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Briefing Paper

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Equity assessment of global mitigation pathways in the IPCC Sixth Assessment Report

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Executive Summary

- The Working Group III contribution to the Intergovernmental Panel on Climate Change (IPCC)'s Sixth Assessment Report (AR6) has based its analysis of global mitigation pathways on a select subset of 1,202 scenarios out of the 2,425 scenarios submitted to it. The IPCC authors decided the vetting/selection criteria and hence the assessed scenarios are not representative of the literature.
- Adherence to the United Nations Framework Convention on Climate Change (UNFCCC) principles of equity and common but differentiated responsibilities and respective capabilities (CBDR&RC) was not part of these criteria.
- The equity assessment presented in this brief was carried out for all the scenarios that use a 10-region classification and correspond to the temperature goals of the Paris Agreement and which were part of the IPCC WGIII assessment.
- The key overall finding is that all scenarios project a highly unequal future world that perpetuates most inequalities. Growth and development, and energy use, are restricted for developing countries, and not just fossil fuel consumption.
- Other significant findings include:
  - Per capita GDP and consumption are projected to remain much higher for developed countries compared with developing countries even in 2050.
  - Primary energy consumption (which includes renewables) is projected to remain much higher for developed countries compared with developing countries.

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- Annex-I countries until net zero continue to appropriate a disproportionate share of the global carbon budget across all scenario categories, irrespective of the temperature target. In all scenarios, the greater the remaining carbon budget, the greater is the fossil fuel consumption projected for developed nations.
- Emissions reductions for developing regions from 2020 to 2030 are comparable to or higher than the emissions reductions for developed regions.
- In the 1.5˚C scenarios with no or limited overshoot, all developing regions are to begin emissions reduction circa 2020, that is, immediately alongside the developed regions.

- The findings show that the scenarios do not take any account of equity and CBDR&RC, and project the perpetuation of global inequalities in a number of economic, energy and emission variables.
- Developing countries are therefore well-advised not to use the scenarios and global mitigation pathways of AR6 as the benchmark or reference for negotiations due to the highly unequal regional outcomes underlying the global targets on which these scenarios are based.

1. Why is this equity assessment of the global mitigation pathways of AR6 necessary?

- There is no explicit reference to equity and the principle of common but differentiated responsibilities and respective capabilities (CBDR&RC) in the global mitigation pathways assessed in the Intergovernmental Panel on Climate Change (IPCC)'s Sixth Assessment Report (AR6).
  - The Summary for Policymakers of the Working Group III (WGIII) contribution to AR6 (April 2022) and the Synthesis Report of AR6 (February 2023) state clearly: *"Modelled scenarios and pathways…are based on a range of assumptions, including socioeconomic variables and mitigation options. These are quantitative projections and are neither predictions nor forecasts. Most do not make explicit assumptions about global equity, environmental justice or intraregional income distribution."*
  - The Summaries for Policymakers of both reports also note: *"Global emission pathways, including those based on cost-effective approaches, contain regionally differentiated assumptions and outcomes, and have to be assessed with the careful recognition of these assumptions."*
- This is clearly not aligned to the principles of the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol and Paris Agreement that acknowledge the fundamental role of equity and CBDR&RC in all aspects of the global climate regime.
  - Article 3.2 of the UNFCCC states: *"The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof."*
- As the IPCC is not bound by a mandate to explicitly incorporate equity and CBDR&RC in all its assessments, the two foundational principles are not consistently applied across all aspects of the IPCC assessments, and are often omitted in specific aspects while they are sometimes invoked as a separate aspect of the discussion.
- As scenarios and global mitigation pathways have begun to play a leading role in UNFCCC discussions and negotiations on questions such as mitigation, enhanced ambition of nationally determined contributions (NDCs) under the Paris Agreement, the long-term low-emission development strategies of Parties and the Global Stocktake, it is essential to provide an equity assessment of these scenarios for use by developing country Parties at the UNFCCC.
- All global mitigation pathways are based on scenarios with some underlying regional classification. In particular, models and scenarios that have an underlying 10- or 11-region classification allow us to distinguish developed and developing regions, which in turn provides the basis for assessing equity in the projected outcomes.

2. Which scenarios and models from the IPCC global mitigation pathways have been included in this equity assessment?

- The equity assessment described in this brief covers 556 scenarios corresponding to 1.5˚-2˚C warming. All these scenarios have a 10-region classification, and the corresponding results are available.
- The WGIII Report of IPCC AR6 finally assessed 1,202 scenarios that passed the selection criteria set by the authors of the IPCC report for the global assessment. This excluded a little over half of the 2,425 scenarios originally submitted to the database.
- What are these selection criteria? These included accepting only scenarios that i) extended up to the year 2100 in time, ii) were based on a formal quantitative model, and iii) reported emissions in the three chief greenhouse gases, namely, carbon dioxide, methane and nitrous oxide.
- The collection of scenarios in the IPCC AR6 WGIII database is not a statistical sample, nor is it drawn by any established sampling technique. These scenarios are submitted by interested scientists based on calls put out by the IPCC authors and the IPCC Bureau, and then vetted and selected.
- WGIII classified the 1,202 scenarios into eight categories based on their respective warming levels, from C1 (50% probability of 1.5˚C warming with no or limited overshoot) to C8 (exceed warming of 4˚C with a greater than 50% probability).
- The scenarios analysed in this brief belong to four of these eight broad categories and are described as follows:
  - C1 with model scenarios in which warming is projected to be limited to 1.5˚C, with a likelihood of 50% or greater (>50%) with “no or limited overshoot”
  - C2 with model scenarios in which warming is projected to be limited to 1.5˚C, with a likelihood of 50% or greater (>50%) with “overshoot of 0.1-0.3 deg. C for up to several decades”
  - C3 with model scenarios in which peak warming is projected to be limited to 2˚C with a likelihood of 67% or greater (>67%)
  - C4 with model scenarios in which peak warming is projected to be limited to 2˚C with a likelihood of 50% or greater (>50%).

