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Nationally determined contributions under the Paris Agreement

Synthesis report by the secretariat

Addendum

Additional information on the contribution of nationally determined contributions towards achieving the objective of the Convention as set out in its Article 2, and towards Article 2, paragraph 1(a), and Article 4, paragraph 1, of the Paris Agreement

Summary

This addendum provides additional information on the contribution of nationally determined contributions towards achieving the objective of the Convention as set out in its Article 2, and towards Article 2, paragraph 1(a), and Article 4, paragraph 1, of the Paris Agreement synthesized from the 164 latest available nationally determined contributions communicated by the 191 Parties to the Paris Agreement and recorded in the interim registry of nationally determined contributions as at 30 July 2021.

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
GWP-100	global warming potential values over a 100-year time-horizon
IMO	International Maritime Organization
INDC	intended nationally determined contribution
IPCC	Intergovernmental Panel on Climate Change
IQR*	interquartile range
LULUCF	land use, land-use change and forestry
N_2O	nitrous oxide
NDC	nationally determined contribution
SR1.5	Intergovernmental Panel on Climate Change Special Report on Global Warming of 1.5 °C
SSP	Shared Socioeconomic Pathway

* Used exclusively in figure 7.

I. Background

1. The ultimate objective of the Convention as defined in its Article 2 is to achieve stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

2. According to its Article 2, paragraph 1(a), the Paris Agreement, in enhancing implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development in efforts to eradicate poverty, including by holding the increase in the global average temperature to well below 2 ºC above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 ºC above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.

3. Under Article 4, paragraph 1, of the Paris Agreement, in order to achieve the long-term temperature goal set out in its Article 2, Parties aim to reach global peaking of GHG emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of GHGs in the second half of the century, on the basis of equity and in the context of sustainable development and efforts to eradicate poverty.

4. The information necessary to facilitate clarity, transparency and understanding of NDCs includes, among other elements, information on:[1]

(a) How the NDC contributes towards achieving the objective of the Convention as set out in its Article 2;

(b) How the NDC contributes towards Article 2, paragraph 1(a), and Article 4, paragraph 1, of the Paris Agreement.

II. Contribution of nationally determined contributions towards achieving the objective of the Convention as set out in its Article 2, and towards Article 2, paragraph 1(a), and Article 4, paragraph 1, of the Paris Agreement

5. This report considers the latest NDCs of all 191 Parties to the Paris Agreement[2] recorded in the interim registry of NDCs as at 30 July 2021, covering 93.1 per cent of total global GHG emissions in 2019,[3] which are estimated at 52.4 Gt CO_2 eq[4] without LULUCF (and around 56.0 Gt CO_2 eq with LULUCF[5]).

[1] Decision 4/CMA.1, annex I, para. 7.

[2] The joint NDC of the European Union and its 27 member States has been counted as one NDC representing 28 Parties.

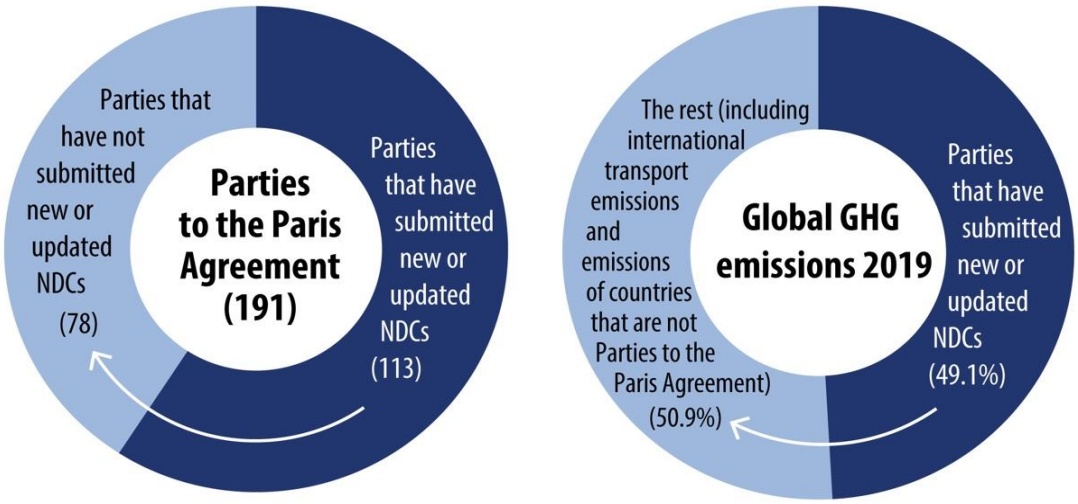
[3] Unless otherwise noted, GHG emission totals in this report are the aggregate sum of CO_2, CH_4, N_2O, hydrofluorocarbon, perfluorocarbon, sulfur hexafluoride and nitrogen trifluoride emissions, without emission or removals from LULUCF, calculated using GWP-100 from the AR6. For NDCs that include estimates of GHG emissions calculated using other GWP values (e.g. from previous ARs), a conversion has been applied.

[4] Including emissions from countries that are not Parties to the Paris Agreement, a harmonization factor to ensure comparability with SSP scenarios assessed by the IPCC, and emissions from international aviation and maritime transport, which accounted for approximately 1.2 and 1.5 per cent, respectively, of emissions in 2019.

[5] Including LULUCF in line with scenarios assessed by the IPCC. The total directly induced net emissions (gross emissions minus gross removals) from land-use change used in this report are consistent with those assumed in scenarios assessed by the IPCC and are estimated at approximately 1 Pg C or 3.6 Gt CO_2 in 2019. However, given the substantial uncertainty of net global LULUCF-

6. A total of 86 new or updated NDCs were communicated[6] by 113 Parties,[7] representing 59.2 per cent of the Parties to the Paris Agreement and accounting for 49.1 per cent of global GHG emissions (without LULUCF) in 2019 (see figure 1).

Figure 1
Coverage of new or updated nationally determined contributions



A. Total emissions in 2025 and 2030

7. Total global GHG emission levels (without LULUCF) taking into account implementation of the latest NDCs of all Parties to the Paris Agreement are estimated to be around 54.8 (52.8–56.8) Gt CO_2 eq in 2025 and 55.1 (51.7–58.4) Gt CO_2 eq in 2030[8] (see figure 2; see also chap. III below for the approach and methods used for estimating the total GHG emission levels).

8. Total GHG emission levels resulting from implementation of only the unconditional elements of the NDCs are projected to be 55.7 (54.5–56.8) Gt CO_2 eq in 2025 and 56.5 (54.6–58.4) Gt CO_2 eq in 2030.

9. If the NDCs are fully implemented, including their conditional elements, total GHG emissions are projected to be 54.0 (52.8–55.3) Gt CO_2 eq in 2025 and 53.6 (51.7–55.5) Gt CO_2 eq in 2030.

