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**Second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it**

**Subsidiary Body for Implementation**
**Fifty-seventh session**
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Item 9 of the provisional agenda
**Second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it**

# Structured expert dialogue on the second periodic review of the long-term global goal under the Convention (2020–2022)

## Synthesis report by the co-facilitators of the structured expert dialogue*

*Summary*

This report on the structured expert dialogue between over 100 experts, Parties and non-Party stakeholders on the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it summarizes the proceedings of the meetings, synthesizes the findings, which are captured in 10 key messages, and concludes with remarks from the co-facilitators.

* This document was scheduled for publication after the standard publication date owing to circumstances beyond the submitter's control.

# Abbreviations and acronyms

| | |
|---|---|
| AR | Assessment Report of the Intergovernmental Panel on Climate Change |
| $CO_2$ | carbon dioxide |
| $CO_2$ eq | carbon dioxide equivalent |
| COP | Conference of the Parties |
| GHG | greenhouse gas |
| IPCC | Intergovernmental Panel on Climate Change |
| NDC | nationally determined contribution |
| SB | sessions of the subsidiary bodies |
| SED2 | structured expert dialogue on the second periodic review of the long-term global goal |
| UNEP | United Nations Environment Programme |

# I. Introduction

## A. Mandate

1. COP 25 decided that the second periodic review of the long-term global goal under the Convention and of overall progress towards achieving it should, in accordance with the relevant principles and provisions of the Convention and on the basis of the best available science:

(a) Enhance Parties' understanding of:

(i) The long-term global goal and scenarios towards achieving it in the light of the ultimate objective of the Convention;

(ii) Progress made in relation to addressing information and knowledge gaps, including with regard to scenarios to achieve the long-term global goal and the range of associated impacts, since the completion of the 2013–2015 review;

(iii) Challenges and opportunities for achieving the long-term global goal with a view to ensuring the effective implementation of the Convention;

(b) Assess the overall aggregated effect of the steps taken by Parties in order to achieve the long-term global goal in the light of the ultimate objective of the Convention.[1]

2. COP 25 also decided that the second periodic review shall follow, mutatis mutandis, the modalities set out in paragraphs 80–90 of decision 1/CP.18, including a structured expert dialogue, and that the review should start in the second half of 2020 and conclude in 2022.[2]

3. SB 56 requested the co-facilitators of SED2 to prepare in a timely fashion,[3] with the assistance of the secretariat, a synthesis report on the meetings of SED2, which covers in a balanced manner the two themes of the second periodic review, referred to in paragraph 1 above, and reflects the dialogue, for consideration at SB 57.[4]

## B. Possible action by the subsidiary bodies

4. The subsidiary bodies may wish to consider this report as part of their deliberations at SB 57 on a draft decision on the second periodic review for consideration and adoption at COP 27 and with a view to informing the first global stocktake under the Paris Agreement.

# II. Summary of proceedings

5. The three meetings of SED2 were held in conjunction with sessions of the subsidiary bodies and open to all Parties and observers. Building on the approach from the first periodic review, the meetings were organized as a fact-finding exchange of views among experts and Parties, addressing the two themes of the review in a balanced manner. Presentations by experts were followed by discussions among Parties and experts on possible interpretations and policy implications of the findings presented. Poster sessions provided additional opportunities for Parties to engage with experts on issues related to the two themes of the review. A summary report on each meeting was prepared by the co-facilitators of SED2.[5]

6. At the first meeting of SED2, which was held virtually in two sessions in November 2020 and June 2021 owing to the coronavirus disease 2019 pandemic, findings relevant to

[1] Decision 5/CP.25, para. 4.
[2] Decision 5/CP.25, paras. 6–7.
[3] Preferably by 23 September 2022.
[4] FCCC/SBSTA/2022/6, para. 69, and FCCC/SBI/2022/10, para. 50.
[5] All presentations, posters and summary reports are available at https://unfccc.int/topics/science/workstreams/periodic-review/SED.

the second periodic review from the three IPCC special reports[6] published since the first periodic review, information from Parties and UNFCCC constituted bodies, and information from relevant reports of United Nations agencies and other international organizations were considered, as well as the summary report[7] on the round table among Parties and non-Party stakeholders on pre-2020 implementation and ambition.[8]

7. The focus of the second meeting of SED2, held during SB 52–55, was on the relevant content of the contribution of Working Group I to the AR6,[9] the fourth Biennial Assessment and Overview of Climate Finance Flows of the Standing Committee on Finance and other reports recently published by international organizations, including the Organisation for Economic Co-operation and Development, Third World Network, UNEP and World Meteorological Organization Regional Climate Centres.

8. The third meeting of SED2, held at SB 56, was informed by 13 submissions of views from Parties and observer organizations[10] and dedicated to considering relevant issues covered in the contributions of Working Groups II and III to the AR6.[11]

# III. Key findings

9. SED2 included consideration of findings from a range of scientific sources and featured extensive discussions among Parties, experts and non-Party stakeholders. This chapter synthesizes the key findings arising from the presentations and discussions at the three meetings. It is organized around 10 key messages (see boxes 1–10), with the first 5 falling under the first theme and the second 5 falling under the second theme of the second periodic review.