3. What are the overall findings of this equity assessment?

- Across all scenarios based on the underlying models, the future in 2050 is projected to be an unequal world that perpetuates or aggravates the inequalities of today.
- This does not refer only to emissions; the inequalities are pervasive with respect to all variables, macroeconomic, fossil fuel consumption as well as emissions-related.
- In the scenarios, such inequalities are projected into the future by restraining any transformative growth in the future in a majority of developing countries.
- The trade-off for developing countries, in these mathematical models and their scenarios, is not between energy from fossil fuels and renewable energy, but between growth and development on one side and no growth and development at all, or one that is relatively frozen around current levels, on the other side.
- The developed countries continue to draw a disproportionate share of the remaining carbon budget.
- The developed countries will continue to use more fossil fuels than developing countries in per capita terms, even by 2050.
- Fossil fuel use in developed countries as a share of the global use of fossil fuels is already disproportionate to their population. However, this share is projected to increase between 2020 and 2050 across all scenarios and warming levels.
- In the C1 scenarios, all developing regions are to begin emissions reduction in 2022 at the latest. In other scenarios, the peaking year is slightly delayed, progressively from C2 to C4, over a decade.

- The modelled scenarios are such that they allocate increased emissions to Annex-I countries when the carbon budget increases from the scenarios C1 through to C4.
- Our analysis clearly shows that in the absence of a claim to a fair share of the global carbon budget by developing countries, it will be assumed in modelling and scenario building that they can manage with far less than their fair share. Developed countries will free-ride and reduce their mitigation burden, appropriating the carbon space that developing countries do not claim.
- Specific subsets of these models make further assumptions for various sectors other than energy which are not explored in this study.

4. Key equity findings in specific variables

In the following, we illustrate the overall points made above with explicit statements for some key variables. Since the modelling results and scenarios which are represented in the IPCC assessment provide only a classification based on geographical regions, developed and developing groups of countries have to be identified using the regional classifications in a suitable manner.

GDP and consumption of goods and services

- In 2050, a significant level of inequality is projected to persist in GDP per capita between developed and developing regions. Moreover, except for China, the per capita GDP in the rest of the world in 2050 is restricted to USD 9,000-USD 28,000 at most, and, for South Asia and Sub-Saharan Africa, is restricted to even lower levels at ~USD 18,000 and ~USD 9,000 respectively. North America and Pacific OECD countries dominate in per capita GDP even in 2050 (see Figure 1).
- It is important to note that the projected per capita GDP level of developing countries is lower than the current per capita GDP levels of developed countries as a whole, and much lower if compared with the current per capita GDP of OECD countries.
- The same picture holds definitively for the consumption of goods and services (see Figure 1).

Energy consumption

- Across scenarios and scenario categories, per capita energy consumption in Annex-I regions remains well above that of non-Annex-I regions, even in 2050 (see Figure 2).
- In these scenarios, on the average, the North American region will continue to enjoy the highest per capita energy consumption in 2050, across scenarios. It is projected to consume about 6-8 times more energy than Sub-Saharan Africa and ~5 times more energy than South Asia in 2050. The current inequality in energy consumption between these regions is therefore projected to persist by 2050. These values are for total primary energy consumption, not just the consumption of fossil fuels, which implies that there is a severe restriction of energy consumption, even from renewable energy sources, for non-Annex-I regions.

Fossil fuel consumption

- Across scenario categories, Pacific OECD and North America will continue to use more coal in per capita terms compared with most developing regions. Sub-Saharan Africa and Latin America have to achieve zero use of coal by this time. Across all scenarios, per capita oil and gas use in North America and Europe will continue to remain high while it is projected to be lower in Africa, South Asia and Latin America compared with all other regions.
- The continued use of oil and gas across the Global North also holds true for even the most stringent C1 category of scenarios that project warming to remain at 1.5˚C with no or limited overshoot (see Figure 3), in which global emissions reach net zero around 2050.

- The highest reduction in fossil fuel use, across all three fuels, is in Sub-Saharan Africa. Across scenarios, the regions of Latin America, Sub-Saharan Africa and South Asia are projected to have a higher share of non-fossil energy in their total primary energy mix as compared with Annex-I regions in 2050. It must be noted here that this is in addition to a much lower value of per capita energy consumption in these non-Annex-I regions. Much of this non-fossil energy is likely to be from biomass-based energy which is also a major element in the results of CO_2 sequestration across these developing regions.

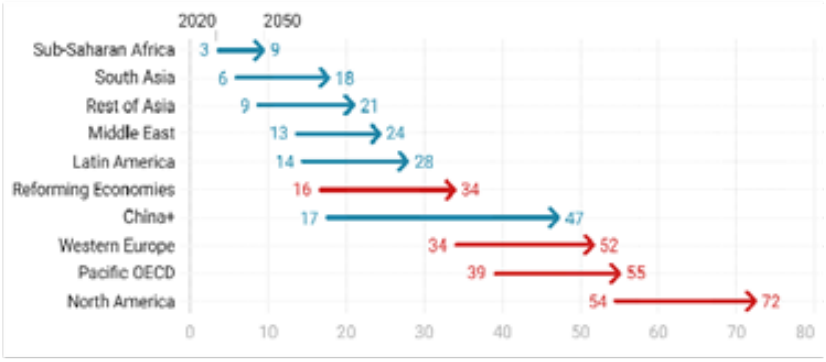
Carbon sequestration from land use and carbon capture and sequestration (CCS)