10. This report also presents total global GHG emission levels resulting from implementation of Parties' INDCs as at 4 April 2016, by reaggregating those INDCs using the latest inventory data, metrics and methods. These total global GHG emission levels (without LULUCF) are projected to be around 56.1 (54.1–58.1) Gt CO_2 eq in 2025 and 58.5 (55.1–61.9) Gt CO_2 eq in 2030 (see figure 2). For comparison, they are estimated to be around 1.3 Gt CO_2 eq or 2.3 per cent higher by 2025 and 3.4 Gt CO_2 eq or 5.9 per cent higher by 2030 than the estimated total global GHG emission levels for these years taking into account implementation of all the latest NDCs.[9]

related emissions, they could have totalled up to 2.5 Pg C or 9.1 Gt CO_2 eq in 2019 (see figure 5.5 in chap. 5 of the contribution of Working Group I to the AR6 (see footnote 15 below)).

[6] As per decision 1/CP.21, paras. 22–24.

[7] As at 30 July 2021, including three submissions received within 12 hours after that deadline in order to take into account as many new or updated NDCs as possible.

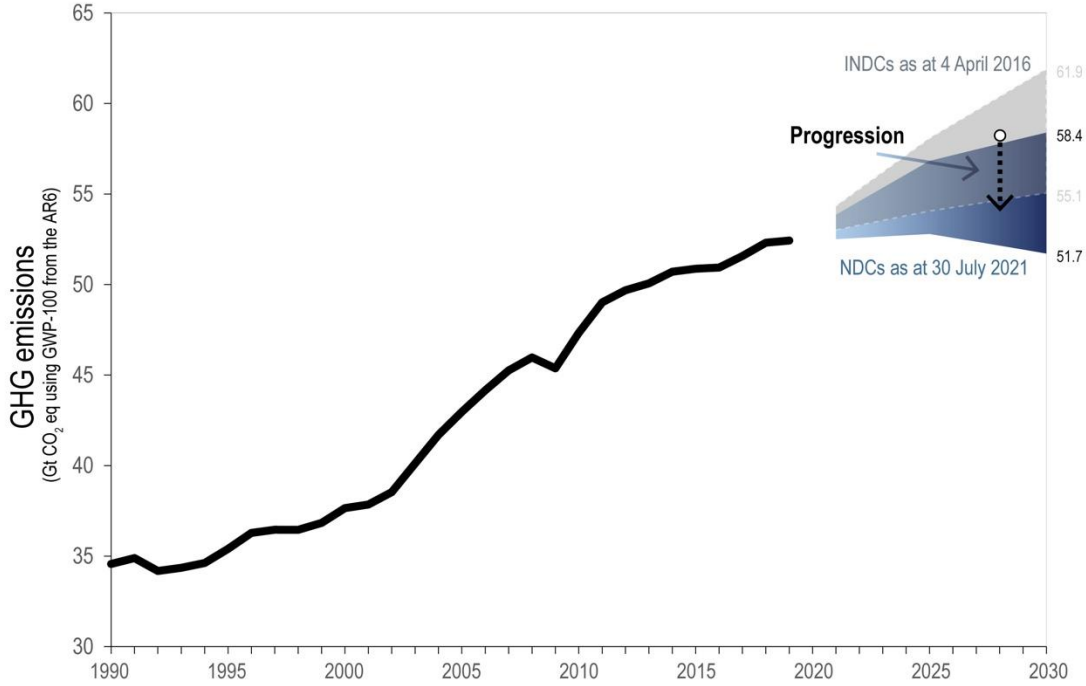
[8] Unless otherwise noted, in this report the average of the quantification is followed by a range that represents the minimum and maximum values after aggregation of the NDCs communicated by Parties, since several presented conditional and unconditional elements of their NDCs and, in some cases, ranges of values for both.

[9] In this report, the term "progression" is used to refer to the difference between the estimated emission levels associated with the implementation of Parties' INDCs communicated to the secretariat as at 4

11. When considering only the new or updated NDCs, the total GHG emissions of the relevant Parties are estimated at 24.4 Gt CO_2 eq in 2019, 23.5 (22.8–24.2) Gt CO_2 eq in 2025 and 21.4 (20.3–22.6) Gt CO_2 eq in 2030. Compared with those Parties' previous NDCs, implementation of their new or updated NDCs is estimated to result in emissions lower by 3.5 (3.1–3.8) per cent in 2025 and 11.3 (10.6–12.1) per cent in 2030. In absolute terms, the projected emission levels for 2025 and 2030 for this group of Parties are now lower than according to their previous NDCs by 0.84 (0.77–0.91) Gt CO_2 eq and 2.73 (2.68–2.78) Gt CO_2 eq, respectively.

12. These Parties' total GHG emissions are now estimated to be 3.4 (0.6–6.2) per cent lower by 2025 and 11.9 (7.3–16.6) per cent lower in 2030 than in 2010. Whereas, according to their INDCs as at 4 April 2016, their total GHG emissions were estimated to be around the 2010 level (ranging from 2.4 per cent below to 2.5 per cent above) in 2025 and 0.7 per cent below (ranging from 5.2 per cent below to 3.7 per cent above) the 2010 level in 2030.

Figure 2
Projected range and progression of emission levels



Note: The projected ranges cover the higher-emission end for unconditional elements of NDCs to the lower-emission end when also taking conditional elements of NDCs into account. Emissions from international aviation included are assumed constant by 2030 at the 2019 level (around 628 Mt CO_2); emissions from international maritime transport of 755 Mt CO_2 eq in 2018 are assumed to be on a linear trajectory by 2030 towards the international maritime sector's target of halving emissions by 2050 compared with the 2008 level (see chap. III below for the sources of these data). The comparison of total emissions resulting from implementation of the INDCs and the latest NDCs includes the difference in assumed bunker emissions (approximately 390 and 540 Mt CO_2 eq lower emissions in 2025 and 2030, respectively).

B. Change in total emissions in relation to the 1990, 2000, 2005, 2010, 2015 and 2019 levels

13. The projected global GHG emission level in 2025 taking into account implementation of all the latest NDCs of all Parties to the Paris Agreement is:

(a) 58.6 (52.7–64.4) per cent higher than the 1990 level (34.6 Gt CO_2 eq);

April 2016 and those according to the NDCs available in the interim NDC registry as at 30 July 2021. In the figures in this report the progression is shown from INDCs as at 4 April 2016 (grey shading), covered in document FCCC/CP/2016/2, to NDCs as at 30 July 2021 (blue shading), aggregated in this report.

(b) 45.6 (40.2–50.9) per cent higher than the 2000 level (37.7 Gt CO_2 eq);

(c) 27.6 (22.9–32.3) per cent higher than the 2005 level (43.0 Gt CO_2 eq);

(d) 15.8 (11.5–20.1) per cent higher than the 2010 level (47.3 Gt CO_2 eq);

(e) 7.7 (3.8–11.7) per cent higher than the 2015 level (50.9 Gt CO_2 eq);

(f) 4.5 (0.7–8.4) per cent higher than the 2019 level (52.4 Gt CO_2 eq).