10. This report is not intended to provide an exhaustive assessment of the issues discussed during SED2; rather it documents what was addressed. In addition, the views expressed by experts during SED2 should not be seen as taking precedence over findings in the AR6 or relevant reports of other international organizations or the constituted bodies. Every effort has been made to ensure that this report synthesizes factual information and reflects the scientific understanding of the issues addressed during SED2.

[6] 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/; IPCC. 2019. *IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*. PR Shukla, J Skea, E Calvo Buendia, et al. (eds.). Available at https://www.ipcc.ch/report/srccl/; and IPCC. 2019. *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*. H-O Pörtner, DC Roberts, V Masson-Delmotte, et al. (eds.). Available at https://www.ipcc.ch/srocc/home/.

[7] FCCC/CP/2021/2.

[8] As per decision 1/CP.25, para. 21.

[9] 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, United Kingdom: Cambridge University Press. Available at https://www.ipcc.ch/report/ar6/wg1.

[10] Available at https://www4.unfccc.int/sites/submissionsstaging/Pages/Home.aspx (in the search field type “second periodic review”).

[11] IPCC. 2022. *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. H Pörtner, D Roberts, M Tignor, et al. (eds.). Cambridge, United Kingdom: Cambridge University Press. Available at https://www.ipcc.ch/report/ar6/wg2; and IPCC. 2022. *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. PR Shukla, J Skea, R Slade, et al. (eds.). Cambridge and New York: Cambridge University Press. Available at https://www.ipcc.ch/report/ar6/wg3.

## A. Long-term global goal and scenarios towards achieving it

Box 1
**Key message: at 1.1 °C warming, the world is already experiencing extreme climate change**

Widespread and rapid changes have been observed in the atmosphere, ocean, cryosphere and biosphere, many of which are accelerating, with associated risks developing sooner than expected. The impacts of these changes pose a clear threat to human well-being.

11. **Global surface temperature has reached 1.1 °C above pre-industrial levels.** The Earth has warmed by an estimated 0.19 °C since 2003–2012, the period covered by the first periodic review. Several billion people are already experiencing temporary local temperature change that exceeds the long-term global goal limits of 1.5 and 2 °C, even if the global average temperature has not reached that level yet. Temperatures will continue to rise. There is about a 40 per cent chance of the annual global average temperature exceeding 1.5 °C above pre-industrial levels in at least one of the next five years.

12. **The impacts on natural systems are severe and accelerating.** The scale of the changes observed in the atmosphere, ocean, cryosphere and biosphere, and across the climate system as a whole, is unprecedented. Ocean heat content is at a record high and Arctic sea ice is at a near-record low. Since the first periodic review, it has become clearer that loss of ice from the Greenland and Antarctic ice sheets is accelerating. Changes in the cryosphere and loss of sea ice accelerate sea level rise. For warm water coral reefs, observed impacts of warming are severe, with ocean acidification already high.

13. Land is under increasing pressure as climate change exacerbates desertification and land degradation. The percentage of dry land and drought areas has increased. The presence and persistence of snow and glaciers is decreasing. Impacts on natural systems are often concurrent; for example, increased occurrence of extreme hot weather with dry and windy conditions leads to more frequent and severe wildfires. Climate impacts are often compounded by the impacts of human activities; for example, with human settlements expanding into forested areas, the impacts of wildfires are exacerbated. Impacts on biodiversity are already apparent, with up to 50 per cent local population loss detected in studied species of land plants and animals.

14. **Climate change poses a clear threat to human well-being.** Disruption to the onset and total amount of seasonal rainfall have reduced agricultural productivity. Changes in snowfall, glaciers and the melting season have altered the amount and seasonality of run-off in related river basins, further imperilling water resources and agriculture. Food security is at risk, with documented declines in maize, wheat and barley yields. Climate-related events (e.g. floods, drought, wildfires) have displaced an average of 23 million people per year over the past decade. Climate change has led to increased mortality on every continent.

Box 2
**Key message: knowledge has improved significantly since the first periodic review but important gaps remain**

Understanding of the relationship between the temperature limits of the long-term global goal and the frequency and intensity of extreme climate events has improved. Social sciences facilitate understanding of pathways to a fair and equitable low-carbon transition. Key uncertainties include tipping points and feedback in natural systems, as well as GHG accounting and the enablers of and limits to rapid social change.

15. **The AR6 provides advanced knowledge on the physical science basis of climate change.** The IPCC has strengthened understanding of the human influence on observed warming by combining two lines of evidence from attribution studies as well as assessments of radiative forcing and climate sensitivity. The current science is significantly more robust

than during the first periodic review, especially key characteristics of scenarios of limiting warming to 1.5 and 2 °C.

