 2.G.3.a medical applications as "NE" in CRT 2(I).A-H. During the review, Singapore indicated that while the source does exist in the country, the emissions are expected to make a minor contribution to the total national emissions and likely to be considered insignificant.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		The TERT recommends that Singapore estimate and report N_2O emissions for subcategory 2.G.3.a. If Singapore considers the emissions to be insignificant, the TERT encourages the Party to estimate the likely level of the emissions and show in the NID that the level is below the threshold of significance established in paragraph 32 of the MPGs.

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 paragraph 31 of the MPGs 3. General (agriculture)	Singapore aggregated its estimates of emissions from the agriculture sector to protect the confidentiality of data from the small number of livestock farms. Singapore used "IE" to indicate that emissions were aggregated but did not use "C" to indicate that reporting the emissions would involve disclosing confidential information. During the review, Singapore indicated that it will consider reporting these emissions as "C" in conjunction with "IE" in the next NID. Noting that reporting emissions from agriculture as "C" in conjunction with "IE" would increase transparency, where reporting emission estimates would involve disclosing confidential information, the TERT recommends that Singapore report the emissions as "C" and "IE" where information has been included elsewhere to protect data confidentiality.
5.A.2	Specified in paragraphs 35 and 47 of the MPGs 3.A Enteric fermentation – CH_4	For the agriculture sector the TERT noted that there are some discrepancies between the numbers reported in the NID tables (e.g. in tables 122 and 124) and CRT 3. For example, for 2022 CRT 3 has 0.012 (rounded to 0.01) kt CH_4 emissions for category 3.A enteric fermentation, whereas NID tables 122 and 124 have 0.02 kt CH_4 emissions for the same category; for 2021, CRT 3 has 0.013 (rounded to 0.01) kt CH_4 emissions for category 3.A, whereas NID table 124 has 0.02 kt CH_4 emissions for the same category. During the review, Singapore explained that such discrepancies are due to the automatic rounding and summation carried out by the ETF GHG inventory reporting tool provided by the UNFCCC, as opposed to in the NID where Singapore rounded figures to two decimal places to increase readability. Singapore noted that the base figures used are the same for both CRT 3 and the NID but some discrepancies may arise in the reporting across the time series because of the different approaches to rounding and summation. The TERT recommends that Singapore use the same approach to rounding that is applied automatically for the CRTs to maintain consistency between the figures in the NID and the CRTs. The TERT also recommends that Singapore consider including in the NID a short explanation of any discrepancies between numbers reported in the NID and the CRTs because of rounding and summation, such as in a footnote to the affected NID tables.
5.A.3	Specified in paragraph 47 of the MPGs 3.I Other carbon-containing fertilizers – CO_2	Singapore stated in the NID (p.125) that CO_2 emissions for category 3.I other carbon-containing fertilizers were likely to be insignificant and have not been estimated. However, Singapore did not provide a numerical estimate of the likely level of the emissions to justify this decision in accordance with the MPGs. During the review, Singapore informed the TERT that, owing to a lack of data, it was unable to derive a numerical estimate of the emissions for category 3.I other carbon-containing fertilizers, and that it will explore developing such an estimate for future NIDs. The TERT encourages Singapore to investigate whether other carbon-containing fertilizers are used in the country and, if so, to estimate and report CO_2 emissions for category 3.I other carbon-containing fertilizers.