- The results on carbon sequestration are presented model-wise since there are variations in the way regions are represented in different models, and the results are sensitive to this.
- The absolute values of CO_2 sequestration from CCS, even before net zero, have to be large, ranging from 171 to 474 $GtCO_2$ for C1 scenarios and from 112 to 724 $GtCO_2$ for C3 scenarios, to restrict warming levels to 1.5˚C and 2˚C respectively, with little or no overshoot.
- Across models, CO_2 sequestration from land use varies between 9 and 163 $GtCO_2$ in C1 scenarios and between 4 and 191 $GtCO_2$ in C3 scenarios. Together, the total carbon dioxide removals projected as necessary, across the range of scenarios, are of the size of the remaining carbon budget itself, ranging from a significant fraction to a value even larger than the remaining carbon budget.
- Of the total sequestration that is projected as necessary, from land use and CCS, before net zero is reached in C1 scenarios, 65% to 85% is located in developing countries. Even with a higher global warming level, as in C3 scenarios, a very similar percentage of 66% to 84% is in the same regions, while the Annex-I countries disproportionately benefit from the increase in the remaining carbon budget.
- Continued fossil fuel use in Annex-I countries, even beyond 2050, is therefore compensated for by higher sequestration in non-Annex-I regions.

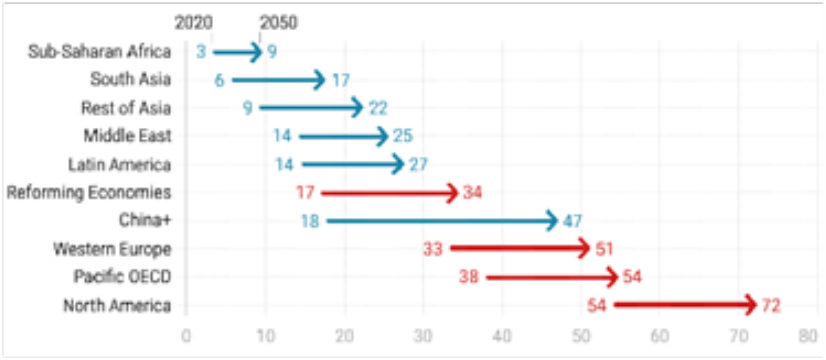
CO_2 emissions and the global carbon budget

- Per capita emissions in Latin America, South Asia and Sub-Saharan Africa are projected to remain the lowest, despite their development needs, with net negative emissions in the Latin American region in 2050 in scenario categories C1 and C2. Latin America reaches net zero emissions earlier than any other region.
- The projected emissions reduction rates expected of different regions in the near term, i.e., between 2020 and 2030, are even more seriously in violation of the principles of equity and CBDR&RC. In the C1 category scenarios, not only do all regions start emissions reductions immediately (by 2022 or earlier), but the rates of emissions reduction are also higher for some developing countries compared with developed countries (see Table 1). In scenarios where some developing countries seem to be given marginally lower rates of reduction or some space to increase their emissions from low base values, this is accompanied by a significantly lower mitigation burden for developed countries too.
- In the C1 scenarios, all developing regions are to begin emissions reduction in 2022 at the latest. In other scenarios, the peaking year is slightly delayed for developing countries, progressively from C2 to C4, by no more than about a decade (see Table 2).
- The cumulative non-LULUCF CO_2 emissions between 1850 and 2019 were ~1,698 $GtCO_2$ (Gütschow et al., 2021). Developed countries have appropriated and continue to consume a disproportionate share of the global carbon budget. Between 1990 and 2019, Annex-I Parties have been responsible for 44% of the cumulative non-LULUCF CO_2 emissions. Model scenarios perpetuate this inequity into the future by projecting a disproportionate allocation of even the remaining carbon budget to developed countries (see Figure 5, Table 3 and Table 4).

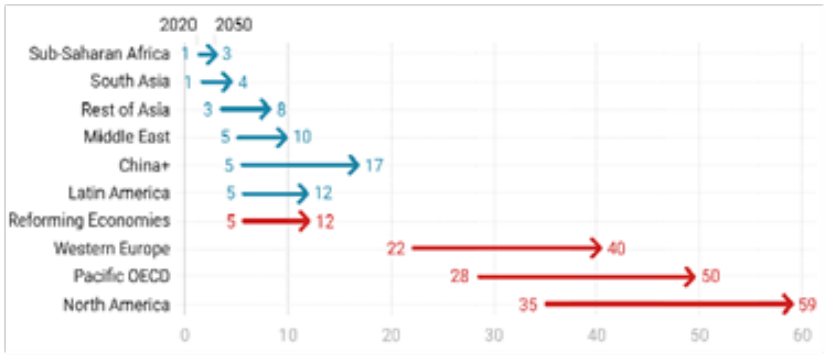
Panel (a) Per Capita GDP in C1 Scenarios [PPP, 2010-'000USD]



Panel (b) Per Capita GDP in C3 Scenarios [PPP, 2010-'000USD]



Panel (c) Per Capita Consumption of Goods and Services in C1 Scenarios [2010-'000USD]



Panel (d) Per Capita Consumption of Goods and Services in C3 Scenarios [2010-'000USD]