14. As shown in figure 3, global GHG emissions in 2030 are projected to be:

(a) 59.3 (49.6–68.9) per cent higher than in 1990;

(b) 46.2 (37.4–55.1) per cent higher than in 2000;

(c) 28.1 (20.4–35.9) per cent higher than in 2005;

(d) 16.3 (9.3–23.4) per cent higher than in 2010;

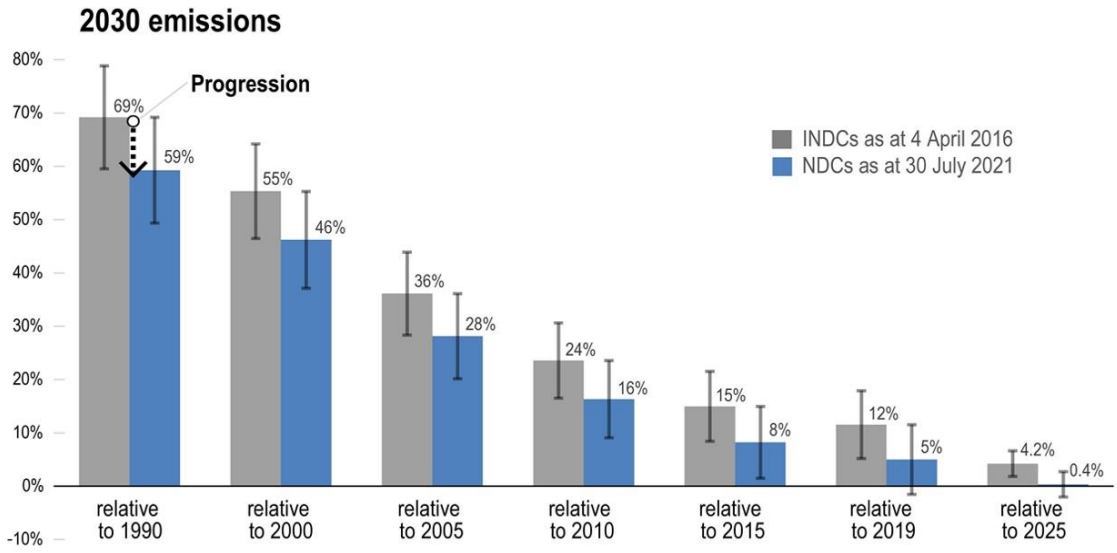
(e) 8.2 (1.7–14.8) per cent higher than in 2015;

(f) 5.0 per cent higher (ranging from 1.4 per cent lower to 11.4 per cent higher) than in 2019.

15. In comparison, the estimated emission level for 2030 associated with implementation of Parties' INDCs implied stronger emission increases above historical levels: 69.2 (59.3–79.1) per cent above the 1990 level, 23.6 (16.3–30.8) per cent above the 2010 level and 11.5 (5.0–18.1) per cent above the 2019 level (see figure 3).

Figure 3

Projected total emission levels in 2030 compared with historical levels and the estimated 2025 level



Note: The 2030 emissions and ranges reflect the average (and min–max ranges) across both the unconditional elements of NDCs and the full implementation of NDCs (including their conditional elements), as discussed in paragraphs 13–15 above.

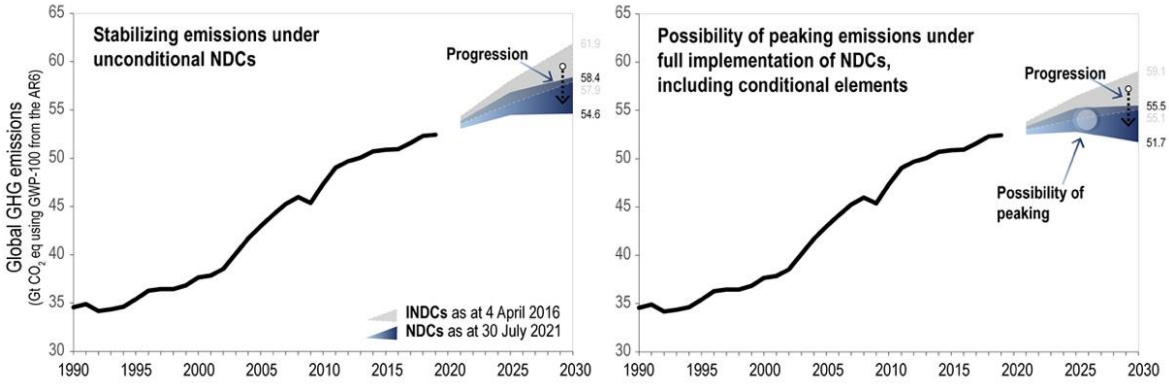
16. The global GHG emission level resulting from implementation of the unconditional elements of all NDCs, including the new or updated NDCs, is projected to be 7.8 (4.2–11.4) per cent higher in 2030 than in 2019; whereas the total GHG emission level resulting from implementation of the NDCs including conditional elements is projected to be only 2.3 per cent higher in 2030 than in 2019 (ranging from 1.4 per cent lower to 5.9 per cent higher).

17. If all NDCs (including their conditional elements) are fully implemented, peaking of global emissions before 2030 could be possible, with the lower bound of the 2030 emission level (51.7 Gt CO_2 eq) estimated to be up to 1.4 per cent below the 2019 level (52.4 Gt CO_2

eq) and 2.1 per cent below the lower bound of the estimated 2025 level (52.8 Gt CO_2 eq) (see figure 4).[10]

18. In comparison, considering the full implementation of INDCs as at 4 April 2016 (including their conditional elements), a continuously increasing trend in emissions is estimated up to 2030, resulting in a global emission level of approximately 8.9 (5.0–12.7) per cent above the 2019 level. Implementation of only the unconditional elements of the INDCs is estimated to result in a global emission level in 2030 of approximately 14.2 (10.4–18.1) per cent above the 2019 level (see figure 4).

Figure 4
Historical and projected total emissions according to nationally determined contributions



Note: Emissions with LULUCF in 2030 resulting from implementation of the new or updated NDCs are estimated to be 59.1 (57.2–61.0) Gt CO_2 eq considering only unconditional elements and 56.2 (54.3–58.1) Gt CO_2 eq assuming full implementation (including their conditional elements).

