Technical document – Approach and methods for estimating emission levels resulting from the implementation of nationally determined contributions and long-term visions, strategies and targets

Abbreviations and acronyms

AR	Assessment Report of the Intergovernmental Panel on Climate Change
CH_4	methane
CO_2	carbon dioxide
CO_2 eq	carbon dioxide equivalent
GHG	greenhouse gas
GWP	global warming potential
IEA	International Energy Agency
IMO	International Maritime Organization
INDC	intended nationally determined contribution
IPCC	Intergovernmental Panel on Climate Change
LT-LEDS	long-term low-emission development strategy(ies)
LULUCF	land use, land-use change and forestry
N_2O	nitrous oxide
NDC	nationally determined contribution

A. Approach

1. The estimated total GHG emission levels in 2025, 2030, 2035 and 2050 of Parties that submitted new NDCs with 2035 targets between 1 January 2024 and 30 September 2025, taking into account the implementation of their new NDCs and their LT-LEDS submitted as at 30 September 2025, are discussed in this report in relation to:

(a) The estimated levels of emissions for those years according to Parties' INDCs submitted as at 4 April 2016 and NDCs submitted as at 31 December 2023 and up until 30 September 2025;[1]

(b) Historical levels of emissions for 1990, 2000, 2005, 2010, 2015, 2019 and 2023;

(c) The global emission levels corresponding to scenarios from the contribution of Working Group III to the AR6[2] consistent with limiting the global average temperature rise to likely below 2 °C above pre-industrial levels (with over 67 per cent likelihood);[3]

(d) The global emission levels corresponding to scenarios from the contribution of Working Group III to the AR6 consistent with limiting the global average temperature rise to below 1.5 °C above pre-industrial levels by 2100 (with over 50 per cent likelihood) with no or limited overshoot during the twenty-first century;

(e) The global emission levels corresponding to scenarios from the contribution of Working Group III to the AR6 consistent with limiting the global average temperature rise to likely below 2 °C above pre-industrial levels (with over 67 per cent likelihood) or with returning warming to 1.5 °C (with over 50 per cent likelihood) after a high overshoot, following estimated NDC emission levels up until 2030 with strong emission reductions thereafter;

(f) Per capita emission levels corresponding to Parties' NDCs and LT-LEDs calculated on the basis of the most recent United Nations population data, historical estimates and the medium-variant projection. For the per capita emission levels used in scenarios from the contribution of Working Group III to the AR6, the scenario-specific population time series are used to derive per capita emission levels;

(g) The estimated total GHG emission levels of all Parties in 2025 and 2030, taking into account the implementation of their latest NDCs, including new or updated NDCs, and their LT-LEDS submitted as at 30 September 2025.

2. For the purpose of this report:

(a) The synthesis covers the information communicated by Parties in their latest NDCs, including new or updated NDCs, and their LT-LEDS. The use of any additional information is described in chapter B below;

(b) The synthesis focuses on the targets, sectors and gases covered by the NDCs. GHG emissions that do not fall within the scope of the NDCs were assessed for the Parties taken together as a group, as explained in paragraph 4(d) below;

3. In order to estimate the emission implications of the NDCs and LT-LEDS, it was assumed that Parties will achieve the conditional and unconditional emission levels projected

[1] The NDCs and LT-LEDS presented in the NDC Synthesis report in 2016 (FCCC/CP/2016/2), the updated NDC synthesis report in 2021 (FCCC/PA/CMA/2021/8/Rev.1), and the 2024 NDC synthesis report (FCCC/PA/CMA/2024/10) were reassessed using the most recent inventory data and methodological approaches as applied to the new NDCs and LT-LEDS included in this report.

[2] IPCC. 2022. Summary for Policymakers. *In*: PR Shukla, J Skea, R Slade, et al. (eds.). *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge and New York: Cambridge University Press. Available at https://www.ipcc.ch/report/ar6/wg3/.

[3] Without giving precedence to the definition of 'pre-industrial', a proxy for pre-industrial times (before approximately 1750) has been chosen here to be 1850–1900, as this report follows the proxy used in the contribution of Working Group I to the AR6 for pre-industrial reference levels. The best estimate by the IPCC for the temperature difference between 1750 and 1850–1900 is +0.1 °C (–0.1 to +0.3 °C) with an anthropogenic component of between 0.0 °C and 0.2 °C (see cross-chapter box 1.2 in the contribution of Working Group I to the AR6).

in their NDCs; no assumptions were made on the likelihood or implications of NDCs not being fully implemented or being overachieved.