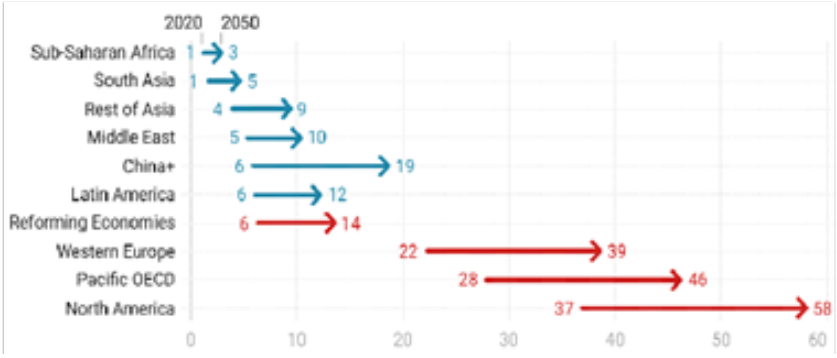
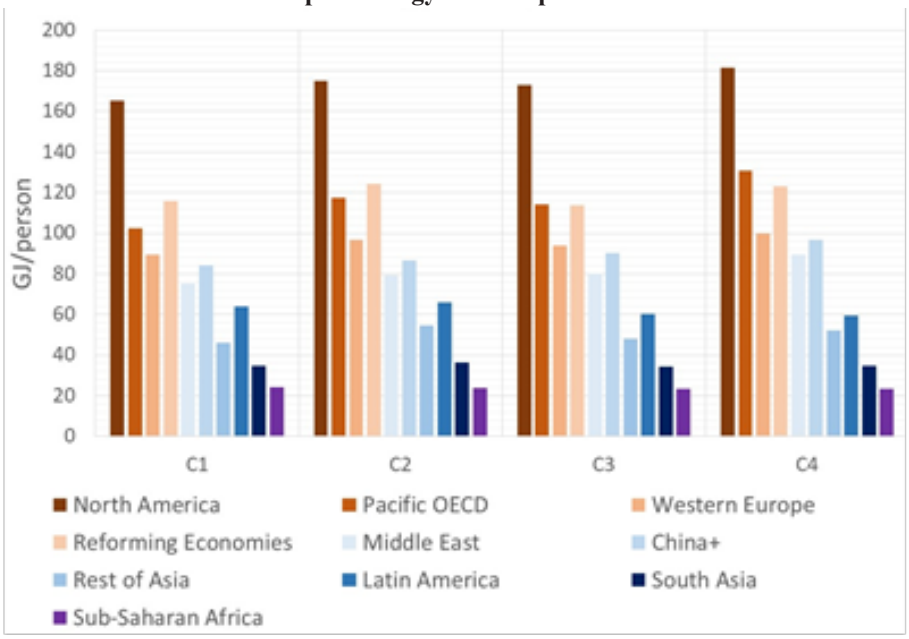
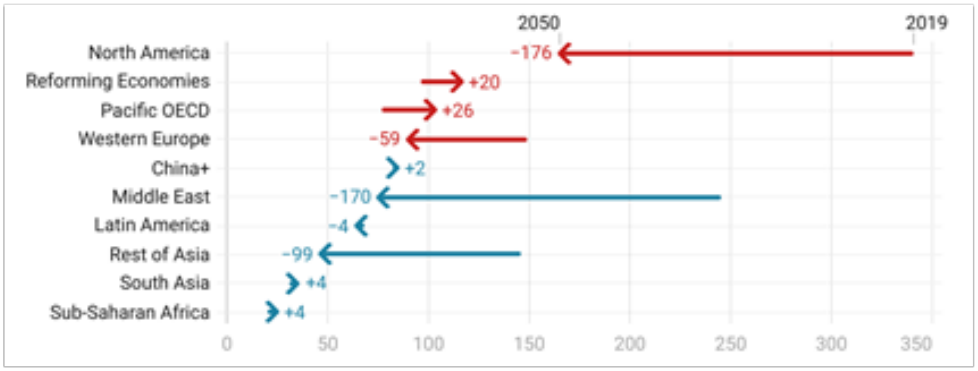


Fig. 1. Projected per capita GDP and consumption in C1 and C3 scenarios (2020 to 2050). Panel (a) shows the weighted average per capita GDP across models for scenario category C1. Panel (b) shows the weighted average per capita GDP across models for scenario category C3. Panel (c) shows the weighted average per capita consumption of goods and services across models for scenario category C1. Panel (d) shows the weighted average per capita consumption of goods and services across models for scenario category C3. Values reported are in units used in the models, i.e., constant 2010 values in '000 USD at purchasing power parity for GDP, and constant 2010 values in '000 USD for consumption. The reddish arrows show Annex-I Parties to the UNFCCC, and the blueish arrows are used for non-Annex-I regions. Figures created with Datawrapper.

Panel (a) Projected Per Capita Energy Consumption in 2050 in Scenario Categories C1 to C4



Panel (b) Per Capita Energy Consumption in 2019 and Model Projections for 2050 – C1 Scenarios



Panel (c) Per Capita Energy Consumption in 2019 and Model Projections for 2050 – C3 Scenarios