16. Progress in understanding natural climate variability has led to the establishment of a linear relationship between the level of global warming and the frequency and intensity of extreme climate events. This relationship implies that every fraction of a degree of warming could lead to a notable increase in the occurrence of damaging extreme climate events. The established near-linear relationship between cumulative $CO_2$ emissions and global warming implies that reaching net zero anthropogenic $CO_2$ emissions is a requirement for stabilizing human-induced global temperature increase at any level, and that limiting global temperature increase to a specific level necessitates limiting $CO_2$ emissions within a carbon budget.[12]

17. **The importance of social sciences and sustainable development is being increasingly recognized.** The breadth and extent of the systemic change required to limit warming is clear, as is the need for transformational change across all sectors. Understanding of the drivers and constraints of a low-carbon transition is improving. Information on equity as it applies to climate impacts and action has significantly increased. The need for justice, equity and fairness in shifting development pathways towards sustainability has been broadly acknowledged.

18. **A key uncertainty concerns the degree to which risk transitions are gradual or non-linear**, that is whether there are tipping points in natural systems beyond which they cannot return to their previous state. Future rate of loss from the Antarctic and Greenland ice sheets is a major gap in knowledge for predicting sea level rise. Biogeochemical tipping points remain poorly understood, such as the ability of vegetation to store carbon and possible feedback associated with tropical or boreal forest dieback. There are significant uncertainties about feedback from emissions related to thawing permafrost.

19. **Closing data gaps and improving the GHG accounting framework will help in tracking impacts of mitigation efforts.** Data and methodological gaps pose a challenge for quantifying and assessing impacts of mitigation actions at both the country and aggregate global level. Such gaps are most pronounced for developing countries owing to their relatively limited capacity. Significant uncertainty remains around emissions and sinks in the agriculture, forestry and other land use sector.

20. **Social sciences must advance to facilitate understanding of enablers of and limits to change.** A key question is how to transition from practices that compound climate risk to transformative practices that reduce emissions and enable equitable development. It is unclear whether and where there are social and environmental limits to the pace and extent of change. In addition, important data gaps remain in relation to loss and damage.

Box 3
**Key message: climate impacts and risks, including risk of irreversible impacts, increase with every increment of warming**

Risks are significantly higher at 2 °C than at 1.5 °C warming. Delaying action reduces options for mitigation and adaptation. Avoiding overshoot of the 1.5 °C limit reduces the risk of crossing tipping points and triggering irreversible impacts.

21. **With every increment of warming, there are larger changes in regional mean temperature, precipitation and soil moisture.** With every increment, temperature and related trends intensify in every region, including an increase in the intensity and frequency

[12] In the contribution of Working Group I to the AR6, "carbon budget" is defined as the maximum cumulative net global anthropogenic $CO_2$ emissions that would result in limiting global warming to a given level with a given probability, taking into account the effect of other anthropogenic climate forcers. This is referred to as the total carbon budget when expressed starting from the pre-industrial period and as the remaining carbon budget when expressed from a recent specified date. Historical cumulative $CO_2$ emissions determine to a large degree warming to date, while future emissions cause future additional warming. The remaining carbon budget indicates how much $CO_2$ could still be emitted while keeping warming below a specific temperature level.

of extremes, such as heat waves and heavy precipitation, as well as agricultural and ecological drought in some regions.

22. **Climate risks are developing and expected to intensify sooner than previously assessed.** Newer evidence indicates that the risk assessment in the AR5 was relatively conservative. According to the risk assessment in the AR6, risks are projected to develop sooner, with most sectors transitioning from moderate to high risk at around 1.5 °C warming.

23. **Since the first periodic review, evidence is increasing that climate impacts and risks are significantly different between 1.5 and 2 °C warming.** Above 1.5 °C warming, risks of dry land water scarcity, wildfire damage, permafrost degradation, tropical crop yield decline and food supply instability are projected to be high or transitioning to high. Warming of 2 °C is projected to bring a significant increase in the frequency of days per year that exceed 30 °C, and to make it challenging to farm multiple staple crops in many current growing areas, whereas significant declines in crop yields can be avoided at 1.5 °C warming. Half as many people will be subject to water stress at 1.5 °C compared with 2 °C warming.

24. **The more temperature increases, the less natural systems are able to offer protection.** Natural land and ocean carbon sinks will become less effective the higher the level of $CO_2$ in the atmosphere. Oceans, in particular, may be approaching their capacity to absorb and store $CO_2$. Evidence is growing that some ecosystems may have already surpassed their adaptation limits. For example, at 1.5 °C warming, 70–90 per cent of warm water coral reefs will disappear, along with the ecosystem services they provide.

25. **Delaying action to reduce emissions could lead to adverse impacts that may take many centuries to reverse or be irreversible.** Warming has already set in motion the slow component of the climate system, that is systems such as the ocean and cryosphere that have a long response time to variations in external forcing. Even without additional warming, glaciers will continue to melt for decades or centuries. Changes in global ocean temperature and deep ocean acidification and deoxygenation are irreversible over even longer timescales of centuries or millenniums.