B. Methods

4. For the purpose of this report:

(a) The total GHG emission levels in 2025, 2030, 2035 and 2050 of Parties that submitted new NDCs with 2035 targets between 1 January 2024 and 30 September 2025 were estimated taking into account the implementation of the Parties' new NDCs and their LT-LEDS submitted as at 30 September 2025. NDCs containing 2035 targets submitted by 57 Parties by 30 September 2025 were considered. A total of 64 Parties submitted new NDCs between 1 January 2024 and 30 September 2025; however, not all of these contained targets for 2035 or were quantifiable in terms of GHG emission implications;

(b) The total emission levels of all Parties in 2025 and 2030 resulting from the implementation of their latest NDCs, including new or updated NDCs, and their LT-LEDS were estimated;

(c) The total emission levels of countries that are not Parties to the Paris Agreement were estimated for 2025 and 2030 using these Parties' INDCs, if available, or constant emissions after their last historical emissions;

(d) The levels of emissions not covered by the NDCs were estimated using data on international bunker emissions and IPCC and recent scientific literature reference scenarios.[4]

5. The total GHG emission levels in 2025, 2030, 2035 and 2050 resulting from the implementation of Parties' new NDCs with 2035 targets and those Parties' LT-LEDS were estimated by adding together the expected levels of emissions for the year in question communicated in each NDC. The resulting emission levels are expressed as average values and minimum–maximum ranges owing to the uncertainties underlying the aggregation of the emission levels and the ranges and conditions expressed in the NDCs.

6. The estimates of total GHG emission levels in 2025, 2030 and 2035 of Parties with new NDCs with 2035 targets are provided for:

(a) The full implementation of both the unconditional and the conditional elements of the NDCs;[5]

(b) The implementation of only the unconditional elements of the NDCs. For Parties that have conditional targets only, the constant extrapolation of emissions from the previous target was assumed;

(c) The implementation of the conditional elements of the NDCs, with Parties assumed to fully implement the unconditional and any conditional elements of their NDCs.

7. Unless otherwise noted, the discussion surrounding total GHG emission levels resulting from the implementation of the NDCs or LT-LEDS is based on the average of the implementation of either only the unconditional or both the unconditional and the conditional elements of the NDCs, as described in paragraph 6(6(a)–6(b)) above.

8. Where a Party included in its NDC or LT-LEDS an expected absolute level of emissions for 2025, 2030, 2035 or later, that figure was used in the calculation of the total

[4] Such estimates are based on emissions and growth rates for 2025, 2030 and 2035 for the countries, sectors and gases not covered by the NDCs and are derived from scenarios assessed by the IPCC in the Shared Socioeconomic Pathways scenario database (available at https://tntcat.iiasa.ac.at/SspDb/dsd) and updated scenarios from the NGFS scenario database (https://data.ene.iiasa.ac.at/ngfs/).

[5] Where Parties stated ranges of emissions for conditional or unconditional targets, for the purpose of calculating the total sum of emissions, the ranges were assumed to cover the lower-emission end of the range that assumes the full implementation of the NDCs, including conditional elements, to the higher-emission end of the range that assumes the implementation of only the unconditional elements of the NDCs.

emission level.[6] Otherwise, the method used for quantifying the estimated level of emissions in the target year depended on the type of target. For example:

(a) For absolute emission reduction targets relative to a base year, the method involved subtracting the percentage emission reduction or limitation specified by the Party for the target year from the base-year level of the emissions covered by the NDC;

(b) For emission reductions below a 'business as usual' or other reference level, the method involved subtracting the emissions corresponding to the percentage reduction specified by the Party from the stated level of emissions in the target year;

(c) If both cumulative and absolute target levels were specified for a specific year, the latter figure was used; if only cumulative targets were specified, they were converted into absolute targets for the target year assuming the linear achievement of targets;

(d) For emissions or intensity targets, the method involved estimating absolute emissions by multiplying the targeted emission intensity by a range of official and third-party projections of gross domestic product for the relevant Party;

(e) Net zero emission, climate neutrality and carbon neutrality targets were assumed to cover the same sectors and gases as the Party's NDC targets for 2030 or 2035, unless otherwise noted in the NDC or LT-LEDS, and the following assumptions were applied for specific types of target:

(i) For net zero emission targets, the assumption that the sum, weighted by GWP values over a 100-year time-horizon from the AR6, of the emissions covered in the target year equals zero;