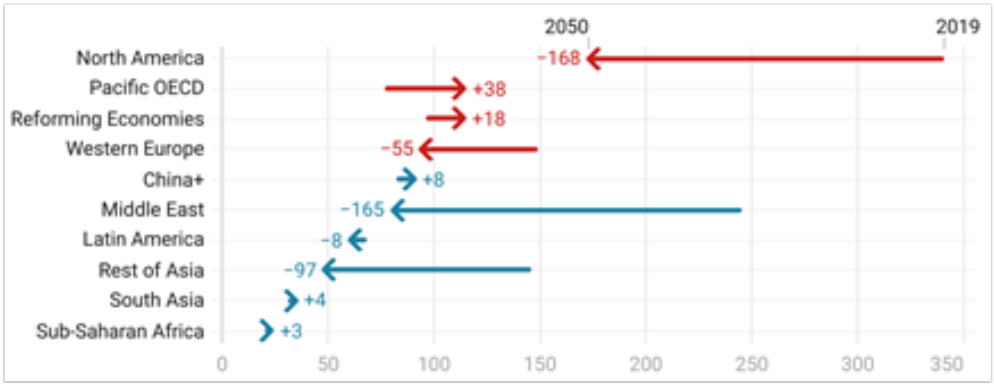
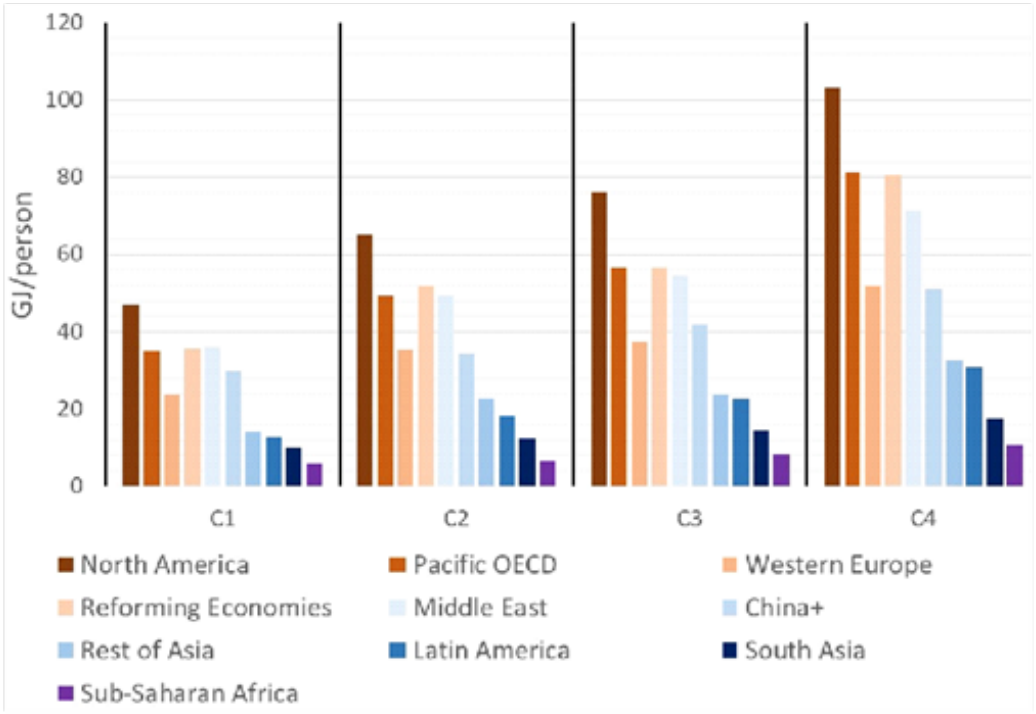


Fig. 2. Per capita energy consumption across C1 to C4 category scenarios. All values are in Giga joules/person/year. Reddish bars/arrows show Annex-I Parties to the UNFCCC and blueish bars/arrows are used for non-Annex-I regions. Panel (a) shows the projected average per capita energy consumption across regions in each category. In Panel (a) the values are weighted averages across the models. Panel (b) shows the actual per capita energy consumption in 2019 vs. the projected value for 2050 in C1 category scenarios. Panel (c) shows the actual per capita energy consumption in 2019 vs. the projected value for 2050 in C3 category scenarios. Panel (b) and (c) figures created with Datawrapper.

Panel (a) Projected Per Capita Fossil Fuel Consumption in 2050 – Scenario Categories C1 to C4



Panel (b) Projected Coal, Oil, and Gas Consumption in 2050 – Scenario Category C1

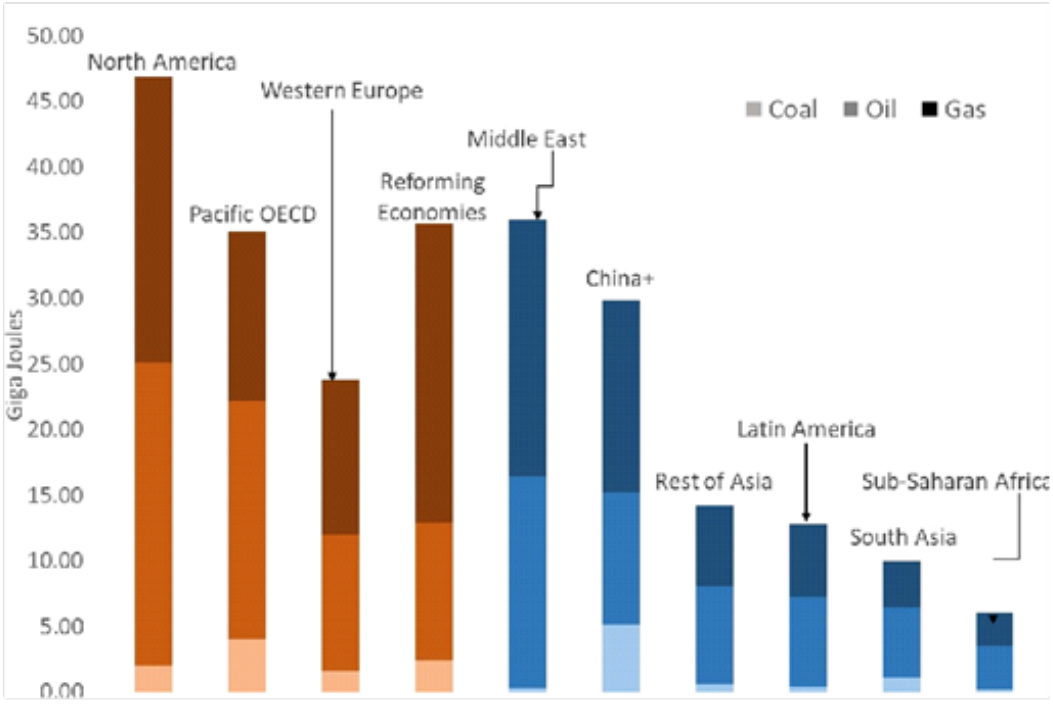
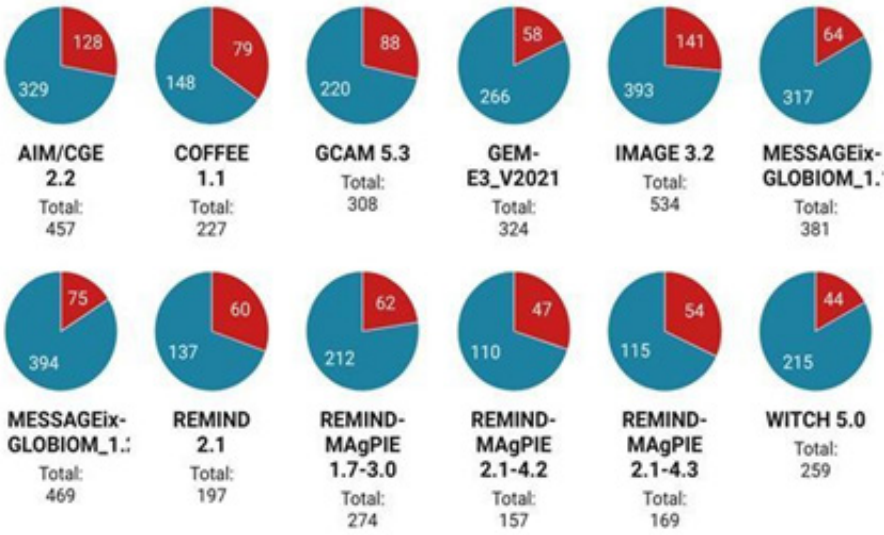