C. Per capita emissions in relation to historical levels

19. Global average per capita GHG emissions slightly increased in 2000–2010 and have been near constant since, estimated at 6.5, 6.2 and 6.6 t CO_2 eq in 1990, 2000 and 2005, respectively, and near constant at 6.9 t CO_2 eq in 2010 and 2015 and 6.8 t CO_2 eq in 2019.[11]

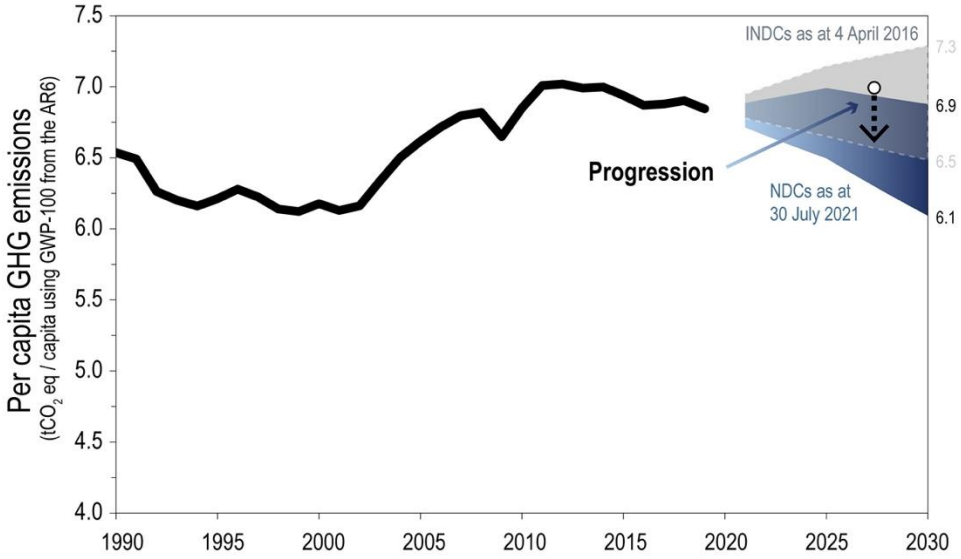
20. On the basis of the latest NDCs, per capita emissions are projected to be 6.7 (6.5–7.0) t CO_2 eq in 2025 and, slightly lower, 6.5 (6.1–6.9) t CO_2 eq in 2030, which is, on average, 1.5 per cent lower in 2025 and 5.2 per cent lower in 2030 than in 2019 (see figure 5).

21. In comparison, on the basis of the INDCs, per capita emissions are projected to be 6.9 (6.7–7.1) t CO_2 eq in 2025 and 6.9 (6.5–7.3) t CO_2 eq in 2030, which is 0.7 per cent higher in 2030 than in 2019.

[10] A similar decrease below the 2025 emission level indicates that global emissions may also peak before 2030 when also accounting for LULUCF.

[11] Unless otherwise noted, in this report per capita emission levels are without LULUCF and calculated on the basis of the 2019 Revision of World Population Prospects of the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (available at https://population.un.org/wpp/) and its medium-variant projection.

Figure 5
Historical and projected per capita emissions



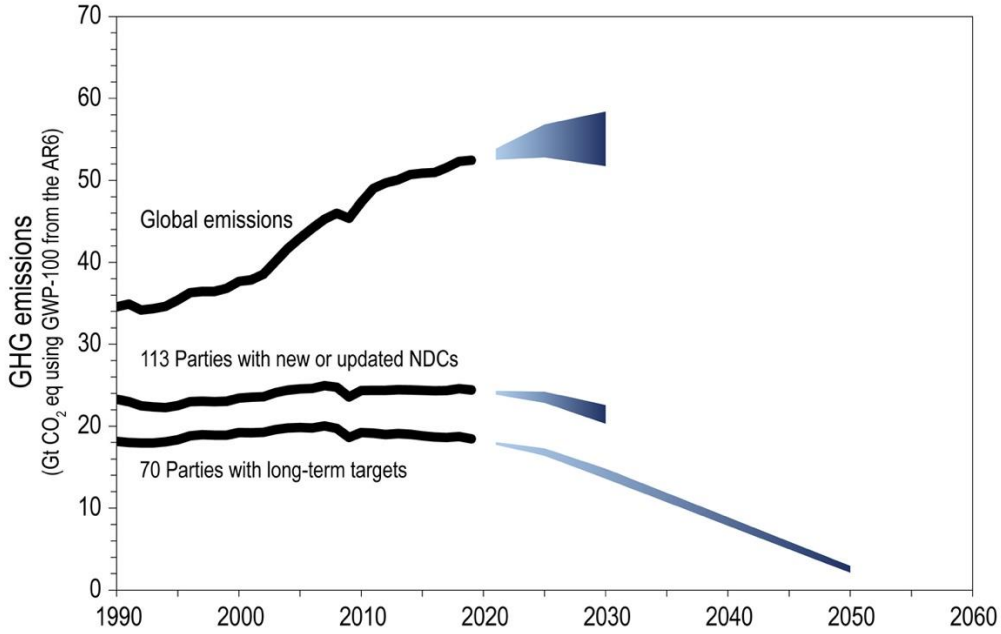
D. Long-term mitigation visions, strategies and targets

22. A total of 70 Parties provided quantifiable information on their long-term mitigation visions, strategies and targets for up to and beyond 2050, which either have already been formulated, are under preparation or have been communicated through a long-term low-emission development strategy. Most of the long-term goals refer to climate neutrality, carbon neutrality, GHG neutrality or net zero emissions by 2050, 2060 or mid-century.

23. The GHG emissions of those Parties in 2010 and 2019 are estimated at 19.2 and 18.5 Gt CO_2 eq, respectively. For 2030, their emissions are estimated at 14.2 (13.6–14.8) Gt CO_2 eq, 26 (23–29) per cent lower than in 2010 and 23 (20–27) per cent lower than in 2019.

24. On the basis of the information provided on long-term mitigation visions, strategies and targets in the NDCs, the total emissions in 2050 of the Parties with long-term targets are estimated at 2.1–2.9 Gt CO_2 eq. Mindful of the inherent uncertainties surrounding such long-term estimates, this represents a GHG emission reduction of about 84–89 per cent below the 2019 level by 2050 (see figure 6).

Figure 6
Estimated emission levels resulting from implementation of nationally determined contributions



25. For the Parties that provided information on long-term mitigation visions, strategies and targets, the average per capita emission level resulting from their implementation is estimated at 1.0–1.3 t CO_2 eq for 2050, which is 85–89 per cent lower than in 2019. The Parties that have put forward a long-term target tend currently to have higher than global average per capita emissions, but by 2030 their per capita emissions are projected to be close to the global average level.

26. In comparison, global per capita emission levels by 2050 under the 1.5 and 2 °C scenarios assessed by the IPCC are very similar, with the well-below 2 °C scenarios ("lower 2 °C")[12] and 1.5 °C scenarios ("1.5 °C with limited overshoot")[13] implying 1.6–2.4 and 0.6–1.2 t CO_2 eq emissions/capita, respectively.