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 35 of the MPGs 4. General (LULUCF) – CO_2, CH_4 and N_2O	Singapore provided a summary of estimated GHG emissions and removals for all LULUCF categories in NID table 130. However, the TERT identified discrepancies between the summarized totals in the NID and the estimates reported in CRT 10s1, particularly for 2022. For example, the total net GHG emissions and removals from LULUCF reported in the NID for 2018–2022 were 10.29, 16.42, 23.59, 31.28 and 38.12 kt CO_2 eq respectively, while the corresponding values in CRT 10s1 were 9.85, 15.90, 23.02, 30.55 and 37.24 kt CO_2 eq respectively. During the review, Singapore explained that such discrepancies, across the time series, are due to the different rounding and summation carried out by the ETF GHG inventory reporting tool and the Party. Singapore highlighted an additional challenge encountered with the ETF reporting tool, which did not allow the addition of the category "land converted to other". Consequently, emissions and removals from processes related to land reclamation from and loss to the sea were reported under category 4.F other land, contributing to further inconsistencies between figures in the NID tables and the figures calculated by the ETF GHG inventory reporting tool. The TERT encourages Singapore to conduct thorough cross-checking and validation of the consistency of numerical data presented in its NID and the CRTs on total net GHG emissions and removals from the LULUCF sector to improve consistency. The TERT recognizes the limitations of the ETF GHG inventory reporting tool but emphasizes the importance of presenting consistent data where possible.
6.L.2	Specified in paragraphs 39–40 of the MPGs 4. General (LULUCF)	In the NID (section 6.1.2), Singapore described the development of its land-use change matrix, mentioning that procedures were carried out to fill data gaps, such as for areas covered by cloud in the satellite imagery. The NID states that artificial land-use changes identified as artefacts in classification, rather than actual conversions, were corrected using a smoothing procedure that specifically addressed land-use changes and conversions that took more than 10 years. The TERT noted that the methodology and assumptions applied in these gap-filling and smoothing procedures were not fully explained in the NID. During the review, Singapore explained that smoothing procedures were applied to address short-term land-use changes, which are inherent to Singapore's highly dynamic redevelopment rates, and to correct artificial land-use changes that took less than 10 years. It indicated that land-use changes exceeding 10 years are not subject to this smoothing procedure but they are kept in the land-use change category until after the default 20-year transition period for land conversions. Singapore stated that in future BTRs it will include more detail on its smoothing procedures. The TERT recommends that Singapore provide more detailed information in its NID on the methodology and criteria applied in the gap-filling processes and the smoothing procedures used to correct artificial land-use changes, particularly specifying how land-use changes exceeding 10 years were handled and the precise criteria employed.
6.L.3	Specified in paragraphs 29, 39 and 40 of the MPGs 4. General (LULUCF)	In the NID (section 6.1.2), Singapore described its process for monitoring land-area changes due to land reclamation from and losses to the sea. The NID states that interpolation and extrapolation were carried out to fill gaps for years without data. The TERT noted that, while interpolation, extrapolation and gap-filling for missing years were mentioned, the methodologies used for these adjustments were not fully explained in the NID. During the review, Singapore indicated that it will elaborate on these elements in the methodology chapter of its next NID. It explained that gains and losses due to the reclamation and loss of land from and to the sea are clearly detectable in satellite images and represent long-term conversions, and the detailed QC process for such land-use change classifications makes misclassifications very unlikely. Singapore considered linear interpolation between years with available data to be the most appropriate method for estimating conversions during those periods.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		Extrapolations were only required for the two years prior to 1973, relevant for the transition period (using a backwards continuation of the trend after 1973 as the best estimate), and for the most recent years since 2018 (using a forward extrapolation of the trend as an interim result until more recent images are analysed). Singapore stated that uncertainty levels are expected to be higher for prior to 1990 and noted that an uncertainty assessment was carried out only for 1990–2022. The TERT recommends that Singapore provide more detailed information in the NID regarding the methodologies used for interpolation and extrapolation of data on land gains and losses, explicitly demonstrating how they, particularly linear interpolation and forward extrapolation, are consistent with the guidance provided in the 2006 IPCC Guidelines (vol. 1, sections 5.3.3.3–5.3.3.4). The TERT encourages Singapore to elaborate on the uncertainty assessment conducted for 1990–2022 for monitoring land-area changes due to land reclamation from and losses to the sea.
6.L.4	Specified in paragraphs 39–40 of the MPGs 4. General (LULUCF)	Singapore did not report comprehensive annual land-use matrices showing all conversions between categories for the entire time series (categories 4.A–H) in the NID or CRTs, but an example was given regarding the conversion figures for forest land converted to settlements between 2021 and 2022. The TERT noted a lack of information on any ground truthing, or verification procedures, used to confirm the accuracy of the land-use matrices derived from satellite imagery. During the review, Singapore provided a detailed explanation of its procedures for generating and verifying land-use maps and land-use changes using satellite imagery. For generating land-use maps, all land-use changes in areas larger than 0.25 ha are manually reviewed against satellite images for the reporting year, the last available satellite mosaic and third-party sources (e.g. Google Earth). For verifying land-use maps, an accuracy assessment is performed after each map is generated, involving the blind interpretation of stratified random sampling points, providing available information layers (ancillary maps, satellite image mosaics, field work data) to the interpreter. On the basis of this independent interpretation, an error matrix is calculated, and bootstrapping is applied to provide 95 per cent confidence intervals for accuracy measures and estimated areas of land use and land-use changes, following Gallaun et al. (2015). For verifying the accuracy of the land-use change mapping, specifically for data derived from SPOT satellites, areas were checked for between 2011 and 2014. For the more recent Pleiades data, verification of land-use change was performed exemplarily for the 10 most common land-use change categories, noting a significant increase in accuracy from SPOT to Pleiades satellite imagery mapping. Singapore clarified that complete annual land-use matrices showing all conversions between categories for the entire time series are available and that it will include them, together with the aggregated land-use change matrix for the full time series, in the next submission. The TERT recommends that Singapore provide detailed information on the ground truthing, or verification procedures, used to confirm the accuracy of the land-use matrices derived from satellite imagery in its BTR or NID. The TERT also recommends that Singapore report complete annual matrices or, at a minimum, an aggregated land-use change matrix covering the entire time series from 1990 onward.
6.L.5	Specified in paragraphs 39, 40 and 57 of the MPGs 4. General (LULUCF) – CO_2	In the NID (section 6.1.2.1), Singapore mentioned using images from both SPOT and Pleiades satellites for two years (2014–2015) to bridge the gap between data sets of different spatial resolutions (the Party had data for 2014 and 2015 from both data sets). The TERT noted that the NID does not include detailed information on how consistency was maintained across data sets with differing resolutions during this period. During the review, Singapore explained that all land use and land-use change figures for 2016 onward are based solely on land-use maps derived from Pleiades images and committed to providing more details thereon in the next NID. For 2014–2015, Singapore explained that separate independent land use and land-use change classifications were performed using both SPOT and Pleiades data. Upon comparing areas with no land-use change across the data sets, Singapore determined that both data sets produced similar results. However, it found that land-use maps derived from SPOT imagery overestimated the proportion of sealed area in certain categories compared with maps derived from Pleiades imagery. A