26. Temperature overshoot – where the warming limit is exceeded but temperature returns to below it at a later time – could trigger ongoing and unstoppable sea level rise, even with rapid $CO_2$ removal. Rapidly reducing GHG emissions significantly decreases the chance of triggering irreversible instabilities in ice sheets that could substantially increase sea level rise, as well as decreases the likelihood of triggering impacts in ecosystems, such as the release of methane from thawing peatlands, that could lead to substantial additional GHG emissions. Some systems, such as the ocean, may have already surpassed a tipping point. For these systems, warming beyond 1.5 °C would exacerbate the deterioration.

27. **Delaying action significantly reduces options for mitigation and adaptation.** Some forms of mitigation, such as increasing soil organic carbon, will become less effective as climate change intensifies. Exceeding 1.5 °C warming is likely to limit the effectiveness of adaptation to many projected climate risks. Above 1.5 °C warming, some natural adaptation solutions, such as ecosystem-based adaptation, may no longer be effective. At 2 °C warming, adaptation may not be possible in some areas of the world. Rapid cuts in emissions will help to keep options open; for example, limiting warming will delay sea level rise, allowing more time for coastal communities to adapt.

28. **Achieving the long-term global goal without overshooting the 1.5 °C limit is imperative in order to avoid the most catastrophic impacts.** Limiting warming to 1.5 °C is not safe, but it is safer than limiting warming to 2 °C. Avoiding temperature overshoot reduces the risk of crossing tipping points and triggering irreversible impacts. Though it is difficult to quantify such impacts, the higher and longer the overshoot, the higher the risk of crossing such tipping points.

Box 4

**Key message: it is still possible to achieve the long-term global goal with immediate and sustained emission reductions**

Pathways to limiting warming to 1.5 °C require emissions to peak in 2025 and be roughly halved by 2030 and at net zero by around 2050. Overshooting the 1.5 °C limit

will mean having to rely on technology to bring warming back below the limit. Key opportunities to reduce emissions include targeting methane emissions and capitalizing on the falling cost of renewable energy and on carbon markets.

29. **It is possible to limit warming to 1.5 °C with no or limited overshoot.** $CO_2$ emissions must be cut roughly in half by 2030 (compared with the 2010 level) and reach net zero around 2050, with a concurrent strong reduction in non-$CO_2$ emissions, such as methane, and reductions must be sustained beyond the end of the century. Scenarios show that failure to reduce non-$CO_2$ emissions lowers the probability of limiting warming to 1.5 °C. Mitigation action is thus needed across all sectors and GHGs.

30. **In scenarios of overshooting the 1.5 °C limit, advanced technologies, particularly $CO_2$ removal technologies, would have to be relied upon in the second half of the century** to bring warming back below 1.5 °C by 2100. Approximately 2,220 Gt $CO_2$ net removals would be needed to reverse temperature overshoot of 0.1 °C. The feasibility of most $CO_2$ removal technology is highly uncertain. Options vary in terms of cost, potential and side effects. Moreover, overshoot could cause adverse impacts that may either take decades or even centuries to reverse or prove irreversible.

31. **Rapidly falling costs of renewable energy present opportunities for pre-2030 emission reductions.** In 2020, the cost of electricity generation using four key renewable energy technologies (solar photovoltaics, onshore and offshore wind, and concentrated solar power) was similar to that for fossil fuels in many places. The annual power generation capacity of solar photovoltaics and wind has quadrupled over the last decade. Uptake of electric vehicles is accelerating. Progress has been made in developing bioenergy and green hydrogen technologies. Investment in energy efficiency, including retrofitting buildings and increasing efficiency of cooling appliances and transport, can contribute to mitigation efforts.

32. **Reducing methane emissions can contribute to slowing the rate of warming in the short term and reducing the peak of warming throughout the twenty-first century.** The latest NDCs cover only a fraction of the methane reduction required to be consistent with the 1.5 °C goal. Fossil fuels, agriculture and waste all offer opportunities to reduce methane emissions. For example, of the 46 Parties accounting for 90 per cent of GHG emissions from agriculture, only 12 included measures targeting livestock in their NDCs. Reducing methane emissions can also contribute to improving air quality, thus yielding co-benefits for health.

33. **Carbon markets have the potential to deliver real emission reductions but remain underdeveloped.** By helping to drive down the cost of emission reductions, carbon markets create room for countries, companies and other actors to enhance their mitigation ambition in both the short and long term. Rules must be clearly defined, however, and designed to ensure that transactions reflect actual reductions in emissions. Markets must be supported by arrangements for tracking progress and providing transparency.

Box 5
**Key message: the window of opportunity to achieve climate-resilient development is rapidly closing**

Ambitious mitigation and transformative adaptation must be accompanied by efforts to address structural inequalities, marginalization and multidimensional poverty. Climate-resilient development requires inclusive, multisectoral and forward-thinking planning, alongside a significant injection of resources.