(ii) For carbon neutrality targets or net zero carbon emission targets, the assumption that their implementation only covers CO_2 emissions. Non-CO_2 emissions are projected using growth rates under a 'current policies' scenario from the latest year of historical emissions or the latest target year in which those emissions were covered (e.g. 2030 or 2035);[7]

(iii) For climate neutrality targets, the assumption that they are implemented as net zero emission targets;

(iv) For long-term targets stated for 2040, the assumption that they are to be maintained up until at least 2050, and for long-term targets stated for beyond 2050 (e.g. 2060 or 2070), the assumption that they are to be proportionally achieved by 2050. In the case of a target stated for beyond 2050, the 2050 emission level is estimated using linear interpolation between emission levels at the latest target date (e.g. 2030 or 2035) and the stated long-term target date (e.g. 2060 or 2070);

(f) For Parties that communicated a combination of any of these targets, resulting in some cases in potential overlaps between the sectors and/or gases covered, expected levels of emissions in 2025, 2030, 2035 or 2050 were estimated individually for each target, while for Parties that stated ranges of targets, both the upper and the lower end of the ranges were used to determine the range of global aggregate emission levels;

(g) For other types of targets, including those related to mitigation co-benefits of adaptation actions and policies and measures, the effects were not quantified in this report unless estimates of resulting emission levels in 2025, 2030, 2035 or 2050 were provided in the NDCs or LT-LEDS.

9. If a Party did not indicate a target for 2025, the level of emissions in 2025 was estimated using linear interpolation between the latest historical emission level available and the estimated level of emissions in 2030 resulting from the implementation of its NDC.

10. The targets communicated by Parties in their new NDCs and LT-LEDS were used in the estimation of emission levels for this report. That information was complemented, as necessary, by data contained in previous INDCs, NDCs and LT-LEDS, the latest GHG

[6] If necessary, a conversion was applied to GHG emission levels expressed in GWP values over a 100-year time-horizon from the AR6.

[7] The growth rates are derived from the Network for Greening the Financial System Phase 5 Global Change Assessment Model current policies scenario (available at https://data.ene.iiasa.ac.at/ngfs/).

inventories, national communications, biennial update reports and biennial reports, and any remaining data gaps were filled using scientific global data sets.[8]

11. In order to quantify the difference in estimated emissions since the INDCs, emissions for the sectors and gases covered were complemented by information on sectors and gases that were not covered. Similarly, sectors and gases that were not covered were included in the total by adding them to the sum of gases and sectors covered in the latest NDCs, including new or updated NDCs. Further, the previous NDCs and INDCs were assessed using the same set of updated reported historical emission data as the new or updated NDCs, unless the previous NDCs or INDCs referred to specific absolute emission or reference levels, including in GHG inventory reports, in which case those were used.

12. The long-term strategies were quantified as stated in the new NDCs or as stated in the long-term strategies officially reported[9] by Parties.

13. Total global GHG emissions were estimated by adding together the GHG emission data for individual Parties contained in their latest GHG inventories, national communications, biennial update reports and biennial transparency reports, complemented by other data from global data sets to address any remaining data gaps.[10] Since emissions from international transport were not included in the sum of emissions for Parties with new NDCs, but in the global totals, historical CO_2 emissions related to international aviation and GHG emissions related to international maritime transport were used to complement country data to arrive at the estimate of total global emissions.

14. Regarding the use of international market-based mechanisms, it was assumed that any international offset would lead to additional emission reductions in other countries. In other words, it was assumed that emission reductions arising from the implementation of one NDC were not counted twice.

15. The analysis took into account the specific GWP values that Parties indicated, namely GWP values over a 100-year time-horizon from the AR2, AR4 or AR5. GWP values over a 100-year time-horizon from the AR6 were used to add together the emissions covered in the NDCs. Where necessary, summed emissions were converted using those GWP values on the basis of Parties' historical CO_2, CH_4, N_2O and other GHG emissions.

C. Key methodological challenges and approaches to addressing them

16. A number of uncertainties and challenges linked to the specification of targets and data availability and quality were taken into account in the approaches and methods applied in the analysis.