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		correction factor was determined and applied in the backwards calculation of all land-use areas for individual years of the time series, starting from 2015, using the land-use change and conversion areas. This process, according to Singapore, ensures consistency across the whole land use and land-use change time series. The TERT recommends that Singapore include more detailed and quantitative information in its NID regarding the methodology used to ensure consistency across land-use classification data sets derived from satellite images of different spatial resolutions, particularly for 2014 and 2015, including providing quantitative results of the comparison between land-use classifications from SPOT and Pleiades data and detailing the specific correction factor determined and applied. Including this information will enhance the transparency of the methodology and the robustness of the land-use change time series.
6.L.6	Specified in paragraph 35 of the MPGs 4. General (LULUCF)	Singapore provided information on general QA/QC checks applicable across all LULUCF categories in the NID (section 6.1.3), but did not report detailed information on how these general or category-specific checks were applied to the data, parameters and methodologies unique to the LULUCF sector. Results and specific examples of LULUCF-specific QA/QC activities were not transparently reported. During the review, Singapore provided examples of QC activities specific to the LULUCF sector, such as data entry checks performed by personnel involved in the initial data entry process and data plausibility checks conducted during data analysis, such as verifying that the observed rates of tree growth between subsequent NFIs were reasonable. Singapore confirmed that it conducts sector-specific QC activities for the LULUCF sector and stated that it will include more detailed information on these QA/QC procedures in subsequent BTRs. The TERT encourages Singapore to include detailed information on the QA/QC procedures applied specifically for the LULUCF sector in its NID, including examples of checks applied for LULUCF-specific data, parameters and methodologies, as well as the results and findings from these checks where possible.
6.L.7	Specified in paragraph 40 of the MPGs 4. General (LULUCF) – CO_2, CH_4 and N_2O	Singapore reported in the NID (section 6.3.2) that it does not track natural disturbances within the LULUCF sector because their effects have been negligible to date, but the threshold or criteria used to define what constitutes “negligible” effects in the context of Singapore’s total LULUCF emissions and removals or the national total GHG inventory was not provided. During the review, Singapore stated that the country is not prone to natural disasters and that disturbances to forests occur infrequently. Natural disturbances are often recorded anecdotally and most such events, like tree falls, occur at very small scales (citing Lai et al., 2022). Singapore explicitly stated that its tracking of forest area has not detected significant forest loss (defined as loss of an area of more than 0.25 ha) due to such disturbances. The TERT recommends that Singapore define “negligible” effects from natural disturbances in its BTR or NID.
6.L.8	Specified in paragraphs 39–40 of the MPGs 4.A Forest land – CO_2	In the NID (section 6.4.2.1.2), Singapore stated that the estimation of the annual biomass growth over 20 years for new forest stands was based on a single observed young forest stand with an initial biomass of below 2 t/ha. The TERT noted that basing the 20-year growth trajectory for new forests on data from a single observed young stand seems limiting. During the review, Singapore referenced a relevant scientific publication (Yee et al., 2016) and explained that young secondary forests in the country, which were cleared after the 1960s, are typically characterized as “waste-woodlands” according to this publication. These areas generally exist as small forest fragments embedded within the urban landscape and are often designated for future development. Singapore stated that, owing to factors such as soil disturbance and seed rain dominated by exotic species, these stands exhibit patchy canopies, which results in lower carbon stocks and increment rates compared with more established forests remaining forests.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		The TERT recommends that Singapore include a detailed explanation of the characteristics and growth patterns of young secondary forests with appropriate references (e.g. Yee et al., 2016) in its NID.
6.L.9	Specified in paragraphs 28 and 43 of the MPGs 4.A Forest land and 4.E Settlements – CO_2	Singapore performed recalculations for categories 4.A forest land and 4.E settlements and updated the EF for carbon stock changes in biomass (see NID p.189). However, the TERT found that the information on recalculations reported in the NID (section 8.3) was not sufficiently transparent. During the review, Singapore explained that the recalculations were conducted using new data obtained from the second NFI, including data on observed carbon stock changes specifically related to above-ground and below-ground biomass. Singapore committed to providing more detailed information on these recalculations in its next NID. The TERT notes the recommendation (see ID# 2.G.8) for Singapore to explain each recalculation.
6.L.10	Specified in paragraphs 39–40 of the MPGs 4.A Forest land and 4.E Settlements – CO_2	In the NID (section 6.4.2.1), Singapore mentioned a remeasurement conducted in 2020 on plots in both forest land and settlements primarily to update diameter increments used in the above-ground biomass growth model. The TERT noted that, while a remeasurement in 2020 was mentioned, details regarding the scope and use of the collected data were not fully explained in the NID. During the review, Singapore confirmed that mortality and recruitment of trees were recorded during the 2020 NFI. Singapore stated that carbon stock changes in the deadwood and litter carbon pools were expected to be more stable and were planned for remeasurement during the 2025 NFI. Singapore committed to including more details on these remeasurements in its next NID. In addition, Singapore informed the TERT that it will check 2025 NFI data and, if required, perform recalculations to validate or inform models for these carbon pools. The TERT recommends that Singapore include more detailed information in its NID regarding the scope and findings of the 2020 remeasurement on plots in forest land and settlements, including information on the parameters measured (e.g. diameter increments, mortality, recruitment) and how the collected data, including any observations related to the deadwood and litter pools, were used to validate or inform updates to the models used for estimating carbon stock changes in the relevant carbon pools (above-ground biomass, biomass losses, deadwood, litter), explicitly addressing the extent to which the 2020 data informed models for the deadwood and litter pools.
6.L.11	Specified in paragraphs 39–40 of the MPGs 4.D Wetlands – CO_2	In the NID (section 6.7.2.1), Singapore stated its assumption that no soil carbon stocks are present in wetlands and, consequently, no carbon gains or losses are reported for wetlands remaining wetlands. For land-use changes to wetlands, the soil carbon stock from the previous land category is reported as a net carbon loss over the default transition period of 20 years. The TERT noted that Singapore's assumption of zero soil organic carbon stock in wetlands is questionable and appears to deviate from the guidance in the Wetlands Supplement (e.g. section 4.2.3.3) and general ecological understanding, as most wetlands typically accumulate organic soils over time. The TERT highlighted that the assumption of zero soil organic carbon stock would require robust justification based on the specific nature of the areas classified as wetlands in Singapore and questioned whether natural wetlands like marshes or swamps were included, for which the assumption of zero soil organic carbon is likely to be incorrect. During the review, Singapore stated that its wetlands largely constitute man-made reservoirs, with areas that are permanently covered in water, and that other natural or man-made water bodies form a relatively small portion. For man-made reservoir wetlands, Singapore noted that no data on soil carbon stocks are available in the literature or IPCC guidelines, and that the 2006 IPCC Guidelines do not provide a method for estimating carbon stock changes in soils due to land-use changes to flooded lands. The TERT recommends that Singapore confirm explicitly whether natural wetland types (such as marshes, swamps or peatlands) do not occur in the country or are entirely excluded from category 4.D wetlands in its NID. If any natural wetlands are included, the TERT recommends that Singapore use the relevant methods in