E. Comparison with scenarios considered by the Intergovernmental Panel on Climate Change

27. According to the SR1.5,[14] net anthropogenic CO_2 emissions need to decline by about 45 per cent from the 2010 level by 2030 (40–60 per cent interquartile range), reaching net zero around 2050 (2045–2055 interquartile range), in order to be consistent with global emission pathways that feature no or limited temporary overshoot of the 1.5 °C warming level. The contribution of Working Group I to the AR6[15] conveyed a similar message in that

[12] Refers to the SR1.5 scenarios that imply warming above 1.5 °C by 2100 but with at least a likely (66 per cent) chance of keeping it below 2 °C relative to the 1850–1900 level. A precise definition of the IPCC SR1.5 scenario categories is available at https://data.ene.iiasa.ac.at/sr15_scenario_analysis/assessment/sr15_2.0_categories_indicators.html.

[13] For the categorization of "1.5 °C with limited overshoot" scenarios, see footnote 18 below.

[14] IPCC. 2018. *IPCC Special Report on the Impacts of Global Warming of 1.5 °C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*. V Masson-Delmotte, P Zhai, H-O Pörtner, et al. (eds.). Geneva: World Meteorological Organization. Available at https://www.ipcc.ch/sr15/.

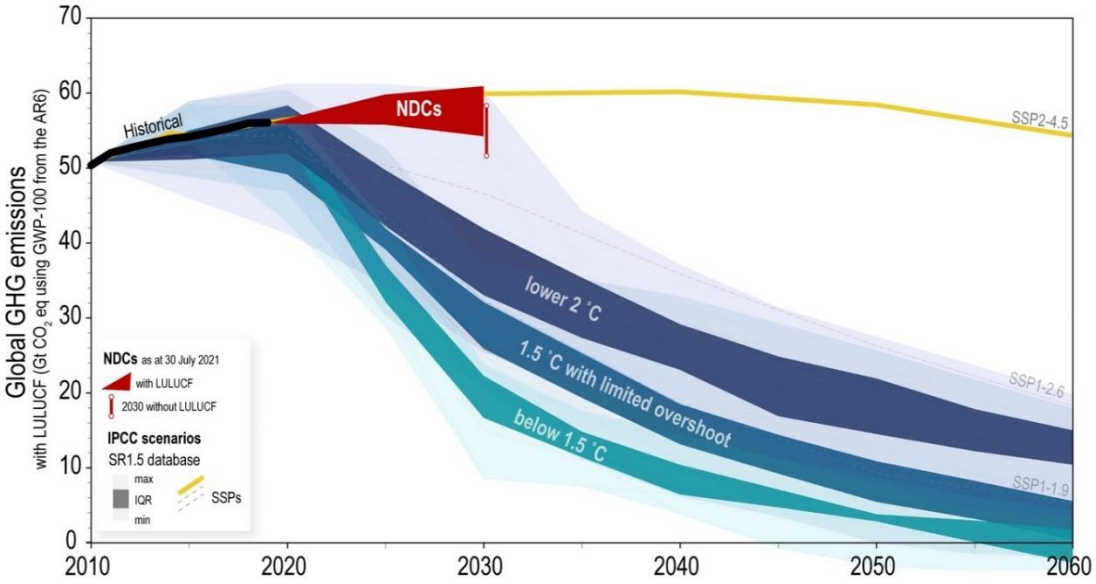
[15] IPCC. 2021. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. V Masson-Delmotte, P Zhai, A Pirani, et al. (eds.). Cambridge: Cambridge University Press. Available at https://www.ipcc.ch/report/ar6/wg1/.

the "very low GHG emissions" scenario considered is the only scenario in which warming is limited to around 1.5 °C and features net zero global CO_2 emissions around 2050. For limiting global warming to below 2 °C, CO_2 emissions need to decline by about 25 per cent from the 2010 level by 2030 on most pathways (10–30 per cent interquartile range) and reach net zero around 2070 (2065–2080 interquartile range). Deep reductions are required for non-CO_2 emissions as well.[16]

28. In figure 7, the total GHG emission levels taking into account implementation of all the latest NDCs are compared with emission levels for three of the scenario groups in the SR1.5 database:[17] a group of scenarios in which global mean temperature rise is kept at all times below 1.5 °C relative to the 1850–1900 level ("below 1.5 °C");[18] a group of scenarios in which warming is kept at around 1.5 °C with a potential limited overshoot and then decrease of global mean temperature rise below 1.5 °C by the end of the century ("1.5 °C with limited overshoot");[19] and a third group that implies warming above 1.7 °C but with a likely chance of it being well-below 2 °C ("lower 2 °C"). The latter group features scenarios with strong emission reductions in the 2020s or only after 2030.

Figure 7

Comparison of global emissions under scenarios assessed in the Intergovernmental Panel on Climate Change Special Report on Global Warming of 1.5 °C with total emissions according to nationally determined contributions



Note: The assessed global emission ranges (including LULUCF) for the IPCC scenarios provided in the SR1.5 (table 2.4) are shown with interquartile ranges (dark ranges). The illustrative SSP scenarios considered in the contribution of Working Group I to the AR6 are indicated (SSP2-4.5 by a yellow solid line, with an estimated end-of-century temperature rise of 2.7 (2.1–3.5) °C).

29. The total GHG emission level in 2030 taking into account implementation of all the latest NDCs is expected to be higher than the emission level in the well-below 2 °C scenarios ("lower 2 °C") by 19.5 (14.9–25.4) Gt CO_2 eq. If full implementation of the NDCs (including their conditional elements) is assumed, the difference between the emission level taking into account the latest NDCs and that in the well-below 2 °C scenarios is reduced to 17.7 (14.0–

[16] Further information on all IPCC scenarios is available at https://data.ene.iiasa.ac.at/iamc-1.5c-explorer/.

[17] See Huppmann D, Rogelj J, Kriegler E, et al. 2018. A new scenario resource for integrated 1.5 °C research. *Nature Climate Change*. 8(12): pp.1027–1030. Available at https://www.nature.com/articles/s41558-018-0317-4.

[18] Refers to the SR1.5 scenarios that imply keeping the global mean temperature rise at all times below 1.5 °C relative to the 1850–1900 level with at least a 50 per cent chance.

[19] Refers to the SR1.5 scenarios that imply keeping warming to around 1.5 °C with a potential limited overshoot and then decreasing the global mean temperature rise to below 1.5 °C with at least a 50 per cent chance by the end of the century relative to the 1850–1900 level.

23.6) Gt CO_2 eq. Without implementation of any conditional elements of the NDCs, that difference increases to 20.6 (16.9–26.5) Gt CO_2 eq.