17. One key challenge relates to the different ways in which Parties expressed their NDC targets in terms of time frame, reference year, and sectors and gases covered. Compared with earlier NDCs, the targets in the new NDCs were generally more clearly defined in quantitative terms, with substantially fewer targets expressed in terms of emission and gross domestic product ratios (intensity targets), reductions below unquantified baselines, and policies and measures. A larger share of targets was communicated relative to a historical base year or quantified future reference level in the new NDCs. Further, other types of targets were communicated that present fewer quantification challenges, such as targets specified in

[8] To ensure a consistent aggregation of emissions, a gas-by-gas data basis was used to perform conversions from different metrics, such as GWP values from the AR2 or AR5 into GWP values from the AR6, which were used consistently for the aggregation presented in this report. Therefore, in some cases, it was necessary to use complementary data sets to estimate the total level of emissions associated with the implementation of the NDCs. The primary complementary sources of gas-by-gas and sectoral data on the emissions of Parties were composite databases, including official submissions under the UNFCCC (such as GHG inventory submissions), with data gaps filled using sources such as the Food and Agriculture Organization of the United Nations and the Emissions Database for Global Atmospheric Research.

[9] See https://unfccc.int/process/the-paris-agreement/long-term-strategies.

[10] To fill sectoral and gas-by-gas data gaps, growth rates from international scientific databases with global coverage were used, as compiled in Gütschow J, Busch D and Pflüger M. 2025. The PRIMAP-hist national historical emissions time series (1750–2023) v2.6.1. *Zenodo*. Available at https://zenodo.org/records/15016289.

terms of absolute future emission levels, cumulative emission budgets and net zero emissions.

18. Further challenges relate to the methodologies used for estimating and projecting GHG emissions and to the quality, clarity and completeness of the data used, including missing information on metrics, such as which GWP values were applied (although more Parties specified their chosen GWP values in their new NDCs); a lack of gas-by-gas emission data for adding together emissions using consistent metrics; missing or incomplete data on the 'business as usual' or other reference scenarios; a lack of clarity on approaches to LULUCF accounting; missing information in relation to the application of conditions in the target year; and a lack of information on the use of international market-based mechanisms and on how double counting was avoided.

19. To address the challenges, the following approaches were applied consistently:

(a) Uncertainties arising from the different ways of expressing targets were addressed by applying the method described in paragraph 8 above;

(b) The synthesis was based on data in Parties' new NDCs with 2035 targets and those Parties' LT-LEDS, as noted in paragraph 5 above, and challenges related to missing data were addressed as described in paragraphs 9–12 above;

(c) Differences in the coverage of sectors and gases were addressed by limiting the Party-level analysis to the GHG emissions covered by the NDCs.

20. Uncertainties linked to conditions specified by Parties in their NDCs were addressed by separately estimating unconditional together with conditional and only unconditional emission reduction levels and expressing the result as a range. Further, any uncertainties in relation to unconditional elements of the NDCs or any ranges of conditional reductions provided were taken into account as separate ranges. These ranges were used when estimating the overall ranges of projected emission levels resulting from the implementation of the unconditional elements of the NDCs, as well as the effect of implementing both the unconditional and conditional elements of the NDCs (see paragraph 6 above).

21. A major area of uncertainty relates to the approaches used for estimating, projecting and accounting for LULUCF emissions and removals. The results presented in this report are subject to the high sensitivity of the methods used for estimating emissions in terms of how emissions and removals from the LULUCF sector were considered. For example, some Parties intend to follow specific LULUCF accounting rules, while others intend to pursue a full carbon accounting approach (i.e. by including LULUCF net emissions or removals in the same way as emissions from any other sector).[11]

22. For this report, the divergent treatment of the LULUCF sector was taken into account when estimating the total emission levels. For example, an approach using a relative target below a historical base-year level was applied to estimate the total national emissions including LULUCF if the Party stated its intention to account for LULUCF in the same way as it accounts for any other sector. To the extent quantifiable with the available data sources, exceptions were taken into account; for example, reported wildfire-related (and approximate estimates for insect-related) emissions were subtracted from the total LULUCF emissions for the base year if emissions related to natural disturbances were not intended to be counted up until 2025, 2030, 2035 or beyond. Where available, reported projections 'with existing measures' in biennial transparency reports formed the basis for estimating future LULUCF emissions and removals, unless the Party provided LULUCF projections in its NDC. Alternatively, the latest available historical data points from country inventories or biennial transparency reports, where available, were assumed to remain constant or, where appropriate, a range of constant and projected LULUCF projections was assumed to reflect the inherent uncertainty of the quantification. Following the target quantification for the individual Parties including LULUCF, the implied emissions without LULUCF were derived for the Parties. In this report, total emissions for groups of Parties are provided without emissions and removals from LULUCF, unless otherwise specified.