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		the 2006 IPCC Guidelines for estimating soil carbon stock changes, while noting that the Wetlands Supplement includes additional methodologies for other wetland types. For the predominant man-made reservoirs and other wetland types, the TERT encourages Singapore to explore the applicability to Singapore of globally available guidelines on emissions from wetlands, such as the 2019 Refinement to the 2006 IPCC Guidelines, or to initiate country-specific studies, measurements or assessments to investigate and quantify potential soil organic carbon accumulation over time, thereby enhancing the accuracy of its reporting for the wetlands category.
6.L.12	Specified in paragraph 31 of the MPGs 4.D.1 Wetlands remaining wetlands – CO_2	In NID table 147, Singapore reported net emissions as 0.00 for subcategory 4.D.1 wetlands remaining wetlands for 2000–2022. However, these emissions were reported as "NA" and "NO" in CRT 4.D. The TERT noted that reporting 0.00 is not appropriate according to the MPGs, which recommend using "NO" to indicate that an activity does not occur or "NA" if an activity occurs but there are no associated emissions or removals. During the review, Singapore responded that it will report emissions for subcategory 4.D.1 as "NO" and "NA" accordingly. The TERT recommends that Singapore report correct estimates or notation keys ("NO" or "NA") for subcategory 4.D.1 wetlands remaining wetlands, including peat extraction and flooded lands, in accordance with the MPGs. The TERT also recommends that Singapore report appropriate notation keys instead of reporting "0.00" for emissions, removals or AD in the NID tables (e.g. for subcategory 4.D.1 wetlands remaining wetlands for 2000–2022).
6.L.13	Specified in paragraphs 39–40 of the MPGs 4.E Settlements – CO_2	In the NID (section 6.4.2.1), Singapore described its approach to estimating above-ground biomass in settlements, noting that, while local models were developed for estimating above-ground biomass for five common tree genera in tree-covered areas in settlements after finding that using standard equations for tropical forest resulted in substantially overestimated above-ground biomass for street trees (compared with Ngo and Lum, 2018), the pan-tropical Chave et al. (2014) model was still used for estimating above-ground biomass for all other tree species in this subcategory. The TERT acknowledged the suitability of the Chave et al. (2014) model for tropical forests but considered the finding of significant overestimation of above-ground biomass for street trees important, and noted the potential for inaccuracy of the Chave et al. (2014) model when used for estimating above-ground biomass for other tree species within the settlements category. During the review, Singapore explained that the current approach (using the Chave et al. (2014) model with modifications for the five specific tree genera) represents the best available information at present and that more detailed information could be considered if available in the future. Singapore committed to providing more detailed information on the criteria used for selecting the models in its next NID. The TERT recommends that Singapore include in its NID any available evidence or justification to support the applicability and accuracy of the Chave et al. (2014) model for estimating above-ground biomass for tree species within the settlements category, beyond the five genera for which local models were developed. If such evidence is limited, the TERT encourages Singapore to provide a qualitative assessment of the potential for the model to overestimate above-ground biomass for these other species. The TERT also encourages Singapore to detail in its NID any considerations or plans for future inventory improvements, including the potential for developing additional local models or applying genus-specific or typology-specific adjustments to enhance the accuracy of the estimation of above-ground biomass for the settlements category.