30. The total GHG emission level in 2030 taking into account implementation of all the latest NDCs is estimated to be 28.1 (25.1–31.6) Gt CO_2 eq higher than the emission level in the "1.5 °C with limited overshoot" scenarios and 37.6 (34.8–41.5) Gt CO_2 eq higher than the emission level in the "below 1.5 °C" scenarios (see figure 7). In the case of full implementation of the NDCs (including their conditional elements), emissions by 2030 are expected to be 26.4 (23.9–30.1) Gt CO_2 eq higher than in the "1.5 °C with limited overshoot" scenarios, and 35.6 (33.5–39.9) Gt CO_2 eq higher than in the "below 1.5 °C" scenarios.[20]

31. The total global GHG emission level in 2030 taking into account implementation of all the latest NDCs is expected to be 16.3 per cent above the 2010 level. According to the SR1.5, to be consistent with global emission pathways with no or limited overshoot of the 1.5 °C goal, global net anthropogenic CO_2 emissions need to decline by about 45 per cent from the 2010 level by 2030, reaching net zero around 2050. For limiting global warming to below 2 °C, CO_2 emissions need to decrease by about 25 per cent from the 2010 level by 2030 and reach net zero around 2070.

32. The information in figure 7 and paragraphs 29–31 above implies an urgent need for either a significant increase in the level of ambition of NDCs between now and 2030 or a significant overachievement of the latest NDCs, or a combination of both, in order to attain cost-optimal emission levels suggested in many of the scenarios considered in the contribution of Working Group I to the AR6. If emissions are not reduced by 2030, they will need to be substantially reduced thereafter to compensate for the slow start on the path to net zero emissions. The SR1.5 identifies net zero CO_2 emissions as a prerequisite for halting warming at any level.

F. Comparison with historical emissions and remaining carbon budgets

33. In the contribution of Working Group I to the AR6, the remaining carbon budgets consistent with keeping warming below 1.5 and 2 °C are assessed. Global cumulative CO_2 emissions in 1850–2019 are estimated at 2,390±240 Gt CO_2. For a 50 per cent likelihood of keeping warming below 1.5 °C relative to the 1850–1900 level, there is an estimated remaining carbon budget of 500 Gt CO_2. As long as cumulative CO_2 emissions from the start of 2020 stay below that level, the best estimate of the IPCC is that long-term average warming can be kept at or below 1.5 °C. If cumulative CO_2 emissions were to exceed 500 Gt CO_2 either before 2030 or thereafter, net negative emissions would be necessary to bring global mean temperature rise to below 1.5 °C in the second half of the century. The remaining carbon budget consistent with a likely chance (67 per cent) of keeping warming below 2 °C is assessed by the IPCC to be 1,150 Gt CO_2 from the beginning of 2020.

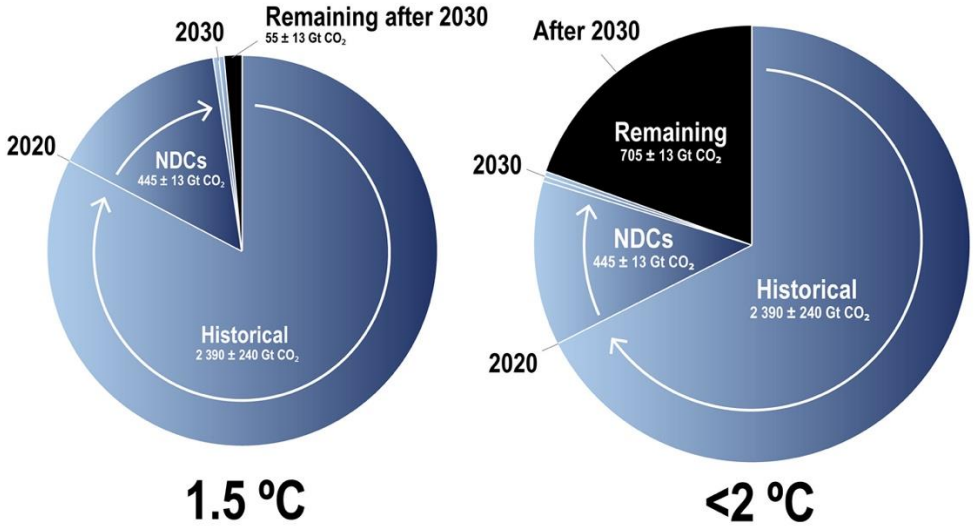
34. On the basis of the latest NDCs, cumulative CO_2 emissions in 2020–2030 are estimated to be around 445 (432–458) Gt.

35. In the context of the carbon budget consistent with 50 per cent likelihood of limiting warming to 1.5 °C, cumulative CO_2 emissions in 2020–2030 based on the latest NDCs would likely use up 89 per cent of the remaining carbon budget, leaving a post-2030 carbon budget of around 55 Gt CO_2, which is equivalent to an average year of CO_2 emissions in 2020–2030 (see figure 8). Similarly, in the context of the carbon budget consistent with a likely chance of keeping warming below 2 °C, cumulative CO_2 emissions based on the latest NDCs would likely use up around 39 per cent of the remaining carbon budget in 2020–2030.

[20] The differences between scenarios from the IPCC database and the global aggregate emissions under implementation of the NDCs are derived from total global emissions including emissions from LULUCF and international aviation and international maritime transport. Differences are provided as medians and interquartile ranges.

Figure 8

Remaining carbon budget consistent with keeping warming at 1.5 °C or having a likely chance of keeping it below 2 °C



III. Approach and methods for estimating emission levels resulting from implementation of nationally determined contributions[21]

A. Approach

36. The estimated total GHG emission levels of Parties in 2025, 2030 and 2050 taking into account implementation of their latest NDCs, including the new or updated NDCs, are discussed in this report in relation to:

(a) The estimated levels of emissions for those years according to the Parties' INDCs;

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

(c) The global emission levels corresponding to scenarios consistent with limiting the global average temperature rise to well below 2 °C above pre-industrial levels;

(d) The global emission levels corresponding to scenarios consistent with holding the global average temperature rise to below 1.5 °C above pre-industrial levels by 2100 with no or limited overshoot;

(e) Per capita emission levels calculated on the basis of the most recent United Nations population data, historical estimates and the medium-variant projection.

37. For the purpose of this report:

(a) The information communicated by Parties in their latest NDCs, including their new or updated NDCs, was considered. The use of any additional information is described in chapter III.B below;

(b) The synthesis is focused 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 Parties taken together as a group, as explained in paragraph 39(c) below;

(c) Information is presented for the represented Parties taken together as a group.

[21] Unless otherwise noted, the approach and methods described in document FCCC/CP/2016/2, chap. II.C, were applied.

38. It was assumed that Parties will achieve the conditional and unconditional emission levels projected in the NDCs; no assumptions were made on the likelihood or implications of the NDCs not being fully implemented or being overachieved.