Fig. 3. Projected per capita fossil fuel consumption in 2050. All values are in Giga joules/person/year. Reddish bars show Annex-I Parties to the UNFCCC and blueish bars are used for non-Annex-I regions. Panel (a) shows the projected average per capita fossil fuel consumption across regions in each category. In Panel (a) the values are weighted averages across the models. Panel (b) shows the distribution of coal, oil and gas in 2050 projected in C1 category scenarios, i.e., scenarios that are projected to limit warming to 1.5˚C with no or limited overshoot with a 50% probability.

Panel (a) Carbon Sequestration from Land Use and CCS in C1 Category Scenarios Across Models



Panel (b) Carbon Sequestration from Land Use and CCS in C3 Category Scenarios Across Models

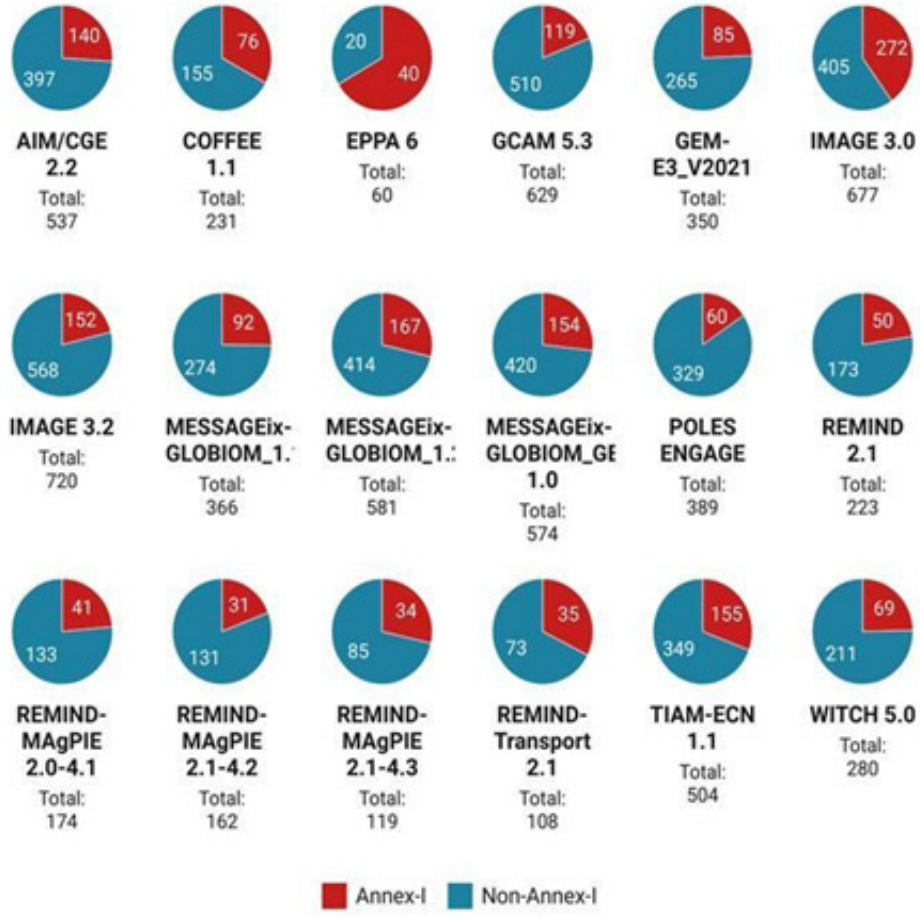


Fig. 4. Projected carbon sequestration between 2020 and the time of net zero CO_2 emissions or till 2100 if the region does not reach net zero CO_2. All values are in $GtCO_2$. Reddish bars/wedges show Annex-I Parties to the UNFCCC and blueish bars/wedges are used for non-Annex-I regions. Panel (a) shows the combined carbon sequestration from land use and CCS in Annex-I and non-Annex-I regions in C1 scenarios. Panel (b) shows the combined carbon sequestration from land use and CCS in Annex-I and non-Annex-I regions in C3 scenarios. Figures created with Datawrapper.