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 30 and 33 of the MPGs	In the NID (section 7.2.1), Singapore stated that there are no emissions from the Semakau landfill because it only receives incineration ash and non-incinerable waste. Regarding the Lorong Halus landfill, closed in 1999, Singapore reported that emissions from 2000 to 2017 were assumed insignificant but also mentioned

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
	5.A.1 Managed waste disposal sites – CH_4	that no data were available to estimate them. The TERT highlighted that the 2006 IPCC Guidelines (vol. 5, chap. 3) recommend estimating emissions from closed landfills for several decades after closure. Singapore reported CH_4 emissions for 2000–2017 as "NE" in NID table 156 (reported as GHG emissions as opposed to CH_4 specifically) but as "NO" in CRTs 5 and 5.A. During the review, Singapore stated that instruments monitoring the landfill gas collection system at the Lorong Halus landfill have reported near-zero CH_4 emissions since 2017. Singapore explained that there is no equipment installed to monitor CH_4 emissions at the Semakau landfill as the waste received (ash and non-incinerable waste) would not generate any CH_4 emissions. Regarding the CH_4 emissions at the Lorong Halus landfill, Singapore informed the TERT that it was not possible to estimate emissions from the closed Lorong Halus landfill for 2000–2017 owing to the lack of available data. The TERT recommends that Singapore estimate emissions from the closed Lorong Halus landfill for 2000–2017, consistently with the 2006 IPCC Guidelines recommendation to estimate emissions from closed landfills for several decades after closure. The TERT also recommends that Singapore report consistent information (estimates or notation keys) for emissions for subcategory 5.A.1 managed waste disposal sites for 2000–2017 in the NID tables and the CRTs.
7.W.2	Specified in paragraphs 31–32 of the MPGs 5.A.1 Managed waste disposal sites – CH_4	In the NID (section 7.2.1), Singapore stated that CH_4 emissions from the Lorong Halus landfill, which closed in 1999 and for which gas extraction stopped in 2017, are considered insignificant as they have reached a low concentration level. However, the TERT noted that, while such emissions were reported as "NE" in NID table 156 for 2000–2017, information regarding the use of "NE" was not reported in CRT 9 for the same period. During the review, Singapore stated that the emissions should be reported as "NA" because the instruments monitoring the landfill gas collection system show near-zero CH_4 emissions from the Lorong Halus landfill. The TERT recommends that Singapore review the application of notation keys for reporting CH_4 emissions from the Lorong Halus landfill for 2000–2017, especially regarding the distinction between reporting "NA" (no emissions occurring) and "NE" (emissions occur but are deemed insignificant). The TERT also recommends that Singapore apply the appropriate notation key consistently in both the NID and CRT 9 and provide clear justification as required by the MPGs.
7.W.3	Specified in paragraphs 26 and 43 of the MPGs 5.A.2 Unmanaged waste disposal sites – CH_4	In the NID (section 7.2.6), Singapore mentioned a recategorization of CH_4 emissions between subcategories 5.A.1 managed waste disposal sites and 5.A.2 unmanaged waste disposal sites, which resulted in an update of the MCF from 1.0 to 0.4. The NID highlights a significant decrease in estimated CH_4 emissions for 2018 as a result of this change (from 19.36 to 7.74 kt CO_2 eq). The TERT noted that Singapore did not transparently report information on the recategorization process for managed and unmanaged waste disposal sites, nor clarify why this change appeared to affect the emission estimates only for 2018. During the review, Singapore explained that an MCF of 1.0 was initially derived from a CDM project on dehydration and incineration of sewage implemented in Singapore between 2010 and 2012. However, during the estimation of emissions for the BTR1, an assessment determined that the contingency sludge disposal site did not fully meet the required criteria to be considered a managed anaerobic site (e.g. lacking specific on-site fire controls). Given this and the practice of disposing sludge at shallow depths (<5 m), Singapore concluded that the site fell under the category of "unmanaged – shallow (<5 m waste)", corresponding to an MCF of 0.4. Singapore clarified that this change in MCF applies for all reporting years, and the example cited for 2018 in the NID was merely illustrative. The response clarified that the updated MCF and new categorization had been applied consistently across all years of the inventory time series. Singapore confirmed the gap in the NID (section 7.2.6), where only 2018 was mentioned, and reaffirmed that the recategorization and the corresponding MCF of 0.4 were applicable to the full time series.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		The TERT notes the recommendation (see ID# 2.G.8) for Singapore to explain each recalculation.
7.W.4	Specified in paragraphs 39–40 of the MPGs 5.A.2 Unmanaged waste disposal sites – CH_4	In the NID (section 7.2.1), Singapore reported a declining trend in CH_4 emissions for category 5.A.2 unmanaged waste disposal sites, decreasing from 64.87 kt CO_2 eq in 2000 to 1.80 kt CO_2 eq in 2022, but detailed information on the methodology, assumptions and parameters used to estimate those emissions was not reported transparently in the NID. During the review, Singapore stated that it estimated CH_4 emissions from disposal of dewatered and dried sludge from wastewater treatment plants at unmanaged sites using a formula from an established CDM methodological tool (used to determine CH_4 emissions avoided from disposal of waste at a solid waste disposal site), which was listed in the NID (section 7.2.2). Singapore provided a table detailing the parameters used, indicating that, while for some parameters default values from the 2006 IPCC Guidelines were used, for others (model correction factor, oxidation factor, MCF, degradable organic carbon, decay constant) more representative or site-specific values based on site investigations and laboratory analysis were used. Concerning the declining trend in emissions, Singapore explained that, prior to 2009, used water sludge was sent directly to unmanaged disposal sites, resulting in higher CH_4 emissions. From 2009 onward, the default option became incineration of used water sludge before the ash was sent to a disposal site, which significantly reduced direct CH_4 emissions from wastewater treatment sludge. Addressing emissions from residual sludge fractions, Singapore clarified that CH_4 emissions do still occur from residual sludge after it is disposed of at disposal sites. These residual emissions, which are expected to reduce year-on-year, are accounted for using the same formula applied to compute CH_4 emissions from disposal of sewage sludge at unmanaged waste disposal sites. Regarding emissions from the incineration process, Singapore confirmed that, where heat is recovered from the incineration of used water sludge, emissions (such as CH_4 and N_2O) are accounted for under the energy sector (specifically category 1.A.1.a public electricity and heat production) and not the waste sector. It clarified that CO_2 emissions from wastewater are not accounted for in the NID, consistently with the 2006 IPCC Guidelines (vol. 5, section 6.1, p.6.6), which state that biogenic CO_2 emissions from wastewater should not be included in national total emissions. Singapore confirmed that it will include the tabular information detailing the parameters used, which was provided during the review, in future NIDs. The TERT recommends that Singapore include detailed information on the methodology, assumptions and parameters used for estimating CH_4 emissions for category 5.A.2 unmanaged waste disposal sites in its NID, including information on: (1) the rationale for the declining trend in CH_4 emissions, explaining the shift in sludge management from direct disposal to incineration; and (2) how CH_4 and N_2O emissions from the incineration of sludge with energy recovery are accounted for and allocated to the energy sector (specifically to category 1.A.1.a).