34. **Achieving climate-resilient development requires thinking beyond climate change.** Climate-resilient development pathways combine ambitious mitigation and transformational adaptation, while emphasizing the importance of addressing structural inequalities, marginalization and multidimensional poverty. In order to limit warming to 1.5 °C, social and ecological systems must be reconfigured. Such transformation must include changes in underlying values, worldviews, ideologies, structures and power relations in human systems.

35. **Climate-resilient development requires inclusive, multisectoral and forward-thinking planning.** It is critical to adopt integrated solutions. Taking a long-term approach to adaptation will be cost-effective and can help to reduce vulnerability by building adaptive capacity and resilience over time. Following an adaptation pathway[13] approach to decision-making can help to keep future options open, and facilitate integration of adaptation into development planning processes and strategies. Equitable partnerships for climate-resilient development must involve not only government actors, civil society and the private sector, but also those that are often marginalized from decision-making processes, such as youth, women, indigenous peoples and peoples with disabilities.

36. **More resources are required over the next decade.** The magnitude of observed impacts and projected climate risks indicates the scale of decision-making, funding and investment needed to achieve climate-resilient development. Increased finance, capacity-building and technology transfer support is needed, especially for developing countries. Adaptation should be a particular focus, as the costs risk increasing faster than the available finance owing to the severity of climate impacts and the inadequacy of mitigation action.

37. **Achieving climate-resilient development is already a significant challenge at the current level of warming.** It will be even more of a challenge if warming exceeds 1.5 °C and may be impossible at warming of 2 °C in some areas. Any further delay in action will mean missing the brief and rapidly closing window of opportunity to ensure a liveable world for future generations.

## B. Assessing the overall aggregated effect of steps taken by Parties

Box 6
**Key message: the world is not on track to achieve the long-term global goal**

Not enough has been done to reduce emissions. The world is on a pathway to global warming of 1.5 °C in 2021–2040 and 2 °C around 2050. A significant gap remains between pledged emission reductions and the reductions required to meet the long-term global goal. The emissions gap must be urgently bridged if achieving net zero emissions and the long-term global goal is to remain possible.

38. **Global GHG emissions are at an all-time high**. In 2010–2019, average annual emissions were at the highest level in human history for each of the major GHGs. In 2019, emissions were 12 per cent higher than in 2010 and 54 per cent higher than in 1990. Emission growth slowed, however, from 2.1 per cent annually in 2000–2009 to 1.3 per cent annually in 2010–2019. The pandemic and associated measures led to an unprecedented drop in global GHG emissions in 2020, including a 5.4 per cent reduction in $CO_2$ emissions. The effect was short-lived, however, with almost no impact on GHG concentrations and an undetectable impact on global temperature.

39. **The emission reductions pledged in NDCs will not lead to limiting temperature rise to 2 °C, much less 1.5 °C.** In all scenarios, the best estimate is that the rise in global surface temperature will reach 1.5 °C on average in 2021–2040. This implies that, by the 2030s, in every single year there is a 50 per cent chance of a global surface temperature of 1.5 °C above pre-industrial levels. In the intermediate scenario, the best estimate is that global surface temperature on average across 20 years will reach 2 °C around 2050 and around 2.7 °C by 2100 (with a 66 per cent probability range from 2.1 to 3.5 °C).

40. **There is a considerable gap between pledged emission reductions and the reductions needed to stay on pathways to limiting warming to 1.5 and 2 °C.** With the current emission reduction policies implemented, warming of 3.2 °C would be expected by 2100. On the basis of the latest emission pledges (i.e. NDCs submitted before COP 26), warming is estimated at 2.8 °C. Staying on this path until 2030 would require rapid emission

[13] As per the AR6, adaptation pathways are a series of adaptation choices involving trade-offs between short-term and long-term goals and values. These are processes of deliberation for identifying solutions that are meaningful to people in the context of their daily lives and for avoid potential maladaptation.

reductions after 2030 as well as negative emissions to bend the temperature curve back down to 1.5 °C by 2100. According to UNEP,[14] even if conditional and unconditional components of NDCs are fully implemented, there will still be an emissions gap of 11–13 Gt $CO_2$ eq in 2030 with respect to limiting warming to 2 °C, and a gap with respect to 1.5 °C of warming of 25–28 Gt $CO_2$ eq.

41. **Full implementation of net zero targets in addition to emission reduction pledges for 2030 could bring the level of warming closer to the long-term global goal.** The above-mentioned emissions gaps do not account for the net zero pledges that Parties made in 2021. Those pledges have significant ambiguities, however, and the plans for implementation and for reviewing progress in the delivery of emission reductions lack transparency.

42. **More ambitious climate action is needed to achieve the long-term global goal.** An ambition level four times higher than the current one is needed to stay on track for a global temperature increase of no more than 2 °C and seven times higher for no more than 1.5 °C of warming. Since the first periodic review, action has not been aligned with the improved knowledge of the pathways to limiting warming. Many countries have brought forward measures and packages that continue to support the high-carbon status quo of their economies, with some even fostering new high-carbon investments.