Table 1. Emissions reductions between 2020 and 2030 in the REMIND and MESSAGE models consistent with 1.5° C warming with no or limited overshoot (C1 scenarios)

Emissions growth between 2020 and 2030 – C1 scenarios – REMIND			Emissions growth between 2020 and 2030 – C1 scenarios – MESSAGE		
	Mean	Median		Mean	Median
Sub-Saharan Africa	-10%	-11%	Sub-Saharan Africa	-16%	-16%
China+	-7%	-7%	China+	-11%	-11%
Western Europe	-6%	-7%	Western Europe	-7%	-7%
South Asia	-3%	-3%	South Asia	-8%	-8%
Latin America	-8%	-7%	Latin America	-12%	-11%
Middle East	-2%	-2%	Middle East	-4%	-3%
North America	-7%	-7%	North America	-7%	-7%
Pacific OECD	-7%	-8%	Pacific OECD	-10%	-10%
Reforming Economies	-6%	-6%	Reforming Economies	-9%	-9%
Rest of Asia	-5%	-5%	Rest of Asia	-6%	-6%

Table 2. Peaking years for developing regions across scenario categories (years are weighted averages across models)

	Peaking years			
	C1	C2	C3	C4
Sub-Saharan Africa	2022	2023	2028	2032
China+	2020	2021	2022	2023
Western Europe	2020	2021	2021	2023
South Asia	2022	2024	2027	2027
Latin America	2020	2021	2022	2021
Middle East	2020	2024	2026	2028
North America	2020	2020	2020	2021
Pacific OECD	2020	2020	2020	2021
Reforming Economies	2020	2021	2022	2023
Rest of Asia	2020	2022	2021	2022

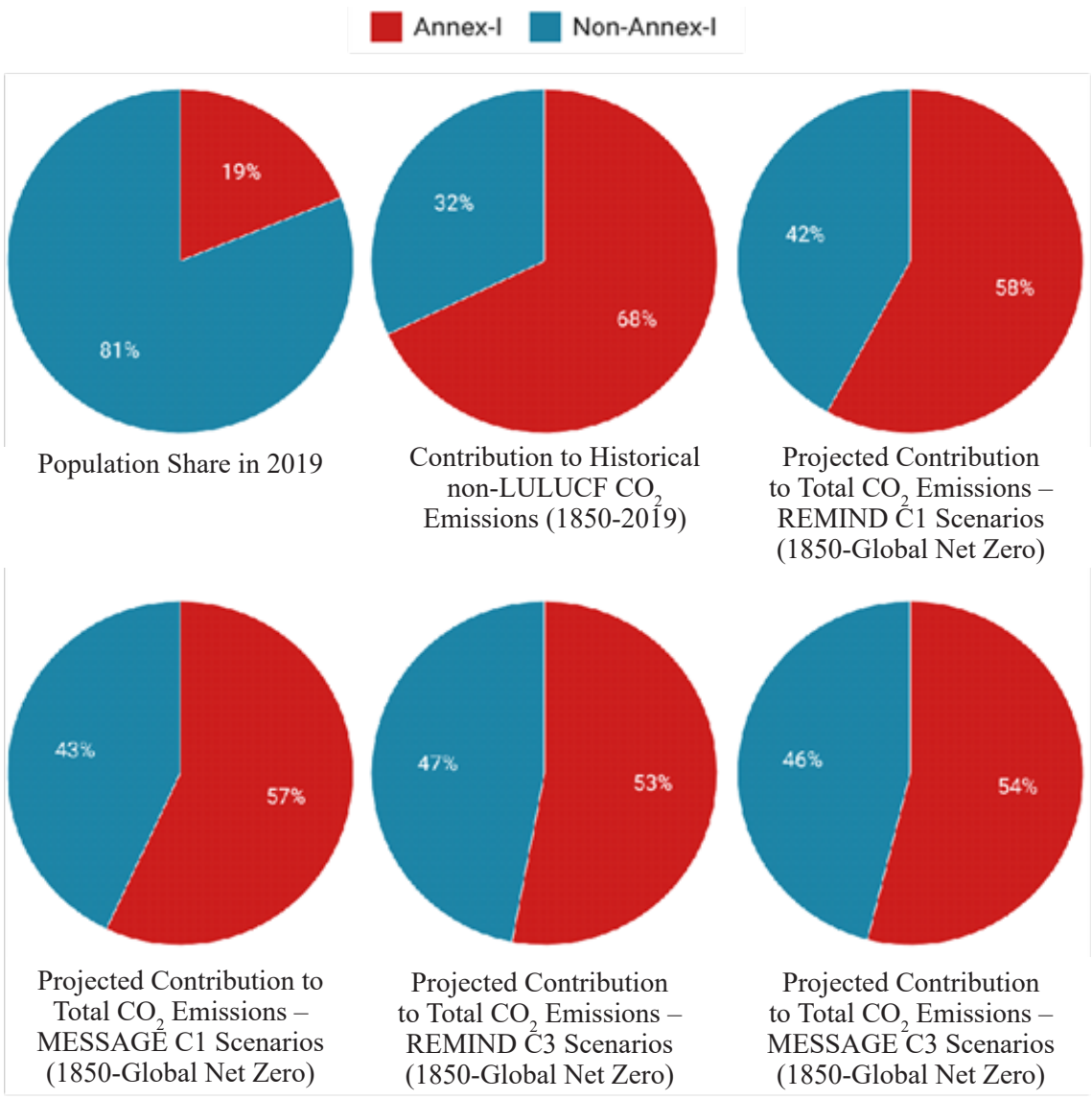


Fig. 5. Fair share, contribution to historical emissions between 1850 and 2019, and contribution to projected total emissions between 1850 and global net zero for scenario categories C1 and C3. Cumulative emissions projections for 2020-net-zero are from the REMIND_MAgPIE model scenarios and MESSAGEix_GLOBIOM model scenarios. The projected contribution to total emissions is the sum of past non-LULUCF CO_2 emissions (1850-2019) and the modelled share of the remaining carbon budget for the respective scenario categories. Population shares are calculated based on regional population estimates in the MESSAGEix_GLOBIOM1.1 model. Figures created with Datawrapper.