7.W.5	Specified in paragraphs 39, 40 and 47 of the MPGs 5.B Biological treatment of solid waste – CH_4 and N_2O	In the NID (section 7.3.1), Singapore reported emissions from community composting activities as “NE” for 2000–2022, stating that, while emissions may have occurred, relevant data were not collected. The TERT noted a lack of transparent information regarding the use of “NE”, how these potential emissions might be accounted for elsewhere (or confirmed as not estimated) and the representation of this in CRT 9. During the review, Singapore confirmed that these emissions were not estimated and indicated that it will include assessing the significance of this source of emissions and potentially collecting data as a planned improvement activity. It reiterated that “NE” was reported for 2000–2022 because emissions may have occurred, but data were not collected. Singapore explained a limitation in the ETF GHG inventory reporting tool that prevented the detailed explanation for reporting “NE” for community composting from being fully reflected in CRT 9, as “NE” was already reported for the same subcategory for emissions from a different source.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		The TERT recommends that Singapore make efforts to collect the necessary data and estimate and report CH_4 and N_2O emissions from community composting activities.
7.W.6	Specified in paragraphs 20 and 22 of the MPGs 5.C Incineration and open burning of waste – CO_2, CH_4 and N_2O	In the NID (section 7.4.2), Singapore reported that emissions from sludge incineration were estimated using a CDM-based methodology. For 2012 onward, emissions were estimated using a forward trend extrapolation of measured facility-specific data for 2010–2011, obtained as part of a registered CDM project. The TERT noted that Singapore did not clearly explain the reasons for using nationally appropriate methodologies (specifically the CDM-based approach) and how this is consistent with the 2006 IPCC Guidelines. During the review, Singapore explained that water sludge is disposed of either through incineration or directly at unmanaged waste disposal sites, and that: (a) For incineration, emissions were calculated using country-specific data from the 2010–2011 CDM project, which is considered a tier 2 approach based on a first-order decay model consistent with the 2006 IPCC Guidelines as it makes use of national data. These data were then extrapolated for subsequent years; (b) For unmanaged waste disposal sites, a formula from an established CDM methodological tool (used to determine CH_4 emissions avoided from disposal of waste at a solid waste disposal site) was used, highlighting that this tool made use of actual sludge data, such as degradable organic carbon, alongside default IPCC values for other parameters, making the methodology more accurate than using default IPCC values alone. In addition, Singapore justified its chosen methodologies and explained that using country-specific data for estimating emissions from incineration is a valid tier 2 approach and that incorporating actual sludge data via the CDM tool for unmanaged waste disposal sites tailors the methodology to national circumstances. The TERT recommends that Singapore demonstrate that its nationally appropriate methodologies are consistent with the 2006 IPCC Guidelines in the BTR by clarifying the methodology used for estimating emissions from sludge incineration for prior to 2010–2011 (if applicable to the inventory time series).
7.W.7	Specified in paragraphs 27 and 29 of the MPGs 5.C Incineration and open burning of waste – CO_2, CH_4 and N_2O	In the NID Singapore reported an uncertainty estimate of ±32 per cent for TIW incineration (section 7.4.4) and stated that data for specific waste types, including oil sludge, solid chemicals and pathogenic waste, for 2005–2007 were omitted from the extrapolation to fill in the data gap for 2000–2004 owing to uncertainty of the accuracy of the data on TIW collection (p.179), although information on the impact of these omitted data on the overall uncertainty of the time series was not reported. Furthermore, backward projections for TIW incineration from 2000 to 2004 were based on gross domestic product and population, and details on any uncertainty analysis conducted for these projected values were not provided. During the review, Singapore explained the rationale for using total gross domestic product and total population as surrogate parameters for projecting chemical TIW and clinical waste respectively, linking them to economic activities and public healthcare services. Singapore stated, as mentioned in annex II to the NID, that the uncertainty resulting from projection and the use of surrogate data had not been estimated for the BTR1 owing to a lack of capacity. Singapore committed to including uncertainty estimates associated with the backward projected AD for TIW in subsequent BTRs. The TERT recommends that Singapore include developing uncertainty estimates associated with the projected AD for TIW in its improvement plan and follow through with this plan in order to enhance the transparency and completeness of the uncertainty assessment for the TIW incineration time series, including regarding the impact of omitting data and the uncertainty related to making backward projections using surrogate data.
7.W.8	Specified in paragraphs 20 and 40 of the MPGs 5.D Wastewater treatment and discharge – N_2O	In the NID (section 7.5.2), Singapore reported using per capita protein consumption statistics for South-East Asia from the Food and Agriculture Organization of the United Nations for estimating N_2O emissions from domestic wastewater treatment, specifically focusing on N_2O emissions from the discharge of treated effluent. The TERT noted Singapore's use of an international database for these AD, which could have a higher uncertainty than country-specific data.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		During the review, Singapore indicated that there are no plans to develop country-specific protein consumption data for estimating N_2O emissions from the discharge of treated effluent. Singapore justified this by noting that these emissions constituted a small fraction (approximately 0.1 per cent) of its total GHG emissions in 2022. It also indicated that it could use country-specific data in the estimations if a full-scale protein study was carried out in Singapore. Given that the uncertainty associated with data from international databases could be higher compared with using country-specific AD, the TERT encourages Singapore to consider using country-specific protein consumption data in the future, if possible, to potentially reduce uncertainty and improve the accuracy of its emission estimates for domestic wastewater treatment and discharge.