B. Methods

39. For the purpose of this report:

(a) The total emission levels of Parties in 2025, 2030 and 2050 resulting from implementation of the latest NDCs, including the new or updated NDCs, were estimated;

(b) The total emission levels of countries that are not Parties to the Paris Agreement were estimated for 2025 and 2030 using their INDCs, if available, or a low SSP reference scenario, downscaled to the country level;[22]

(c) The levels of the emissions not covered by the NDCs in 2025, 2030 and 2050 were estimated using data on international bunker emissions and IPCC reference scenarios.[23]

40. The total GHG emission levels in 2025, 2030 and 2050 resulting from implementation of the latest NDCs, including the new or updated NDCs, were estimated by summing the expected levels of emissions for the same year communicated in each NDC. The resulting emission levels are expressed as average values and minimum–maximum ranges owing to the uncertainties underlying the aggregation and the ranges and conditions expressed in the NDCs.

41. The estimates of total GHG emission levels in 2025 and 2030 are provided as follows:

(a) For the full implementation of both the unconditional and conditional elements of the NDCs;[24]

(b) For implementation of only the unconditional elements of the NDCs. For Parties that have conditional targets only, 'business as usual' reference scenarios were assumed;

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

42. Unless otherwise noted, the discussion of total GHG emission levels resulting from implementation of the NDCs is premised on the average of the implementation of either the unconditional or also the conditional elements of the NDCs, as described in paragraph 41(b) above.

43. Where a Party included in its NDC an expected absolute level of emissions for 2025, 2030 or later, that figure was used in the calculation of the total emission level.[25] Otherwise, the method used for quantifying the estimated level of emissions in the target year (2025 or 2030) depended on the type of target:

(a) For absolute emission reduction targets relative to a base year, it was calculated by 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;

[22] As footnote 23 below.

[23] Such estimates are based on emission figures for 2025, 2030 and 2050 for the countries, sectors and gases not covered by the NDCs derived from scenarios assessed by the IPCC in the SSP scenario database at https://tntcat.iiasa.ac.at/SspDb/dsd. The country-level estimates for the low SSP1 reference scenario follow Grutsch J, Jeffery ML, Günther A, et al. 2020. Country resolved combined emission and socio-economic pathways based on the RCP and SSP scenarios (Version 1.0). *Zenodo*. Available at http://doi.org/10.5281/zenodo.3638137. The SSP1 reference scenario was developed using the Integrated Model to Assess the Greenhouse Effect.

[24] 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 full implementation of the NDCs, including conditional elements, to the higher-emission end of the unconditional range.

[25] If necessary, a conversion was applied using GWP-100 from the AR6.

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

(c) Cumulative annual emission reductions were assumed to increase linearly, except where cumulative reductions both up to 2030 and beyond were stated. In the latter case, reductions in 2030–2050 were assumed as a constant reduction over the stated target period. If both cumulative and absolute target levels for a specific year were specified, the latter figure was used;

(d) Net zero emission or climate- and carbon-neutrality targets were assumed to cover the same sectors and gases as the Party's NDC targets for 2030, unless otherwise noted in the NDC:

(i) For net zero emissions it is assumed that the sum, weighted by GWP-100 from the AR6, of the covered emissions in the target year equals zero;

(ii) Carbon-neutrality targets or net zero carbon emission targets are implemented as only covering CO_2 emissions and keeping non-CO_2 emissions constant at the 2030 level by the target year;

(iii) Climate-neutrality targets are implemented as net zero emission targets;

(iv) Any long-term targets stated for 2040 are assumed to be maintained up to at least 2050 and any stated for 2060 are assumed to be proportionally achieved by 2050. In the latter case, the 2050 emission level is estimated as the 2030 emission level plus two thirds of the emission difference between the 2060 and 2030 emission levels;

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

(f) For other types of target, including in relation 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 and 2030 were provided in the NDCs.

44. 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 implementation of its NDC.

45. If a Party had previously communicated a target with a time frame of up to 2020 (e.g. in the context of pre-2020 action), the level of expected emissions in 2020 associated with that target was used.

46. If a Party did not indicate a target for 2030, the emissions trajectory between the latest historical emission level available and 2025 was assumed to continue at the same rate after 2025.

47. In order to show the progression of Parties' long-term targets for up to 2050, if the previous NDC did not indicate a long-term or 2050 target, the emissions trajectory for 2025–2030 was assumed to continue at the same rate after 2030.

48. The targets communicated by Parties in their latest NDCs, including the new or updated NDCs, were used in the estimations for this report, but that information was complemented, as necessary, by data contained in the latest GHG inventories, national communications, biennial update reports and biennial reports, with any remaining data gaps filled using scientific global data sets.[26]

[26] To ensure 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 for estimating the total level of

49. In order to quantify the difference in estimated emissions since the INDCs, emissions for the covered sectors and gases for all Parties were complemented by information on non-covered sectors and gases. Similarly, non-covered sectors and gases were added at the total level to the sum of covered gases and sectors for the latest NDCs, including the new or updated NDCs. Also, the INDCs were assessed using the same set of updated reported historical emission data as the new or updated NDCs, unless the INDCs referred to specific absolute emission or reference levels, including in GHG inventory reports, in which case those were used.

50. The long-term strategies were quantified as stated in the latest NDCs, including the new or updated NDCs, or as stated in the long-term strategies officially reported[27] by Parties.

51. Total global GHG emissions in 2019 were estimated by summing the GHG emission data for individual Parties contained in their latest GHG inventories, national communications and biennial update reports, complemented by other data from global data sets to address any remaining data gaps.[28] Since emissions from international transport were not included in the sum of emissions for Parties with new or updated NDCs, but in the global totals, historical CO_2 emissions related to aviation and GHG emissions related to maritime transport were used to complement the country data to arrive at the global total emission estimate.

52. As regards the use of international market-based mechanisms, it was assumed that any international offset will lead to additional emission reductions in other countries. In other words, it was assumed that emission reductions in the context of the implementation of one NDC are not double counted in the context of implementing another.

53. The analysis took into account the specific GWP values that Parties indicated, namely GWP-100 from the AR2, AR4 or AR5. GWP-100 from the AR6 were used to sum 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.

54. To facilitate comparison of projected and historical GHG emission estimates calculated using GWP-100 from the AR6, AR5 and AR4, the total emission levels without LULUCF are provided in the table below calculated using the different GWPs.

Estimates of historical emissions in 2010 and 2019 and projected emissions for 2025 and 2030 calculated using different global warming potential values

		GWP-100 AR6	*GWP-100 AR5*	*GWP-100 AR4*
2010	Historical	47.3	47.2	46.5
2019	Historical	52.4	52.2	51.4
2025	NDC implementation, unconditional elements	55.7 (54.5–56.8)	55.4 (54.2–56.5)	54.7 (53.5–55.8)
2025	Full NDC implementation, including conditional elements	54.0 (52.8–55.3)	53.7 (52.5–55.0)	53.1 (51.8–54.3)
2030	NDC implementation, unconditional elements	56.5 (54.6–58.4)	56.2 (54.3–58.1)	55.5 (53.6–57.4)
2030	Full NDC implementation, including conditional elements	53.6 (51.7–55.5)	53.3 (51.4–55.2)	52.7 (50.8–54.6)

emissions associated with 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 to the UNFCCC and GHG inventory submissions, with data gaps filled using sources such as the Food and Agriculture Organization of the United Nations and the Emission Database for Global Atmospheric Research.