Table 3. Fair share vs. modelled share of the remaining carbon budget between 2020 and net zero for C1 scenarios (all values in $GtCO_2$)

	REMIND			MESSAGE		
	Share of the Remaining Carbon Budget (1850-Net-Zero) - With Historical Responsibility	Share of the Remaining Carbon Budget (2020-Net-Zero) - Without Historical Responsibility	Modeled Share of the Remaining Carbon Budget for C1 Category Scenarios from the REMIND Models	Share of the Remaining Carbon Budget (1850-Net-Zero) - With Historical Responsibility	Share of the Remaining Carbon Budget (2020-Net-Zero) - Without Historical Responsibility	Modeled Share of the Remaining Carbon Budget for C1 Category Scenarios from the MESSAGE Models
Sub-Saharan Africa	265	69	27	278	82	15
China+	200	102	144	219	122	116
Western Europe	-217	43	39	-209	51	44
South Asia	479	126	69	503	150	104
Latin America	115	44	30	124	52	31
Middle East	74	34	52	81	41	117
North America	-356	26	58	-352	30	72
Pacific OECD	-41	11	13	-40	13	16
Reforming Economies	-113	19	28	-110	23	26
Rest of Asia	110	42	56	118	50	71
Total	**516**	**516**	**516**	**614**	**614**	**614**

Table 4. Fair share vs. modelled share of the remaining carbon budget between 2020 and net zero for C3 scenarios (all values in $GtCO_2$)

	REMIND			MESSAGE		
	Share of the Remaining Carbon Budget (1850-Net-Zero) - With Historical Responsibility	Share of the Remaining Carbon Budget (2020-Net-Zero) - Without Historical Responsibility	Modeled Share of the Remaining Carbon Budget for C3 Category Scenarios from the REMIND Models	Share of the Remaining Carbon Budget (1850-Net-Zero) - With Historical Responsibility	Share of the Remaining Carbon Budget (2020-Net-Zero) - Without Historical Responsibility	Modeled Share of the Remaining Carbon Budget for C3 Category Scenarios from the MESSAGE Models
Sub-Saharan Africa	308	112	77	331	135	41
China+	263	165	210	297	200	206
Western Europe	-190	70	48	-176	84	95
South Asia	557	204	129	600	247	137
Latin America	142	70	47	157	85	66
Middle East	95	56	85	107	67	157
North America	-341	41	81	-332	50	130
Pacific OECD	-35	17	17	-31	21	31
Reforming Economies	-101	31	46	-95	37	51
Rest of Asia	136	68	95	150	82	95
Total	**834**	**834**	**834**	**1008**	**1008**	**1008**

5. Brief methodological notes

- It is important to underline that the scenarios used in the IPCC AR6 Working Group III report do not constitute a proper statistical sample drawn from among all the scenarios available, as they are, among other considerations, voluntarily submitted to the IPCC by their authors and then vetted by criteria imposed by the authors of the IPCC assessment. Of the 1,202 scenarios that were finally assessed by the IPCC team of authors after applying the vetting and selection criteria,[1] 591 scenarios (over 49% of the total) are from one model intercomparison project, viz., ENGAGE. An additional 70 (5.8%) of the scenarios are from the Shared Socio-economic Pathways (SSP) model intercomparison project.
- The 556 scenarios assessed in this brief are modelled using 21 Integrated Assessment Models (IAMs).
- All these scenarios are based on a 10-region classification of the world. In the IPCC assessment for global mitigation pathways, there is no scenario that does not have a regional classification underlying the global results. Even if the submission of the scenarios to the IPCC is given purely in global terms, the project data provides access to the underlying regional assumptions and outcomes.
- The regional classification differs to some extent across all the models. In the calculation of all values of variables reported in the models, we estimate per capita values based on the population projections from the respective model scenarios, as reported. For the calculation of historical emissions, we use the classification of the MESSAGEix_GLOBIOM1.1 model since this model reports explicit results for Africa.
- For each region and for each model, we calculate the weighted average of the projected values of all variables, typically at 2050. This weighted average for a variable is taken by categorising the scenarios according to their cumulative emissions to net zero, in bins of 10 $GtCO_2$, and weighting, by the number of scenarios in that bin, the mean value of the variable for all scenarios in that bin. This bin distribution is kept the same for all variables. The per capita values of key variables are reported as a weighted average across all models for each scenario category. In some cases, we also report weighted averages across all scenario categories as well. For variables for which we report absolute values, the differences in regions must be accounted for. In this case, we do model-wise calculations and report values for the MESSAGEix_GLOBIOM and REMIND_MAgPIE models as these have the highest number of scenarios assessed in this report.
- The IPCC database of scenarios is available at https://data.ece.iiasa.ac.at/ar6/#/workspaces

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[1] Details of the vetting process and the parameters used for the same can be found in Annex III on "Scenarios and Modelling Methods" of the Working Group III Contribution to the Sixth Assessment Report of the IPCC.

References

1. Gütschow, J., Günther, A., & Pflüger, M. (2021): The PRIMAP-hist national historical emissions time series (1750-2019). v2.3.1. zenodo. https://doi.org/10.5281/zenodo.5494497
2. IPCC (2021): Summary for Policymakers. In: *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, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3-32. doi:10.1017/9781009157896.001
3. IPCC (2022a): Summary for Policymakers. In: *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.001
4. IPCC (2022b): *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926
5. Moss, R.H., Edmonds, J.A., Hibbard, K.A., Manning, M.R., Rose, S.K., Van Vuuren, D.P., ... & Wilbanks, T.J. (2010): The next generation of scenarios for climate change research and assessment. *Nature*, *463*(7282), 747-756.
6. UNFCCC (2016): Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015. FCCC/CP/2015/10/Add.1, Decision 1/CP.21.
7. UNFCCC (2019): Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on the third part of its first session, held in Katowice from 2 to 15 December 2018. FCCC/PA/CMA/2018/3/Add.2, Decision 19/CMA.1.