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*
NA	NA	No areas of improvement identified

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*
NA	NA	No areas of improvement identified

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 75(f) of the MPGs	Singapore indicated (e.g. in the BTR1, p.29 and table 11) that it may use ITMOs towards meeting the target of its first NDC. However, information about the impact of ITMOs on the peaking of emissions and the budget and preparations for using them was not provided in the BTR1. During the review, Singapore clarified that emissions are currently projected to peak before 2030 and then decrease until 2030 as a result of the implementation of mitigation measures before the planned use of ITMOs. Singapore also clarified that it has signed five implementation agreements on the collaborative use of ITMOs with Bhutan, Chile, Ghana, Papua New Guinea and Peru, establishing a framework for the generation and transfer of ITMOs from carbon mitigation projects aligned with Article 6 of the Paris Agreement. The TERT recommends that Singapore include information on the impact of ITMOs on the peaking of emissions before 2030 and encourages Singapore to provide more information on the budget and preparations for using ITMOs in the BTR to improve transparency.
10.2	Specified in paragraph 77(c) of the MPGs	Singapore left the cell for reporting the contribution of the LULUCF sector to the achievement of the NDC in CTF table 4.1 (row 11) blank. However, in the BTR1 (table 15), Singapore reported that the contribution of the LULUCF sector is not applicable since the inventory time series includes the LULUCF sector. During the review, Singapore clarified that the relevant cell in CTF table 4.1 (row 11) should contain "NA" for both 2021 (column E) and 2022 (column F).

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		The TERT recommends that Singapore report the contribution of the LULUCF sector to the achievement of the NDC in CTF table 4.1 as "NA".

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 paragraphs 82(h) and 84 of the MPGs	Singapore did not report the start year of implementation of the policy or measure for increasing the modal share of public transport in CTF table 5. During the review, Singapore explained that it has been making efforts to increase the modal share of public transport over the years and will continue to include this measure in its long-term urban and transport planning. The TERT recommends that Singapore report the start year of implementation of the policy or measure for increasing the modal share of public transport in CTF table 5 or clarify the reasons for its omission by, for example, using notation keys and custom footnotes.
11.2	Specified in paragraph 85 of the MPGs	Singapore left the cells for reporting on the achieved emission reductions for two policies and measures (promoting energy efficiency in households by promoting the purchase of energy-efficient appliances, and low-carbon electricity imports) and the expected emission reductions for one (enhancing plastics recycling) blank in CTF table 5. During the review, Singapore explained that: (a) The achieved emission reductions from promoting energy efficiency in households were included with those for the policy or measure for minimum energy performance standards for domestic appliances as it is hard to disaggregate the impacts; (b) Regarding the import of low-carbon electricity, conditional licences have been signed and the final investment decisions for the first batch of projects is in preparation; (c) The beverage container return scheme under the measure for enhancing plastics recycling will commence on 1 April 2026 and it is not possible to project the resulting emission reductions as details of the scheme have not yet been finalized. Singapore also explained that, for measures where their individual impact is difficult to clearly separate from other measures, it could consider indicating emission reductions achieved as "IE" and indicate in a custom footnote the measure under which the emission reductions have been allocated. The TERT recommends that Singapore report the achieved emission reductions for the policies and measures for promoting energy efficiency in households and low-carbon electricity imports and the expected emission reductions for enhancing plastics recycling in CTF table 5 or clarify the reasons for their omission, by, for example, using notation keys and custom footnotes.
11.3	Specified in paragraph 85 of the MPGs	Singapore reported the emission reductions (expected and achieved) for the carbon tax as "NA" in CTF table 5 and explained in the BTR1 (table 16) that the carbon tax is not a stand-alone measure. During the review, Singapore provided additional information, stating that the National Climate Change Secretariat's policy and economic research teams, in collaboration with the Economics Division of the Ministry of Trade and Industry, are working to estimate the emission reductions expected to result from the carbon tax by using an in-house computable general equilibrium model. Noting that the carbon tax is a policy with widespread impacts on industries and consumers, the TERT encourages Singapore, to the extent possible, to explore feasible approaches to estimating and reporting the expected and achieved impacts of the carbon tax on emission reductions in CTF table 5.