Box 7
**Key message: despite some progress on mitigation and adaptation, more efforts are needed**

Parties are taking clear steps to reduce emissions. An increase in national climate laws, strategies and policies has led to significant avoided emissions. Adaptation action is widespread but remains incremental, with little evidence of reduced climate risk resulting from it. Some human and natural systems may be encountering, and even surpassing, their adaptation limits.

43. **Developed and developing countries alike are taking steps to reduce emissions** consistently with their pre-2020 implementation pledges**.** Despite some fluctuations, there is a clear declining trend in the total emissions of developed country Parties (though not for each individual Party), with a 3.4 per cent decrease between 2010 and 2018. The scale of the absolute reductions for those countries is small, however, compared with overall global emission growth. Developing countries are also taking steps to decouple their economies from emissions and to slow emission growth.

44. **There has been a steep rise in implementation of climate laws and establishment of institutions.** Since the first periodic review, governments have enacted more climate laws that cover more emissions directly. According to the AR6, laws in 56 countries covered 53 per cent of emissions in 2020. Climate strategies and policies that address emissions indirectly have also proliferated, from 340 in 2010 to 690 in 2020. Over 20 per cent of global emissions are covered by carbon taxes or trading that incentivize low-cost emission reduction.

45. **Multiple lines of evidence suggest that mitigation policies have led to avoided global emissions of at least 1.8 Gt $CO_2$ eq annually.** Key policies and measures reported in developed countries are aimed at increasing the share of renewable energy in total power generation, phasing out coal, improving energy efficiency and electrifying road transport. Developing countries' policies are aimed at encouraging green growth and low-carbon transition.

46. **International cooperation is having positive results.** The Kyoto Protocol led to measurable and substantial avoided emissions. The Paris Agreement makes a shift to facilitating national-level mitigation towards a shared goal, though it remains to be seen if the long-term global goal will be achieved.

47. **Adaptation action is widespread but remains largely fragmented and incremental.** Actions have been taken to reduce vulnerabilities to the adverse impacts of

[14] UNEP. 2021. *Emissions Gap Report 2021*. Nairobi: United Nations Environment Programme. Available at https://www.unep.org/resources/emissions-gap-report-2021.

climate change (e.g. developing multi-hazard warning systems, adopting climate-smart agriculture and urban planning). Gaps in the provision of and access to information, technology and finance remain considerable and hinder effective adaptation at scale. As a result, most adaptation to date has been small-scale behavioural change, with little evidence of transformative adaptation. Moreover, there is increasing evidence of maladaptation (adaptation that results in unintended consequences), which disproportionately affects the vulnerable and marginalized.

48. **Adaptation planning is advancing but tracking progress remains difficult.** According to UNEP,[15] 72 per cent of countries have at least one national adaptation planning instrument in place. A total of 125 developing countries, including all the least developed countries, have begun the process of formulating and implementing national adaptation plans. Methodologies for measuring and quantifying progress are limited, however, with little evidence of climate risk reduction, avoided losses or improved adaptive capacity in connection with trends in adaptation planning, finance and implementation.

49. **Limits to adaptation may already have been met and even surpassed.** Such limits may be soft, implying that, while no current adaptation measures exist to address a risk, they might in future; or they may be hard, implying that no adaptation action exists or will exist to avoid an intolerable risk. Sea level rise, for example, presents hard limits to adaptation for populations on urban atolls, where lack of fresh water could make life intolerable.

Box 8
**Key message: equity is key to achieving the long-term global goal**

Historical emissions are unequal. The impacts and risks associated with warming are also unevenly distributed. Parties have differing responsibilities and capacities to contribute to achieving the long-term global goal, but many are constrained by structural inequalities. Equitable action therefore requires fair consideration of the remaining carbon budget, inclusive decision-making and a just transition.

50. **Climate change has inequitable causes and consequences.** The total magnitude of historical contributions to cumulative net anthropogenic $CO_2$ emissions varies substantially across regions. Historical emissions per capita also vary widely, being highest in North America and lowest in Southern Asia. Warming is also unevenly distributed. Impacts and risks are disproportionately borne by people and communities most exposed and most vulnerable in both developing and developed countries. Climate change often exacerbates pre-existing poverty and inequality.

51. **Parties have different starting positions, face different circumstances and have different opportunities to contribute to achieving net zero emissions and the long-term global goal.** Parties' capacities for mitigation and adaptation are shaped by structural, global inequalities. The pandemic has hampered efforts to respond to the impacts of extreme weather events. At-risk communities have faced the challenge of tackling the pandemic and climate-related hazards simultaneously. Furthermore, the pandemic has led to increased debt for many countries, constraining their ability to take action to transform their economies in line with low-emission and climate-resilient pathways.