23. Emissions from international aviation and maritime transport are not considered in national emissions inventories. These 'bunker' emissions must be added to the aggregated

[11] A few Parties specified in their NDCs how natural disturbances and harvested wood products are to be accounted for.

Parties' emission time series in order to obtain global emissions that are comparable with the emissions scenarios assessed by the IPCC. For this report, estimates of CO_2 emissions from aviation bunkers are taken from IEA statistics.[12] The carbon-neutral growth target for the sector[13] is assumed to result in emissions being at the same level in 2025, and up until 2035. For marine bunkers, CO_2, CH_4 and N_2O emissions in 2012–2018 are derived from the fourth IMO GHG study,[14] specifically the voyage-based emissions. The time series is completed by the respective CO_2 marine bunker growth rates from IEA statistics. It is illustratively assumed that emissions from international maritime transport will decrease to approximately 20 to 30 per cent below the 2008 level by 2030, in line with a linear achievement of the IMO 2023 strategy goal[15] to reduce them to net zero by or in around 2050. This is assumed to represent a reduction of 90 to 100 per cent by 2050.

24. For the global GHG emission time series to 2030, infilling and harmonization at the global level were applied as for the scenarios in the scenario database of the contribution of Working Group III to the AR6 – with a gas-by-gas split and adjustments towards historical best estimates of global emission levels. The application of a harmonization scaling factor allows NDC-consistent emission projections to be obtained, in line with historical emission estimates. All emissions not reported by Parties to the Paris Agreement are addressed through this harmonization process, other than those related to adjustments for international transport (as described in paragraph 23 above).

25. A selection of scenarios from the scenario database of the contribution of Working Group III to the AR6 was used to calculate the difference between the per capita emissions for Parties that have new NDCs with 2035 targets and the latest IPCC-assessed emissions scenarios. Specifically, the C1 category of scenarios was analysed to illustrate the difference between per capita emission levels under the NDCs and LT-LEDS and pathways that lead to 1.5 °C of warming. The C1 category of scenarios limits warming to below 1.5 °C above pre-industrial levels by 2100 (with over 50 per cent likelihood) with no or limited overshoot. The C3a category of scenarios was analysed to illustrate the difference between per capita emission levels and scenarios that limit warming to below 2 °C above pre-industrial levels (with over 67 per cent likelihood).[16] These scenarios feature an onset of concerted mitigation actions by 2020. The combination of C2 and C3 category scenarios that meet the policy category P3b[17] was analysed to illustrate the difference between per capita emission levels and scenarios that limit warming to below 2 °C above pre-industrial levels (with over 67 per cent likelihood) or return warming to 1.5 °C (with over 50 per cent likelihood) after a high overshoot, following estimated NDC emission levels up until 2030 with strong emission reductions thereafter. The differences in per capita emission levels are stated as medians and interquartile ranges for the distribution of differences between per capita emission levels under the NDCs and LT-LEDS and these scenarios. The comparison between per capita emission levels of countries with new NDCs and the global averages of per capita emission levels under IPCC scenarios was undertaken for GHG emissions without LULUCF, given how Parties' LULUCF inventories report more than just anthropogenic emissions.

[12] IEA data on CO_2 emissions from fuel combustion (available at http://dx.doi.org/10.1787/co2-data-en).

[13] See International Civil Aviation Organization Resolution A41-42. Available at https://www.icao.int/environmental-protection/climate-change. Emissions from 2024 to 2035 are 85 per cent of 2019 levels, consistent with resolution A41-42.

[14] IMO. 2020. *Fourth IMO Greenhouse Gas Study*. London: IMO. Available at https://www.imo.org/en/OurWork/Environment/Pages/Fourth-IMO-Greenhouse-Gas-Study-2020.aspx.

[15] See Annex 1 to the 2023 IMO Strategy on Reduction of GHG Emissions From Ships. Available at https://www.imo.org/en/ourwork/environment/pages/2023-imo-strategy-on-reduction-of-ghg-emissions-from-ships.aspx.

[16] See table SPM.2 in the Summary for Policy Makers of the contribution of Working Group III to the AR6.

[17] Figure SPM.4 in Summary for Policy Makers describes that combination of C3 and C2 scenarios that meet the P3b policy category as 'Limit warming to 2 °C (>67 per cent) or return warming to 1.5 °C (>50 per cent) after a high overshoot, NDCs until 2030'. The same set of scenarios is used here.