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
11.4	Specified in paragraph 88 of the MPGs	Singapore did not identify actions, policies and measures that influence GHG emissions from international transport, specifically international aviation and maritime transport. During the review, Singapore provided the following additional information: (a) Singapore supports a sectoral approach led by the International Maritime Organization in addressing GHG emissions from international shipping. In supporting the International Maritime Organization target of achieving net zero emissions by or around 2050, the Maritime and Port Authority of Singapore published its Sustainability Report 2024 detailing its efforts to transform and decarbonize its maritime sector; (b) Singapore supports a sectoral approach led by the International Civil Aviation Organization in addressing GHG emissions from international aviation. In relation to achieving the long-term global aspirational goal of net zero carbon emissions from international aviation by 2050, the Party published the *Singapore Sustainable Air Hub Blueprint* in 2024, which declares that Singapore will work with aviation stakeholders to reduce emissions from Singapore's airport operations by 20 per cent from the 2019 level by 2030 and achieve net zero domestic and international aviation emissions by 2050. To achieve these goals, 12 initiatives across the airport, airline and air traffic management domains will be rolled out to decarbonize Singapore's aviation sector, including use of sustainable aviation fuels for flights departing Singapore from 2026, wider use of cleaner energy vehicles and more optimal flight routes to reduce travel time and carbon emissions. The TERT encourages Singapore to include information on actions, policies and measures that influence GHG emissions from international aviation and international maritime transport in the BTR, including its net zero targets for by or around 2050.
11.5	Specified in paragraph 90 of the MPGs	Singapore did not report information on the assessment of the economic and social impacts of its response measures. During the review, Singapore explained that it was not able to compile this information in time for inclusion in the BTR1. The TERT encourages Singapore to make further efforts to provide detailed information, to the extent possible, 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 paragraph 94 of the MPGs	Singapore reported 'with measures' projections but did not report 'with additional measures' or 'without measures' projections. During the review, regarding the 'with additional measures' scenario, Singapore explained that it considers the reporting of 'with measures' projections to be sufficient in terms of presenting estimates of emission reductions that can be achieved through its adopted policies and measures, as any planned measures can be functionally taken as adopted once publicly announced by the national Government. The TERT encourages Singapore to consider the possibility of reporting a 'with additional measures' and a 'without measures' scenario in the BTR.
13.2	Specified in paragraph 96(a) of the MPGs	Singapore reported projections by sector and by gas, and for the national total, using a common metric consistent with that in its NIR, relative to actual inventory data for the preceding years, provided with and without LULUCF, presented in graphical and tabular formats. However, detailed information about the methodology used to develop the projections was not included. The BTR1 (pp.66–

ID#	*Reporting requirement*	*Description of area of improvement with recommendation or encouragement*
		67) presents the assumptions used and the main drivers of emissions, without providing any numerical values for those drivers. The TERT encourages the Party to report in the BTR more detailed information on the models and approaches used and the key underlying assumptions and parameters used for projections.
13.3	Specified in paragraph 96(c) of the MPGs	The BTR1 does not present the assumptions on policies and measures included in the 'with measures' projections. The TERT encourages Singapore to indicate the assumptions on policies and measures included in the 'with measures' projections and, if reported, in the 'with additional measures' projections.
13.4	Specified in paragraph 96(d) of the MPGs	The BTR1 does not include a sensitivity analysis for the projections. The TERT encourages Singapore to provide a sensitivity analysis for any of the projections, together with a brief explanation of the methodologies and parameters used.

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 improvements 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		
NA	NA	No capacity-building needs identified
NIR		
NA	NA	No capacity-building needs identified
Information necessary to track progress in implementing and achieving the NDC under Article 4 of the Paris Agreement		
NA	NA	No capacity-building needs identified

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

Annex

Documents and information used during the review

A. Reference documents

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

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

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IPCC. 2014. *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*. T Hiraishi, T Krug, K Tanabe, et al. (eds.). Geneva: IPCC. Available at https://www.ipcc.ch/publication/2013-supplement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories-wetlands/.

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B. Additional information provided by the Party

Responses to questions during the review were received from Mein Yeak Siow (National Climate Change Secretariat of Singapore), including additional material. The following references were provided by Singapore and may not conform to UNFCCC editorial style as some have been reproduced as received:

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Civil Aviation Authority of Singapore. 2024. *Singapore Sustainable Air Hub Blueprint*. Available at https://www.icao.int/sites/default/files/sp-files/environmental-protection/Documents/ActionPlan/singapore-sustainable-air-hub-blueprint.pdf.

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