52. **There is a need to act not only urgently but also equitably.** Equity among Parties includes fair consideration of the remaining carbon budget, which is estimated to be 500 Gt $CO_2$ eq (for a 50 per cent probability of limiting warming to 1.5 °C). It also includes increased provision of support to enable ambitious mitigation and effective adaptation. Reducing debt burdens may free up fiscal space for developing countries to meet their climate and development goals. Equity within countries and among generations entails inclusive planning and decision-making processes, as well as a just transition away from carbon-intensive economies.

[15] UNEP. 2021. *Adaptation Gap Report 2020*. Nairobi: UNEP. Available at http://www.unenvironment.org/resources/adaptation-gap-report-2020.

Box 9

**Key message: key enablers of climate action are not aligned with the urgency of a rapid and equitable low-carbon transition**

Climate finance is growing but continues to fall short of needs and commitments. The financial system overall is poorly aligned with the Paris Agreement goals, with investment in fossil fuels still outweighing climate investment. Capacity to respond to climate change remains most lacking where risk is highest. Data and methodological gaps inhibit measurement and reporting of emission reductions. Low-carbon technologies are feasible but there are economic and financial barriers to their dissemination.

53. **Climate finance flows have increased significantly since the first periodic review.** According to the AR6, public and private finance combined reached USD 685 billion in 2018 compared with USD 359 billion in 2012. Total public financial support reported by Parties included in Annex II to the Convention in their biennial reports (as at October 2020) amounted to USD 45.4 billion in 2017 and USD 51.8 billion in 2018. Investment in renewable energy and sustainable transport accounts for most climate finance flows.

54. **Current climate finance flows are inadequate to meet needs.** To meet mitigation and adaptation objectives, annual flows would need to be three to six times larger than currently for 2020–2030. Developed countries fell short of the USD 100 billion commitment set out in the Paris Agreement. Support for mitigation remains greater than for adaptation across all finance channels. A significant proportion of public finance is in the form of loans and other non-grant instruments. About 40 per cent of climate finance overall is non-concessional.

55. **The financial system remains largely unaligned with meeting the Paris Agreement goals and the long-term global goal.** There has been a significant increase in climate finance initiatives by investors, corporations and other businesses since adoption of the Paris Agreement. Total climate finance flows remain relatively small in volume, however, indicating opportunities to increase investment in climate action. Investment in fossil fuels and emission-intensive activities remains larger than flows for climate adaptation and mitigation.

56. **Capacity to respond to climate change is increasing but lacking most where risk is highest.** Information is increasingly available and robust at regional scale for climate change impact and risk assessments. Mitigation assessments have been improved by building on existing data-collection processes, strengthening coordination with enforcement entities and clearly communicating the purpose of data sharing with stakeholders. Climate services fall short of demand, however, with multi-hazard warning systems still underdeveloped in many developing countries. Moreover, research capacity is highly unevenly distributed, with only 1 per cent of global finance for research going to African institutions.

57. **Data and methodological gaps hamper reporting and limit understanding of the climate system.** Many developing countries lack complete information on their emissions. There are persistent data gaps in national GHG inventories, as well as gaps in skills and technology for estimating the effects of mitigation and adaptation policies and measures. These gaps make it challenging to quantify and assess mitigation and adaptation action at the aggregate global level. There is also an acute gap in systematic observation, which limits understanding of the climate system and capacity to predict and adapt to extreme climate events.

58. **Low-carbon and adaptive technologies have been successfully developed and deployed, but barriers to technology transfer persist.** Low-carbon electrification has emerged as highly feasible for transportation, industry and buildings. Renewable energy makes up a growing share of the total energy mix, reflecting rapidly falling prices. Other relevant technology developments include the adoption of solar photovoltaics and onshore wind technology and uptake of electric vehicles.

59. **For developing countries, economic and financial challenges are the most important barriers to technology transfer and diffusion.** Priority technologies for

mitigation include solar, hydropower, bioenergy, electrification of vehicles, traffic management and public transportation. Priority technologies for adaptation include water storage, monitoring and management, crop diversification, drip irrigation and water catchment. There is also a need for increased education and training to help countries to make early-stage decisions, matching countries' technology priorities with funding sources and establishing a bridge between the finance and policy communities.

Box 10
**Key message: knowledge, technology and resources are needed to transform global systems in line with low-emission pathways and climate-resilient development**

The financial system has sufficient capital to decarbonize economies and enhance climate resilience towards meeting the long-term global goal. Support provided by developed to developing countries can help to de-risk investment and enable technology transfer. Continued capacity-building will enable more robust and transparent reporting on GHG emission reductions and adaptation efforts. Improved climate services will help to reduce climate impacts on lives and livelihoods.

60. **Aligning the financial system with the objectives of the Paris Agreement requires shifting financial flows from short- to long-term investments.** Such a shift demands an increase in overall energy and infrastructure investments, including directing existing capital towards clean energy. Public incentives and direct government financing can boost the development of new infrastructure projects and accelerate early-stage technology innovation. There is a need for increased investment in research and development to enable cost-effective emission reduction. The financial system has sufficient global capital and liquidity to close current investment gaps.

61. **Accelerated financial support from developed to developing countries is a critical enabler.** The United Nations Conference on Trade and Development estimates that about 2 per cent of global gross domestic product (at least USD 1.7 trillion annually) is needed for developing countries to achieve the objectives of the Paris Agreement and the 2030 Agenda for Sustainable Development.[16] Public finance has the potential to de-risk investment and unlock private capital. Significant, well-planned and stable patterns of public expenditure can crowd in private investment and lead to increased employment, wages and technological advances. Private finance has proven particularly critical for developing and deploying renewable energy technology, with initial government support giving the private sector confidence to invest. The continued decrease in renewable energy costs means that investment in developing countries will go further.

62. **Continued capacity-building, especially in developing countries, will help to enable reporting and enhance international cooperation.** Training and guidance will help Parties to use appropriate methodologies for tracking and verifying GHG emission reductions and monitoring adaptation efforts across all sectors. Establishing data-sharing protocols and developing standardized data-sharing formats will ensure systematic data collection and help in filling country-level and aggregate data gaps. Well-established and -functioning systems of reporting are essential for transparency of action and support. In addition, improved climate literacy and education will facilitate efforts to achieve the long-term global goal.

63. **Investing in enhanced climate services will help to improve understanding of the climate system and enable effective adaptation.** Strengthening research and systematic observation will improve capacity to predict and adapt to extreme climate events. Robust monitoring linked to early warning systems can inform anticipatory action and contingency planning, thereby reducing disaster risk and impacts on lives and livelihoods. Inter-agency collaboration on making information on extreme climate events and impacts interoperable will improve capacity to tailor weather and climate services to sectors and users.

[16] See https://www.youtube.com/watch?v=0AKjjeaaQBU.

# IV. Concluding remarks

64. SED2 brought together government representatives, experts and civil society representatives from all regions. The aim was to ensure geographical, gender, regional and institutional balance at each meeting, as well as equilibrium between the two themes of the second periodic review in terms of time allocated to presentations and discussion. The productive and informative discussions helped Parties to understand the key findings from the IPCC reports and reports presented by other international organizations. SED2 was a valuable addition to the science–policy interface, as it informed and supported policy formulations. Face-to-face conversation with the policymaking community was considered essential for scoping future assessments of the science of climate change.

65. SED2 has shown that every increment of additional global warming increases risk for both natural and human systems. Many sectors and systems transition to being at high or very high risk at around 1.5 °C warming. Climate-resilient development may be impossible at 2 °C warming. Avoiding overshoot of the 1.5 °C limit reduces the risk of crossing tipping points and triggering potentially irreversible changes in the climate system. **The co-facilitators of SED2 are therefore of the view that Parties must redouble efforts to significantly reduce emissions prior to 2030 as this is the only way to remain on a pathway to limiting warming to 1.5 °C with no or limited overshoot.**

66. SED2 has also shown that, while there has been some progress in reducing GHG emissions and enhancing adaptation, efforts remain insufficient to achieve the long-term global goal. A significant gap remains between Parties' emission reduction pledges and the reductions required to limit warming to 2 °C, let alone 1.5 °C. SED2 has further shown that, although adaptation is widespread, it is hampered by lack of access to finance and linked to limited evidence of resulting risk reduction. Overall, capacity to address climate change remains most lacking where risk is highest. **The co-facilitators are therefore of the view that Parties must act not only urgently but also equitably in reducing emissions and enhancing adaptation. Continuing to scale up financial support and support for other means of implementation will enable more ambitious mitigation and effective adaptation by all Parties towards achieving the long-term global goal.**

67. SED2 can inform the first global stocktake, taking place from 2021 to 2023, in two ways. First, experience of the structured expert dialogues under both the first and second periodic reviews can provide best practices for the technical dialogue of the global stocktake. The structured expert dialogues have demonstrated the value of face-to-face, question-and-answer style discussion among experts, Parties and non-Party stakeholders. They have also shown how presentations and discussions can be organized, paying attention to balance between themes, which can inform the organization of the global stocktake around its three thematic areas (mitigation, adaptation, and means of implementation and support) and the consideration of aspects relating to loss and damage and response measures.

68. Secondly, the structured expert dialogues have captured the evolving scientific understanding of the long-term global goal and efforts to achieve it, thus providing a foundation on which Parties can continue to build a shared understanding of how to enhance the implementation of the Convention and the Paris Agreement. By paving the way for the global stocktake, SED2 has contributed to ongoing efforts to assess collective progress towards achieving the objectives of the Paris Agreement and the long-term global goal.

69. The co-facilitators hope that SED2 has informed Parties by providing the best available scientific knowledge, guided by the principles and provisions of the Convention, including equity and common but differentiated responsibilities and respective capabilities. They also hope that SED2 will enable Parties to make well-informed decisions on strategies for achieving the long-term global goal.