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

[28] 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, Jeffery L, Gieseke R, et al. 2021. The PRIMAP-hist national historical emissions time series (1750-2019) v2.3. *Zenodo*. Available at https://zenodo.org/record/5175154#.YUMLQJ0zZpl.

C. Key methodological challenges and approaches to addressing them

55. A number of uncertainties and challenges are involved in these approaches and methods linked to target specification and data availability and quality.

56. 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 those in the INDCs, the targets in the new or updated 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 or policies and measures. A larger share of targets relative to a historical base year or quantified future reference level was communicated in the new or updated NDCs, as well as more other types of target that present fewer quantification challenges, such as targets specified in terms of absolute future emission levels, cumulative emission budgets and net zero emissions.

57. 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 the chosen GWP values in their new or updated NDCs); lack of gas-by-gas emission data for summing emissions using consistent metrics; missing or incomplete data on the 'business as usual' or reference scenario; lack of clarity on approaches to LULUCF accounting; missing information in relation to the application of conditions in the target year; and lack of information on the use of international market-based mechanisms and how double counting was avoided.

58. A consistent approach to addressing these challenges was applied:

(a) Uncertainties arising from the different ways of expressing targets were addressed by applying the method described in paragraph 43 above;

(b) As noted in paragraph 40 above, the synthesis was based on data in the latest NDCs, including new or updated NDCs, and challenges related to missing data were addressed as described in paragraphs 44–50 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.

59. Uncertainties linked to conditions specified by Parties in their NDCs were addressed by separately estimating unconditional and conditional, and only unconditional, emission reduction levels and expressing the result as a range. Also, 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 in estimating the overall ranges of projected emission levels resulting from implementation of the unconditional elements of NDCs, as well as the effect of the implementation of both unconditional and conditional NDC elements (see para. 41 above).

60. 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 global emissions to how emissions and removals from the LULUCF sector were considered. For example, some Parties intend to follow specific LULUCF accounting rules, while others will pursue a full carbon accounting approach (i.e. include LULUCF net emissions or removals in the same way as emissions from any other sector).[29]

61. For this report, the divergent treatments of the LULUCF sector were taken into account in 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 as 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)

[29] A few Parties specified how natural disturbances and harvested wood products are to be accounted for.

emissions were subtracted for the base year if emissions related to natural disturbances were intended not to be counted up to 2025 or 2030. In the absence of other methods for estimating LULUCF-related accounting for some Parties, a (discounted) continuation of credits or debits from the first commitment period of the Kyoto Protocol was assumed, where applicable. Where available, reported projections 'with existing measures' 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 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 for the Parties were derived. Total emissions for groups of Parties are provided in this report without emissions and removals from LULUCF, whereas LULUCF emissions are included in global totals pursuant to the approach described in paragraph 62 below.

62. There is a difference in definition between the estimation of anthropogenic GHG emissions and removals from the LULUCF sector under the UNFCCC, and the estimation of emissions related to land-use change as part of the global emission estimates of the IPCC (see figure 5.5 in chap. 5 of the AR6) and the scenarios in the SR1.5 database. To enable comparison between estimated total emission levels and estimates from the SR1.5 in this report, the underlying calculations for estimating total emissions for 2025 and 2030 take into account LULUCF emission and removal estimates provided by Parties. The main difference between LULUCF emission data reported by Parties and the anthropogenic net emissions from land use that form the basis of the emissions scenarios in the SR1.5 database is the treatment of indirectly anthropogenically induced CO_2 sinks on managed land.[30] In order to estimate total emissions for this report consistently with the global emission estimates of the IPCC, global aggregate emissions have been adjusted for this indirectly induced CO_2 sink.[31] Thus, only directly induced anthropogenic sinks are included in the anthropogenic emission estimates and indirectly induced sinks via CO_2 fertilization are considered part of the natural carbon cycle response to the anthropogenically induced increase of CO_2 concentrations. This enables the total emission estimates presented in this report to be comparable with those of the IPCC.

63. According to the INDCs as at 4 April 2016, the change in the total LULUCF emissions and projections was within the range of the change in land-use change emissions from current levels to 2025 and 2030 in the AR5 reference scenarios.[32] Likewise, the resulting net anthropogenic LULUCF emissions are within the wide range of scientific estimates (see figure 5.5 in chap. 5 of the contribution of Working Group I to the AR6). This qualitatively supports the need to maintain the approach described in paragraph 62 above to presenting the global emission estimates in this report in order to be consistent with the global emissions scenarios assessed by the IPCC.

64. Emissions from international aviation and maritime transport are not considered in national emissions inventories. These "bunker" emissions have to be added to the aggregated 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 International Energy Agency statistics,[33] with a linear extension of emissions in 2018 (603.6 Mt CO_2) to 2019 (627.9 Mt CO_2). The post-2020 carbon-neutral growth target of the sector[34] is assumed to result in emissions being at the

[30] See Grassi G, Stehfest E, Rogelj J, et al. 2021. Critical adjustment of land mitigation pathways for assessing countries' climate progress. *Nature Climate Change*. 11(5): pp.425–434. Available at https://www.nature.com/articles/s41558-021-01033-6.

[31] Specifically, the indirectly induced CO_2 sinks according to the SSP1-1.9 scenario as provided in supplementary table 8 in Grassi et al. (2021).

[32] See https://unfccc.int/files/focus/indc_portal/application/pdf/technical_annex_-_synthesis_report.pdf, chap. E.

[33] On CO_2 emissions from fuel combustion, available at http://dx.doi.org/10.1787/co2-data-en.

[34] See International Civil Aviation Organization resolution A40-18, available at https://www.icao.int/environmental-protection/Documents/Assembly/Resolution_A40-18_Climate_Change.pdf.

same level in 2025 and 2030 as in 2019. For marine bunkers, CO_2, CH_4 and N_2O emissions in 2012–2018 are derived from the fourth IMO GHG study,[35] specifically the voyage-based emissions. The time series is completed by the respective CO_2 marine bunker growth rates from the International Energy Agency statistics. Emissions from international maritime transport are illustratively assumed to decrease to approximately 17 per cent below the 2018 level by 2030 in line with a linear achievement of the IMO 2018 initial strategy goal[36] to reduce them by 50 per cent below the 2008 level (around 790 Mt CO_2 eq) by 2050. The assumed 17 per cent absolute GHG emission reduction is an illustration of the sector's 40 per cent emission intensity improvement target for 2030.

[35] 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.

[36] See https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx.