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Climate Justice and Equitable Futures:

What Is Missing in IPCC AR6 Scenarios and How to Go Beyond

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Abbreviations

AR6	Sixth Assessment Report
AR7	Seventh Assessment Report
CMA	Meeting of the Parties to the Paris Agreement
CO2	carbon dioxide
COP	Conference of Parties
GDP	gross domestic product
GHG	greenhouse gas
Gt	gigatonnes
IAM	Integrated Assessment Model
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
OECD	Organisation for Economic Co-operation and Development
PPP	purchasing power parity
SPM	Summary for Policymakers
UAE	United Arab Emirates
UNFCCC	United Nations Framework Convention on Climate Change

Abstract

This policy brief unpacks how and why the scenarios and models of the Sixth Assessment Report of the IPCC project climate action pathways that lead to unacceptable futures. These pathways restrict well-being for the majority of the world's population and lead to a world with perpetual global inequalities in income, consumption, and energy use, while increasing the number of people exposed to the risk of hunger and endangering food security. The brief also demonstrates the possibility of alternate perspectives and outlines what must change in the preparation of the Seventh Assessment Report of the IPCC in order to foreground equitable futures that ensure climate justice and the well-being of all.

Key Messages

- IPCC AR6 models and scenario projections for 2050 lead to futures that perpetuate or aggravate the inequalities of today across all indicators.
  - Developed countries are projected to continue to use more fossil fuels per capita than developing countries, even in 2050.
  - Increases in per capita energy use and increases in income and consumption levels in the global South are restricted to remain well below the levels of the global North.
- Models and scenarios of AR6 project an unequal sharing of the mitigation burden.
  - Less stringent global mitigation targets lead to even less action by the global North, while the burden on the global South remains stringent.
  - The poorest regions of the world bear the highest near-term mitigation burden.
- Meeting temperature goals through high levels of land-based mitigation project serious damage to the development goals of the global South.
  - Food security worsens and the risk of hunger increases in the more stringent 1.5°C scenarios.
  - Even by 2050, none of the scenarios will meet the 2030 Sustainable Development Goals.
- Alternate futures with highly improved projected outcomes for the developing world are possible and demonstrated with one illustrative new approach in this brief.

- Projections for the future through climate action in the IPCC AR7 Report – in order to retain relevance as one of the key sources of the «best available science» for the world – should:
  - radically revamp the approach to scenarios,
  - delink scenarios from the underlying models,
  - develop models that allow for the implementation of equitable futures, and
  - include the full range of scenarios available in the global literature.

«Global modelled pathways» in the IPCC's AR6

What are the emission reduction targets that need to be met globally to limit global warming to 1.5°C above pre-industrial levels? The answer to this question was widely advertised to be among the most significant findings from the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC).

In the wake of the IPCC's press conference, global media widely reported the following line from the Summary for Policymakers (SPM) of the Working Group III contribution on the «Mitigation of Climate Change» (released in April 2022): «GHG emissions are projected to reduce by 43% by 2030 and 84% by 2050 in **global modelled pathways** that limit warming to 1.5°C (>50% probability) with no or limited overshoot.»

These projections from the «global modelled pathways» were immediately cited in the Sharm el-Sheikh Implementation Plan decision at COP27 in 2022 (UNFCCC, 2022), notably transformed from projections into prescriptions for what the real world «requires» in order to meet the 1.5°C warming target. Such projections were transformed again into required global targets in the UAE Consensus decision at COP28 in 2023 (UNFCCC, 2023), while a similar projection from the «global modelled pathways» of the Special Report on Global Warming of 1.5°C was similarly cited as a «requirement» in the Glasgow Pact decision of COP26 in 2021(UNFCCC, 2021).

Neither the outreach of the IPCC, nor the relevant COP/CMA decisions or numerous media reports highlighting these results provided much clarity on where these projections came from. More importantly, to the surprise and consternation of audiences in the global South, these statements threw little light on how these global targets were to be distributed across different countries and regions (TWN, 2022). These feelings were exacerbated by the unwelcome realisation that, in the absence of relevant information, these emission reduction targets were likely to be uniformly distributed across countries, despite the vast inequalities and disparities in the responsibilities – historical and current – for greenhouse gas emissions.

Regardless of the efforts of developing-country governments during the final stages of approval of the Working Group III SPM to ensure the provision of more details, the final text only offered sketchy information on the distribution of these mitigation targets across countries, especially between developed and developing countries (TWN, 2022). The term «global modelled pathways» indicates clearly, of course, that they are a result of models. However, beyond this, the only qualifiers that provided some indication of the underlying assumptions in the models or the pathways they project appeared in **Box SPM.1**. It states the following:

«Emissions pathways and scenarios project the evolution of GHG emissions based on a set of internally consistent assumptions about future socio-economic conditions and related mitigation measures [Footnote 46]. These are quantitative projections and are neither predictions nor forecasts. Around half of all modelled global emission scenarios assume cost-effective approaches that rely on least-cost emission abatement options globally. The other half look at existing policies and regionally and sectorally differentiated actions. Most do not make explicit assumptions about global equity, environmental justice or intraregional income distribution. 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.»

Footnote 46 further clarifies:
«Key assumptions relate to technology development in agriculture and energy systems and socio-economic development, including demographic and economic projections. IPCC is neutral with regard to the assumptions underlying the scenarios in the literature assessed in this report, which do not cover all possible futures. Additional scenarios may be developed.»

Although these are important qualifiers which indicate that **model results must be read and interpreted carefully**, most third-party use of the IPCC results – especially in multilateral and plurilateral negotiations and in associated literature – DOES NOT include even these weak qualifiers. Indeed, all too often, it is missed in IPCC outreach as well.

In this policy brief, which is based on recent peer-reviewed literature from the authors and others, we explore these assumptions in some detail utilising the database of the scenarios used by the IPCC Working Group III authors to arrive at their results. We particularly focus on the distribution of the mitigation burden in these scenarios and their evaluation based on equity and the principle of common but differentiated responsibilities and respective capabilities.

Currently, the scenarios of AR6 severely lack equity in distributing the mitigation burden; are premised on curtailing growth in the developing world, perpetuating gross energy inequalities; permit the continued disproportionate and unfair appropriation of even the remaining carbon budget by developed countries; and lead to the exacerbation of food insecurity and an increase in the numbers of those at risk of hunger (Kanitkar et al., 2024; Jaiswal et al., 2024).

This brief demonstrates that the IPCC modelling and scenarios assessment process, the nature of current mainstream modelling, and the scenario approaches need radical change. We demonstrate one such potential new approach as an illustration of the new thinking, and the knowledge production effort that is urgently required (Ranjan et al., 2024).

Projecting Inequitable Futures

It has now been clearly established, and even acknowledged by the IPCC (2023), that scenarios assessed in the AR6 project perpetuate poverty as well as energy and income inequalities into the future. Key results of the equity assessment of IPCC AR6 scenarios (Kanitkar et al., 2024; Jaiswal et al., 2024) show the following:

- **The future in 2050 is projected to be an unequal world that perpetuates or aggravates the inequalities of today across all key indicators.**
- **Developed countries use more fossil fuels than developing countries in per capita terms, even by 2050.**
- **The poorest region of Sub-Saharan Africa bears the highest near-term mitigation burden.**
- **Food insecurity and the risk of hunger increase in the more stringent 1.5°C scenarios due to high dependence on land-based mitigation.**
- **None of the scenarios meet even the Sustainable Development Goals.**

A comparison of the outcomes for scenario categories C1 (50% probability of limiting warming to 1.5°C with no or limited overshoot) and C3 (67% probability of limiting warming to 2°C) shows the perpetuation of existing socio-economic and energy inequalities across regions, over which higher mitigation burdens are then further imposed (see the box on the representativeness of IPCC scenarios for further details on the scenario categories).

IPCC AR6 scenarios perpetuate inequalities across all key indicators and in all scenario categories. Figures 1(a) and 1(b) show projections for the gross domestic product (GDP) in scenario categories C1 and C3.

Figure 1a: Per Capita GDP in C1 Scenarios (1.5°C – 50% probability with no or limited overshoot)
('000 $-PPP)

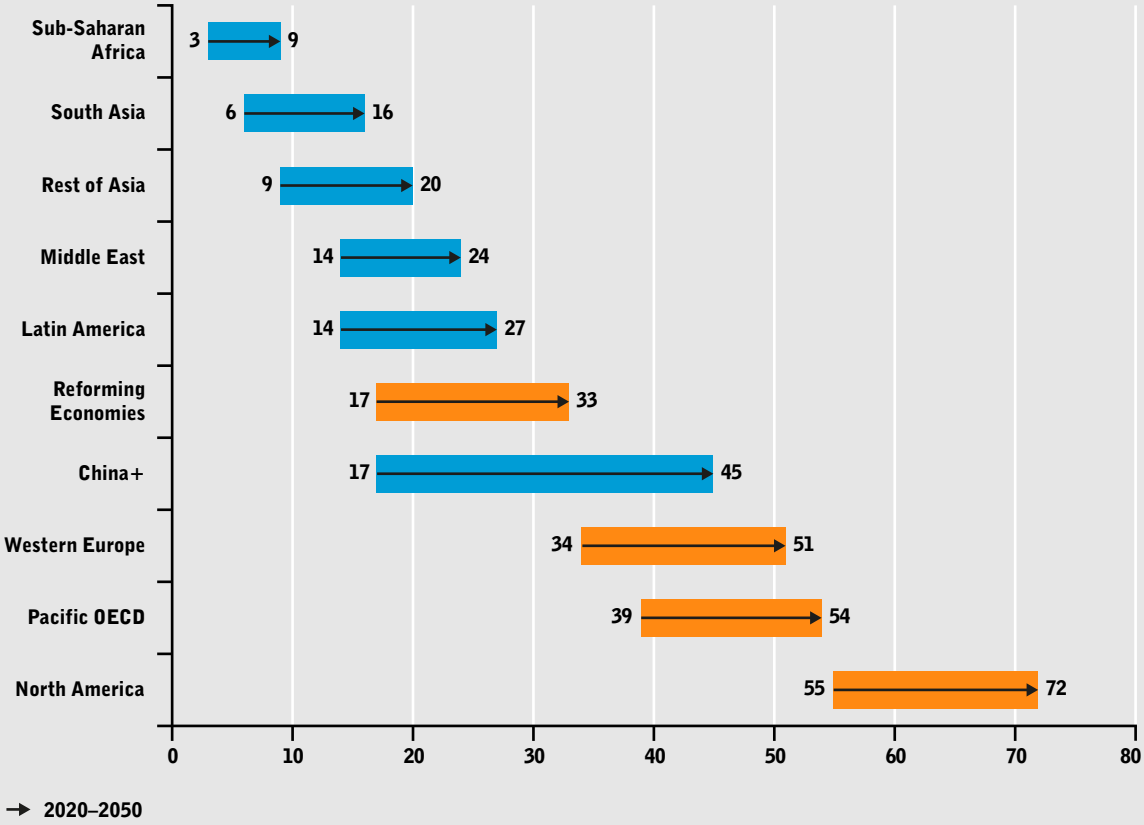
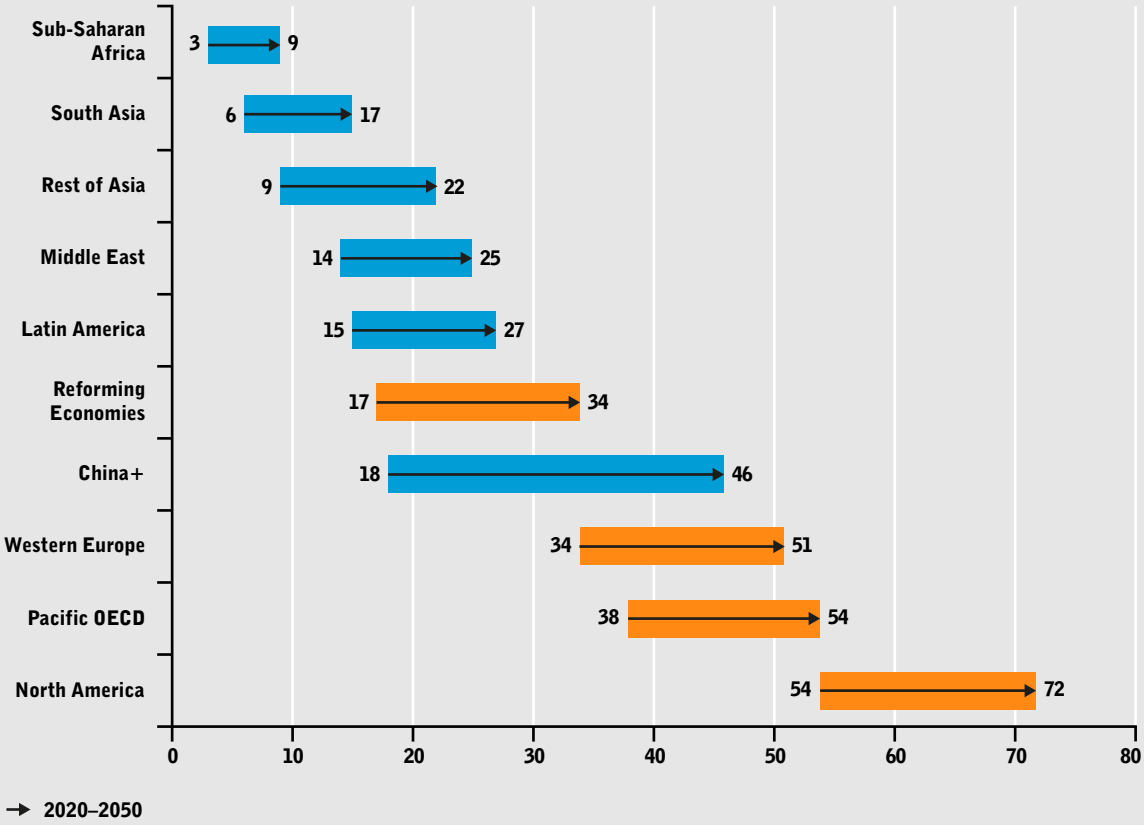
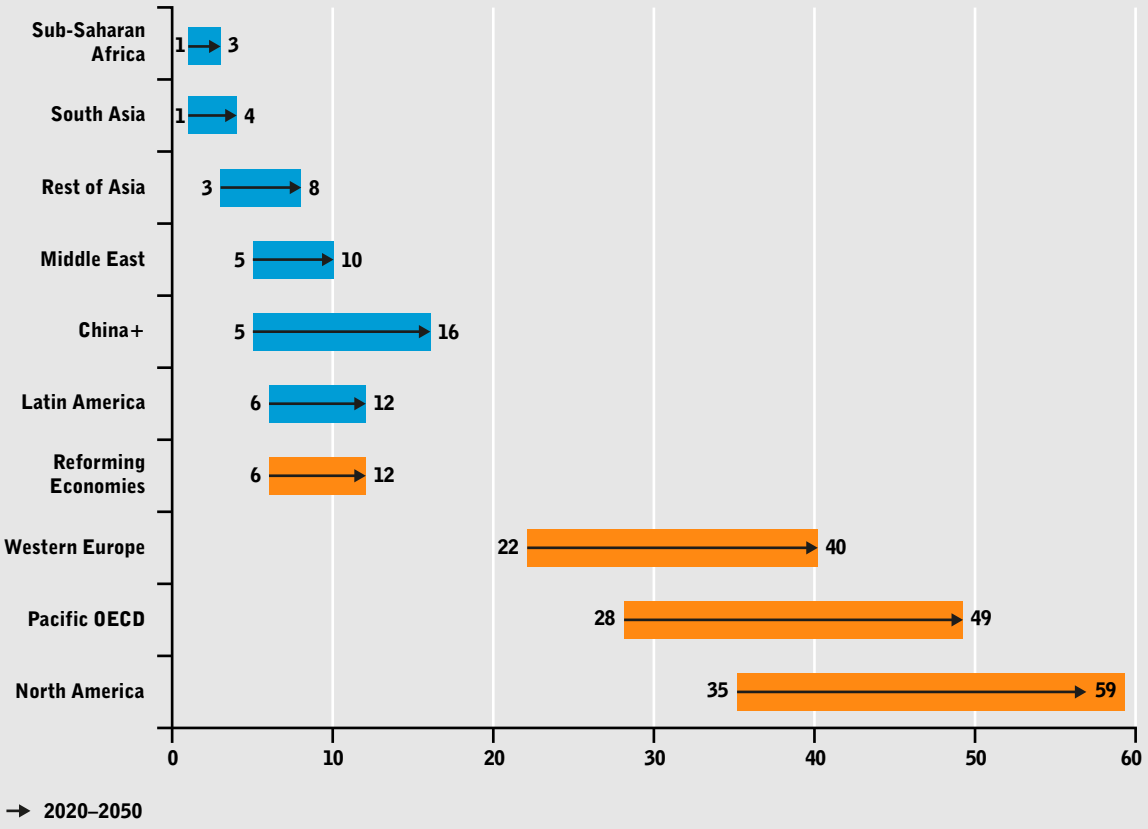


Figure 1b: Per Capita GDP in C3 Scenarios (2°C – 67% probability)
('000 $-PPP)



In 2020, the average global per capita GDP in the scenarios was about $14,000 (in 2010 constant dollars), and four regions were below this global average in 2020. Whereas the average global per capita GDP is projected to increase to $27,000 by 2050, per capita GDP of the four regions of Sub-Saharan Africa, South Asia, the Middle East, and the Rest of Asia will continue to remain below the global average (Kanitkar et al., 2024). The projections for a related indicator – the consumption of goods and services – are even more stark in illustrating the exacerbation of existing inequalities (see Figure 2).

Figure 2: Per capita consumption of goods and services in scenarios C1
Projections do not vary significantly in the C3 scenarios as compared to C1 scenarios



Similarly, substantial inequalities in the levels of per capita energy consumption are projected in the scenarios, with developed regions consuming well above regions of the global South, even by 2050. This implies the continuation of significantly low levels of energy consumption, even from renewable energy sources, for developing regions (i.e. non-Annex-I regions in UNFCCC language) in 2050 (see Figure 3).

This higher level of energy consumption in Annex-I regions is supported by the continued use of fossil fuels by these regions, even in 2050. Per capita fossil fuel consumption in North America and Pacific OECD regions remains higher than in all others, even in 2050 (see Figure 4). As a higher quantum of the remaining carbon budget becomes available for the less stringent temperature target of 2°C, the benefits accrue to developed countries in

Figure 3: Per capita primary energy consumption in 2050 in C1 and C3 scenarios
GJ/person

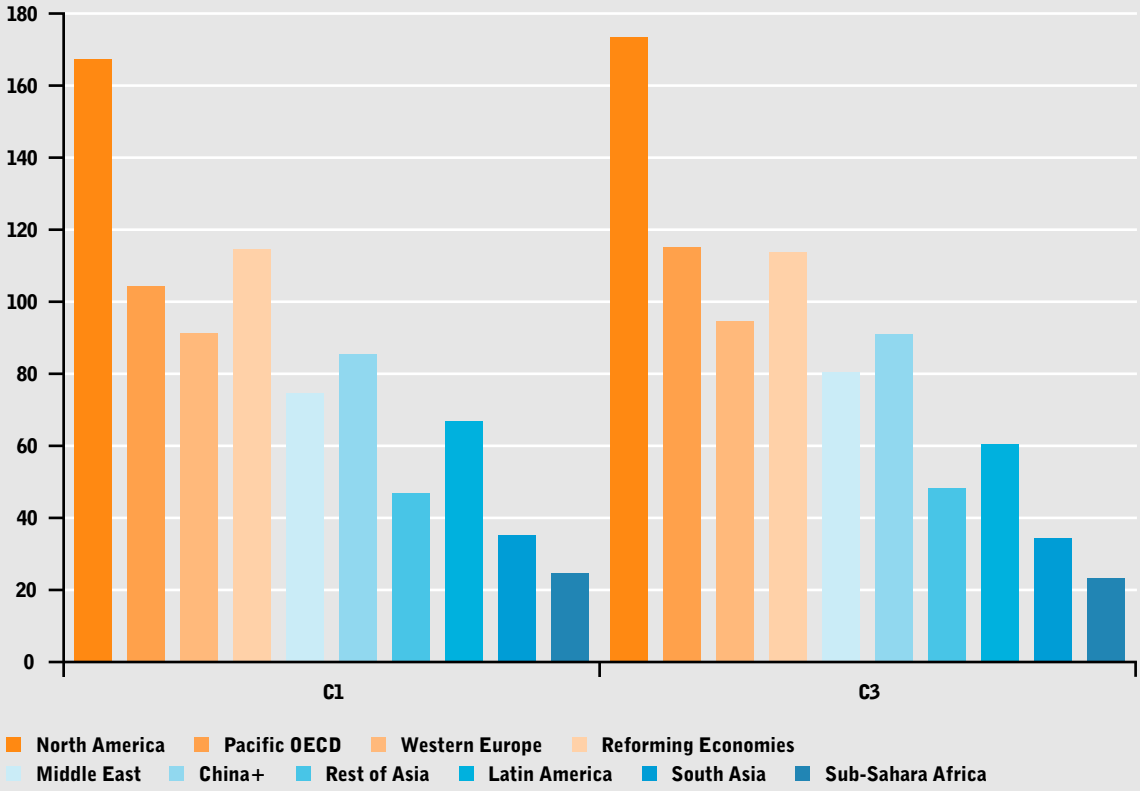
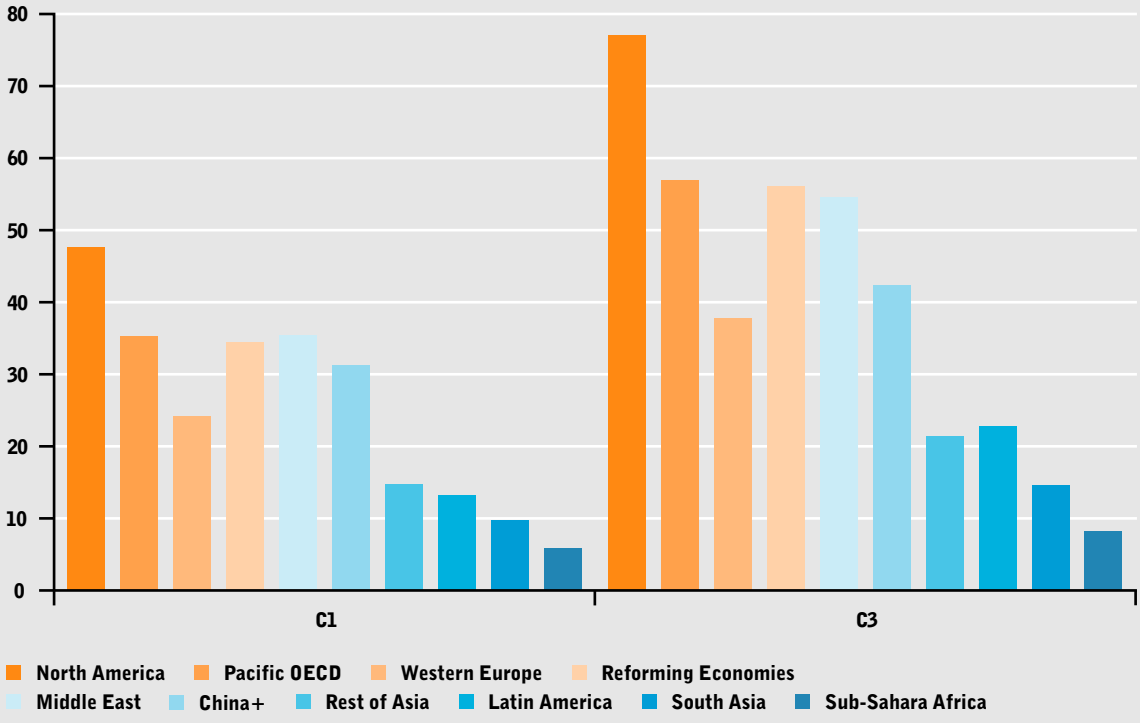


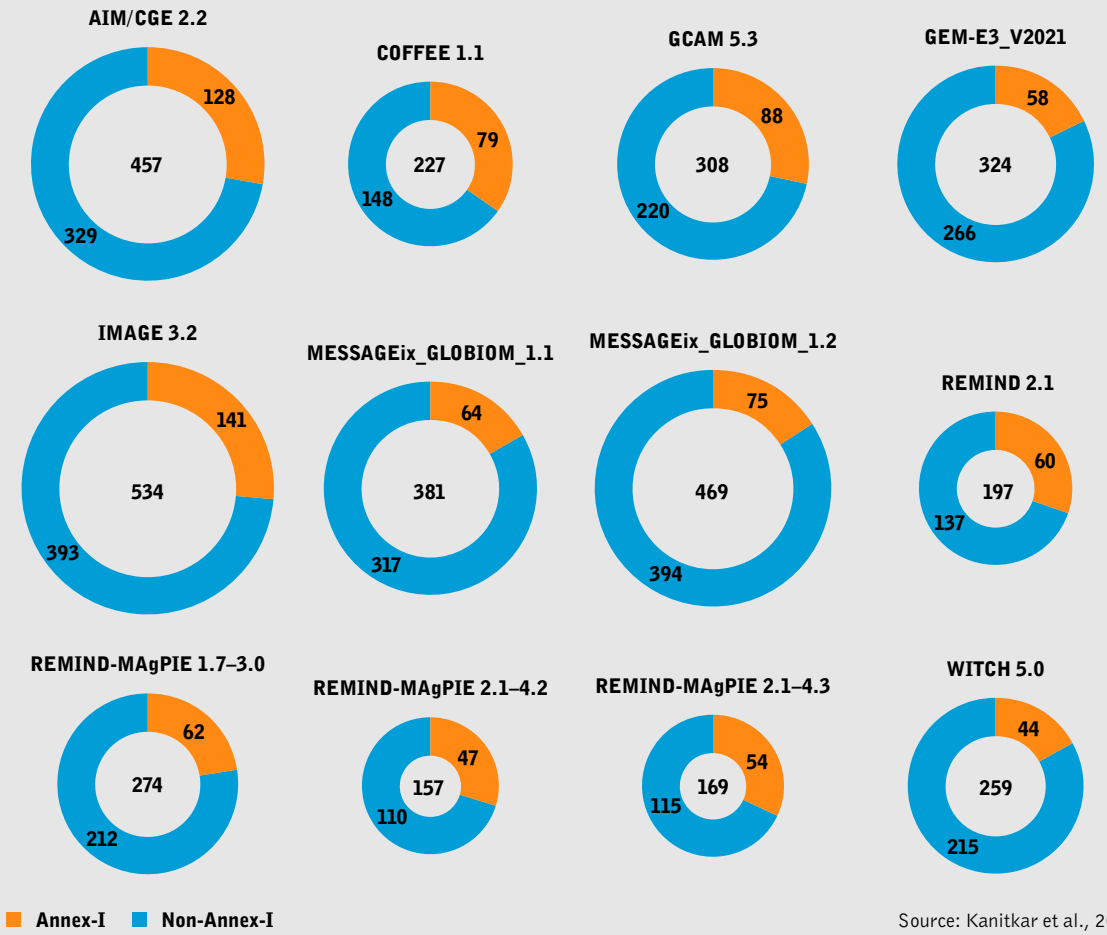
Figure 4: Per capita fossil fuel (coal, oil and gas) consumption in 2050 in C1 and C3 scenarios
GJ/person



the form of increased per capita fossil fuel consumption, even as there is little change for the least energy-consuming developing regions. This illustrates sharply the inequality-perpetuating characteristics built into the scenarios and their underlying models.

On the other hand, an overwhelming amount of the carbon dioxide (CO_2) removal/sequestration that is assumed in the models – either from land use or from carbon capture, utilisation and storage (CCUS) – is in the non-Annex-I regions. The values of sequestration projected are also very high, sometimes exceeding the amount of the remaining carbon budget itself (see Figure 5).

Figure 5: CO_2 sequestration from land use and CCUS before the time of net-zero emissions in C1 scenarios across all models assessed in AR6
All values in $GtCO_2$



Source: Kanitkar et al., 2024

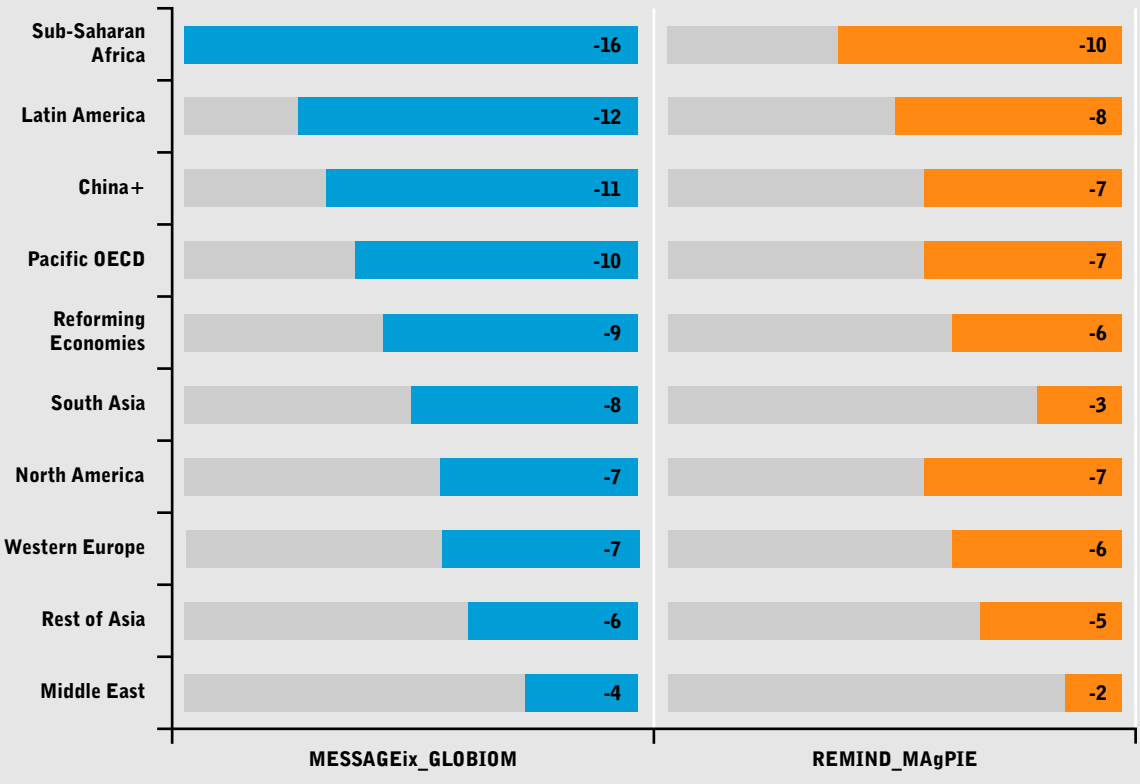
Such high levels of carbon sequestration, as projected in the scenarios, have serious consequences. They lead to **increasing levels of food insecurity and a significant increase in the number of people at risk of hunger** (Jaiswal et al., 2024; Fujimori et al., 2019; Fujimori et al., 2022; Hasegawa et al., 2018). Importing such projections as global «requirements» for emissions reductions in COP decisions means opening the door to demanding that climate action be imposed on the global South, despite the serious threat to food security.

As we approach the Seventh Assessment Report (AR7) **amidst increasing evidence that the 1.5°C target may be breached**, there is an increasing emphasis on «overshoot» pathways, implying a temperature overshoot beyond 1.5°C in the short term, but a return to 1.5°C by the end of the century. These pathways rely on large amounts of CO_2 removal carrying with them all the problems mentioned above, in addition to the uncertainty that these may eventually prove to be ineffective. Dependence on speculative solutions that lead to high levels of food insecurity in pursuit of climate outcomes that may not even be achieved would be a case of the cure being worse than the disease.

In essence, although energy consumption in the global South is suppressed in the scenarios through the projection of low GDP growth and even lower levels of consumption of goods and services, an additional mitigation burden is further imposed on developing countries through higher mitigation requirements. Sub-Saharan Africa is projected to undertake the maximum reduction in emissions in «this critical decade» between 2020 and 2030 (see Figure 6).

This is a gross violation of the principles of equity and common but differentiated responsibilities and respective capabilities (CBDR&RC) enshrined in the UNFCCC and its Paris Agreement, and it constitutes a continued, disproportionate grab of the carbon budget by developed countries.

Figure 6: Average values of near-term (2020–2030) annual emissions reductions in two models contributing the highest number of scenarios to AR6
CAGR-%



Why do scenarios project unequal futures?

To answer the question of how such unequal futures arise in these scenarios, it is necessary to address the question of whether such outcomes are a result of the assumptions made to construct the scenarios, or whether it is the approach used for modelling itself that lies at the heart of the problem.

All the scenarios assessed in AR6 are the outcomes of calculations carried out using Integrated Assessment Models (IAMs). These models provide an integrated view of the economy, energy systems, and emissions, though of course they are based on assumptions inherent in the calculational methods of these models. It is important to note here that this does not mean that scenarios without an underlying IAM are not possible. It is simply that the IPCC chose to not accept such scenarios for consideration in the Working Group III Report of AR6.

In most IAMs that underlie the scenarios of AR6, the macro-economic component is modelled using the general equilibrium framework, the energy-economy interactions are modelled using «least-cost» optimisation approaches, and vegetation models are coupled to these to capture land-use and carbon sink dynamics (Krey et al., 2020; Fricko et al., 2017). Apart from these specific choices of modelling tools, there are also assumptions in projecting specific socio-economic variables to the future. Though some of these assumptions originate ostensibly as «baselines» of possible future growth trajectories – when emissions projections are transformed into «requirements» – such assumptions become prescriptions to perpetuate inequalities.

Some of these assumptions and implicit causal relationships in the models are briefly discussed below (based on the discussion in the supplementary material from Kanitkar et al., 2024).

GDP and Consumption of Goods and Services

In the typical IAM framework, the GDP and consumption outcomes are **provided by general equilibrium models**, either within the IAM itself or as external input. The general structure of production functions in general equilibrium models restricts the range of GDP projections that are possible (Li et al., 2023). Additionally, the use of the «Negishi framework» in most versions of these models freezes income inequalities at existing levels (Stanton, 2011). This **significantly restricts** the degree of convergence in GDP outcomes that **is possible in this framework**, even if some scenario designs **claim to be marginally better than others**.

Primary Energy Consumption

Primary energy consumption and GDP are strongly correlated, and this correlation does not decline significantly across the modelled time period or across scenarios. Although projections for final energy demand may vary based on assumptions for demand-side management and other assumptions, projections for primary energy consumption continue to depend on GDP. Hence, lower levels of income for large parts of the global South directly lead to lower levels of energy consumption in these regions.

Fossil Fuel Consumption

Fossil fuel consumption is linked to least-cost assumptions in the models that favour emissions reductions in developing regions and slows down the projected rate of emissions reductions in the developed regions. Hence, per capita fossil fuel use remains higher in developed countries, even in pathways that have less stringent constraints on the carbon budget. If price assumptions in the models indicate that it would be cheaper to sequester carbon through land-based mitigation in Asia, for example – as compared to reducing natural gas use in North America, for example – this is the outcome that models will provide. This is therefore an assumption built into the modelling approach (least-cost optimisation).

Carbon Sequestration from Land Use and Carbon Capture and Storage

The large amounts of sequestration assumed in the models may be linked to multiple model assumptions, including a) least-cost assumptions that lead to higher levels of mitigation through land-based mitigation than through fossil fuel phase-out, b) the potential for sequestration assumed in the vegetation models, c) the assumptions for land available for sequestration, and d) the degree of the shift from food crops to energy crops that is assumed to be feasible in the models. The amount of sequestration projected in the models is therefore a result of both the model structure and model assumptions. There are serious concerns about this, such as the declining effectiveness of some sequestration measures with increasing warming; the socioeconomic barriers to implementation; the implications for livelihoods and impacts on Indigenous communities; and their potential to deter or delay fossil fuel emission reductions (Carton et al., 2020; Honegger et al., 2021; Dooley & Kartha, 2018; Anderson & Peters, 2016), in addition to the impacts on food security, discussed below.

Food Security and the Risk of Hunger, and the Sustainable Development Goals

Outcomes for food security and the risk of hunger are, among others, due to the heavy reliance on carbon sequestration in the AFOLU (Agriculture, Forestry and Other Land Use) sector in the absence of rapid emissions reductions in the developed countries and the scarcity of the remaining carbon budget, least-cost considerations, and the substantial grandfathering of emissions in general. Most significantly, IAMs and scenarios do not incorporate food security or poverty eradication as a necessary condition or constraint, but they claim, post-processing, that the additional transfers of resources arising from carbon tax or carbon trading revenue, for example, could be used to ameliorate the situation.

Near-term Reductions in CO_2 Emissions

Emissions reductions across regions are an outcome variable resulting from the least-cost optimisation approach in the models and assumptions about abatement costs and carbon prices embedded in the energy models. Grandfathering of emissions and ignoring historical responsibility in allocating the mitigation burden, and the consequent emission reduction targets, are inevitable in these scenarios and modelling approaches.

Sharing the Remaining Carbon Budget

Although the remaining carbon budget is applied as a global constraint, its regional distribution is a result of all other mitigation assumptions in the models and scenarios. Therefore, this is an outcome variable, which, like near-term CO_2 reductions, is driven by assumptions made in the models to drive abatement across sectors and regions.

Pervasive inequalities in the IAMs and scenario frameworks

The grandfathering of emissions – the perspective that either ignores historical emissions or allows those with high levels of historical emissions to emit even in the future due to «locked-in» infrastructure – is a persistent feature of current IAMs and scenarios frameworks, even though grandfathering is widely recognised as an inequitable allocation of the mitigation burden among countries. This is most strikingly exposed by the fact that, for higher temperature targets, the increased flexibility in emission reduction pathways is gifted to the developing countries.

In fact, successive editions of the IPCC Assessment Reports themselves incorporate grandfathering by projecting emissions reductions from a reference year that advances with every successive edition of the report.

In general, the current IPCC AR6 models and scenarios do not consider (or indeed quite deliberately ignore) equity or the principle of common but differentiated responsibilities and respective capabilities in their construction. This is not merely a policy gap. It also leads to scientifically incomplete results, as the corresponding equitable scenarios and futures are not explored alongside the existing scenarios.

One of the arguments in defence of these scenarios is that these are «realistic scenarios» and reflect the various possibilities that may arise in the context of global and regional economic, social, and policy trends. However, the IPCC scenarios and future projections have for some time now played a performative role. In the use of the findings of the IPCC Assessment Reports and their interpretation in IPCC outreach and the UNFCCC negotiations arena, these scenarios and their emission reduction projections have now become prescriptive, demanding that the world has to follow such paths (or an average over such paths) in future. That its original intent was merely descriptive, as noted above, to describe the possible futures under different socio-economic conditions, is forgotten or ignored. This has become strikingly clear from the efforts by developed countries and key international actors among non-party stakeholders to include such grossly inequitable projections for the future into COP decisions under the UNFCCC.

Are the IPCC scenarios representative?

A second important reason why the AR6 scenarios are **unrepresentative of the full space of possibilities and range of input and outcome variables related to socio-economic, technological, and climate considerations** lies in the very process of scenario selection, vetting, and assessment.

The Working Group III contribution to the IPCC 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 selection of these 1,202 scenarios was based on vetting criteria set by IPCC authors that required scenarios to have an underlying model, contain projections at least up to 2100, have at least the energy and land-use sectors represented, and be within a certain range of economic and demographic projections that could be suitably justified based on past trends (Peters et al., 2023). As a result, the final list of scenarios – after going through the process of submission and vetting – did not represent the literature in its entirety. For example, there may have been scenarios that used equity as the basis for allocating mitigation burdens that are compatible with carbon budgets to limit warming to 1.5 to 2°C, but their projections only went up to 2050 or did not include energy projections; such scenarios were not included in the final list of 1,202 global scenarios assessed by the IPCC.

WG III classified these 1202 scenarios into 8 categories based on their respective warming levels starting 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).

Of these, four categories, C1-C4 correspond to the temperature goals of the Paris Agreement covering 700 out of the 1202 scenarios.

Results in this policy brief are based on an analysis of 556 of these 700 scenarios which have an underlying 10 region classification.

The Working Group III then proceeded to assess these scenarios as «ensembles» by assuming that each scenario category represented a statistical distribution. Although Chapter 3 of the IPCC AR6 Working Group III Report and the Annex to this chapter provided a few more details about these scenarios, what was elevated to the Summary of Policymakers was a quasi-statistical assessment of the set of scenarios. The statement (quoted in the previous section) on the 43% emissions reductions in global modelled pathways is an example of this. The SPM itself has a slightly more expanded form of this statement.

Assessing scenarios in this manner as though they constitute a statistical sample is deeply misleading for multiple reasons. First, the collection of scenarios in the IPCC AR6 WGIII database is not a statistical sample, nor is it drawn by any established sampling technique (Peters et al., 2023; Rogelj, 2022). These scenarios are submitted by interested scientists, based on calls by the IPCC, and then vetted and selected.

The International Institute for Applied Systems Analysis (IIASA) was given the responsibility of preparing and maintaining a database for the submission of the scenarios. A pre-determined structure for a database, results in restricting the types of scenarios that can be submitted for assessment (Peters et al., 2023). Indeed, there have been multiple issues raised since AR6 about the lack of ease in uploading scenarios, problems with creating similar databases for national scenarios, etc. (IPCC, 2023). And the fact that 23% of the global scenarios that were part of the AR6 assessment are submitted by the IIASA itself also raises potential issues concerning conflict of interest.

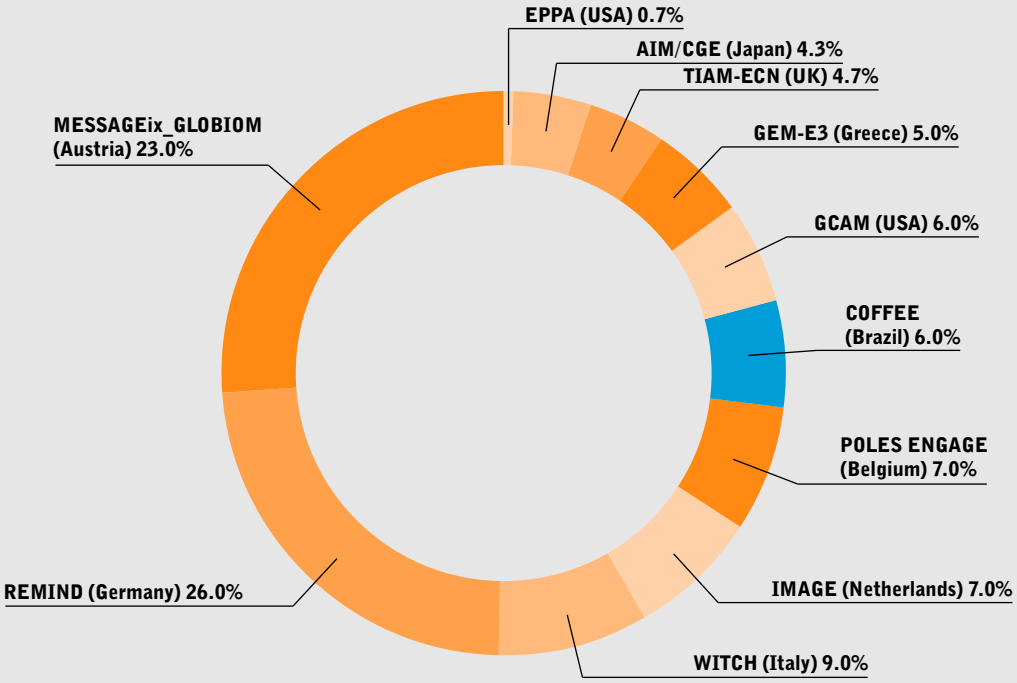
Second, 49% of the 556 scenarios with an underlying 10-region classification that are compatible with the temperature goals of the Paris Agreement come from just two major institutions (see Figure 7a). Such a disproportionate number of scenarios from just two institutions mean that any statistically estimated outcome of the scenario ensembles (such as means or medians) is likely to be skewed in favour of the results submitted by these institutions.

Third, given that the scenarios do not constitute a statistical sample, assessing them in terms of percentile ranges and medians is highly inappropriate. The IPCC reports do not clarify what the reason is for the differences between scenarios, even within one category. For example, the median emissions reductions by 2030 projected across the 97 scenarios of the C1 category (69 of which have an underlying 10-region distribution), is 43%. The 5-95th percentile range of emissions reductions for the year 2030 projected in these scenarios extends from 34% to 60%.

It is not clear why 5% of the scenarios that project either lower than 34% reductions or higher than 60% reductions are excluded. It is not as though there is any statistical significance associated with the choice of the 5-95th percentile range. Also, the IPCC report does not delve into the reasons for the differences between scenarios within the same category. We also do not have any explanation for the different assumptions that lead to the differences in projections for emissions reductions.

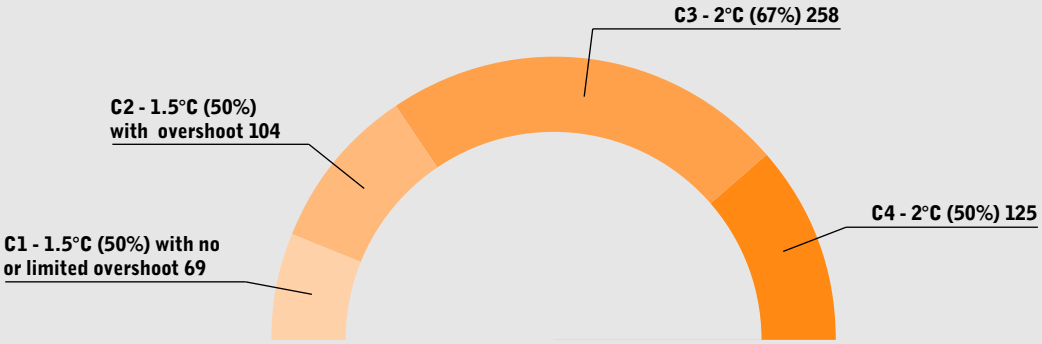
In short, the scenarios chapter – Chapter 3 of the IPCC AR6 Working Group III Report – does not represent scientifically robust analysis. Yet, it is the chapter that has received the most attention in the media and has played a disproportionate role in informing policy – especially decisions of the UNFCCC – since its release.

Figure 7a: Distribution of scenarios assessed in IPCC AR6 by regions in which they are produced



Source: Figures reproduced from Kanitkar et al. (2024)

Figure 7b: Distribution of scenarios assessed in IPCC AR6 by climate response



Source: Figures reproduced from Kanitkar et al. (2024)

Are scenarios that ensure both equity and climate compatibility possible?

The answer to this is undoubtedly a yes, as we argue below.

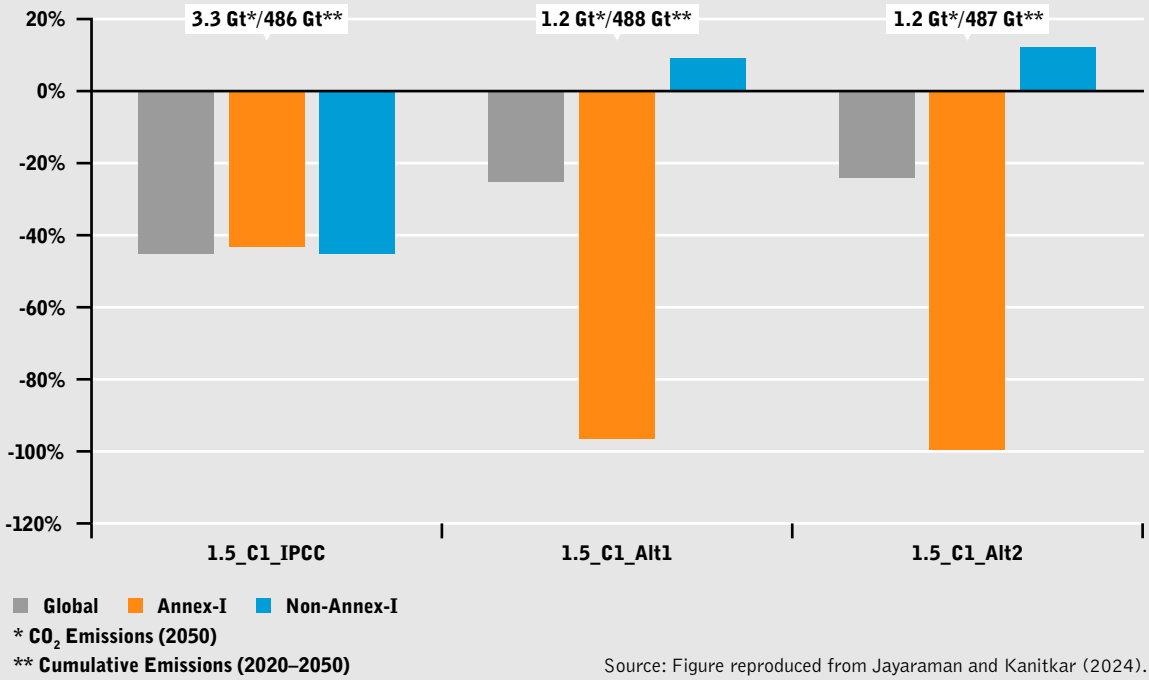
Equitable distribution of the mitigation burden

Consider first the case of the equitable distribution of the mitigation burden. As we have seen above – in the median scenario that the IPCC AR6 highlights – emissions reductions to meet the temperature target are achieved by burdening developing countries with a higher share of the mitigation burden. However, alternative scenarios are possible, as illustrated by Figure 9.

The real constraint that needs to be considered to limit warming, is to ensure that CO_2 emissions remain within the global carbon budget (IPCC, 2014; IPCC, 2021). The alternative scenarios shown in Figures 8 and 9 maintain the carbon budget constraint and allow a little more time for developing countries to start reducing emissions by allocating a higher mitigation burden to developed countries. In the absence of meaningful emissions reductions by developed countries, the burden will be passed on to the developing countries. This is a consequence of the fact that the developed countries already consumed well beyond their fair share of the global carbon budget by 2020. The fact that every generation of scenarios produced or assessed by the IPCC continually grandfathers the past by shifting goalposts further into the future is therefore a serious problem.

The median scenario for 2°C warming offers more flexibility if the appropriate equity and differentiation criteria were to be imposed on the distribution of the burden between non-Annex-I and Annex-I countries. However, in the AR6 scenarios, a good part of the increase in the remaining carbon budget for 2°C warming (compared to 1.5°C warming) benefits the developed countries. An equitable solution would be to maintain high levels of emissions reductions for developed countries while providing more carbon space to developing countries. This possibility is illustrated in Figure 10, which uses the median scenario for 2°C warming from the IPCC AR6 Working Group III Report (this is the median scenario in category C3, as in Table SPM.2 of the report of Working Group III).

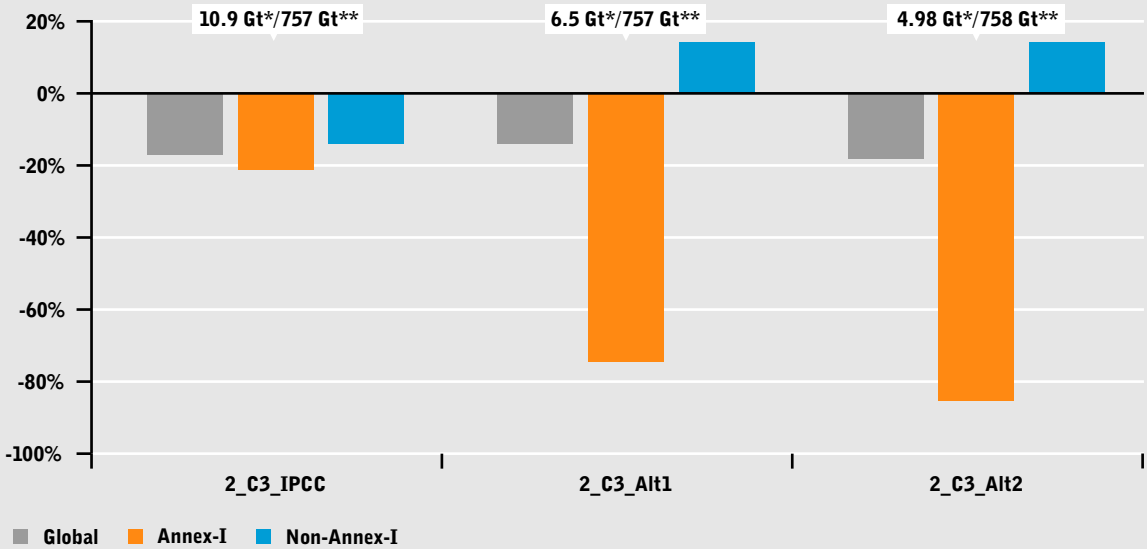
Figure 8: CO_2 reductions between 2020 and 2030 projected in the median of all assessed scenarios of the IPCC for limiting warming to 1.5°C with no or limited overshoot with a 50% probability, compared with alternative scenarios constructed by authors



* CO_2 Emissions (2050)
** Cumulative Emissions (2020–2050)

Source: Figure reproduced from Jayaraman and Kanitkar (2024).

Figure 9: CO_2 reductions between 2020 and 2030 projected in the median of all assessed scenarios of the IPCC for limiting warming to 2°C with a 67% probability, compared with alternative scenarios constructed by authors



* CO_2 Emissions (2050)
** Cumulative Emissions (2020–2050)

Source: Figure reproduced from Jayaraman and Kanitkar (2024).

A sustainable future for all

Ranjan et al. (2024) indicate the possibilities for the second issue: the projection of a world that is more equitable and sustainable. IAMs project global energy and emissions trajectories based on multi-region optimisation (Krey et al., 2020) across regions classified by geographical location. This does not capture differentiation in terms of social and economic development, which is used in frameworks that approach the issue with a development-led perspective (Liu et al., 2021; Cevik, 2022) as well as by the UNFCCC and its Paris Agreement. Following Ranjan et al. (2024), in the analysis presented in this brief, we classify 179 countries in five development groups based on 15 indicators for income, health, education, infrastructure, energy, and emissions. Figure 10 shows some illustrative examples of country classification based on development-related variables.

By moving away from neo-classical approaches to estimate GDP growth, consumption, investments, etc., and projecting energy convergence pathways that are based on sufficiency thresholds estimated for these variables (Ranjan & Kanitkar, 2025), we constructed a range of scenarios that allow developing countries to meet their aspirations, without profligate energy use or overconsumption of the carbon budget. This is balanced by reductions in the wasteful consumption of energy in developed countries without the loss of well-being in these countries.

Figure 10a: Infant Mortality Rate in the 179 countries assessed
Deaths per 1000 live births

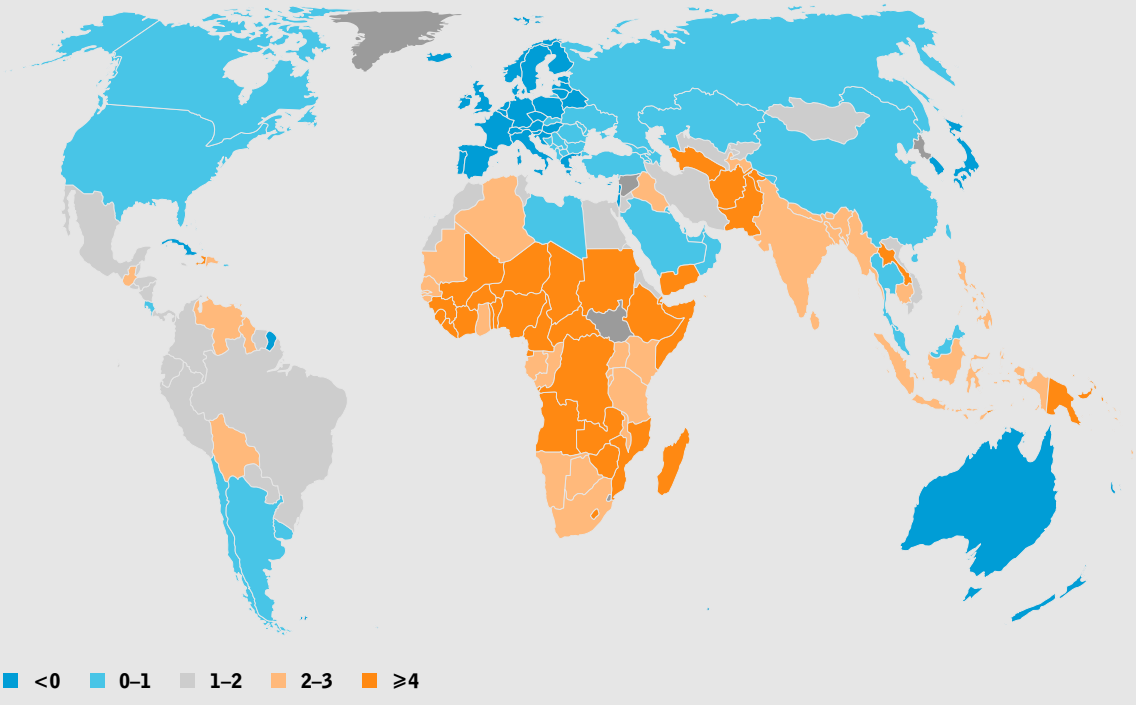


Figure 10b: Life Expectancy at Birth
Years

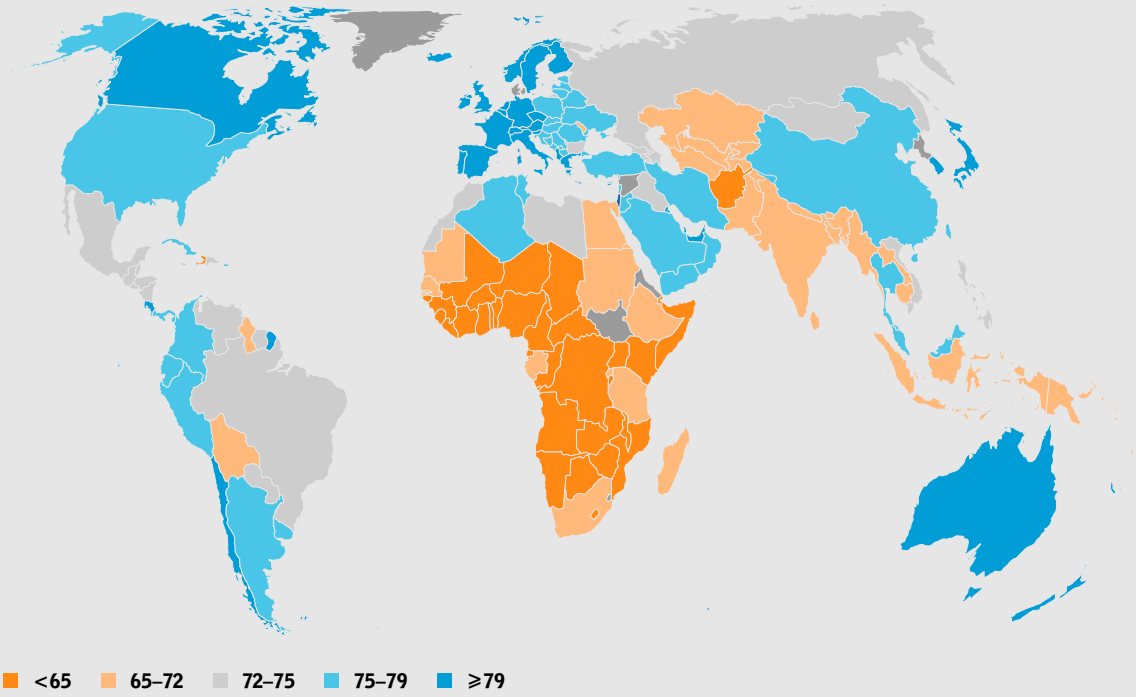


Figure 10c: Daily Calorific Intake
kcal/person

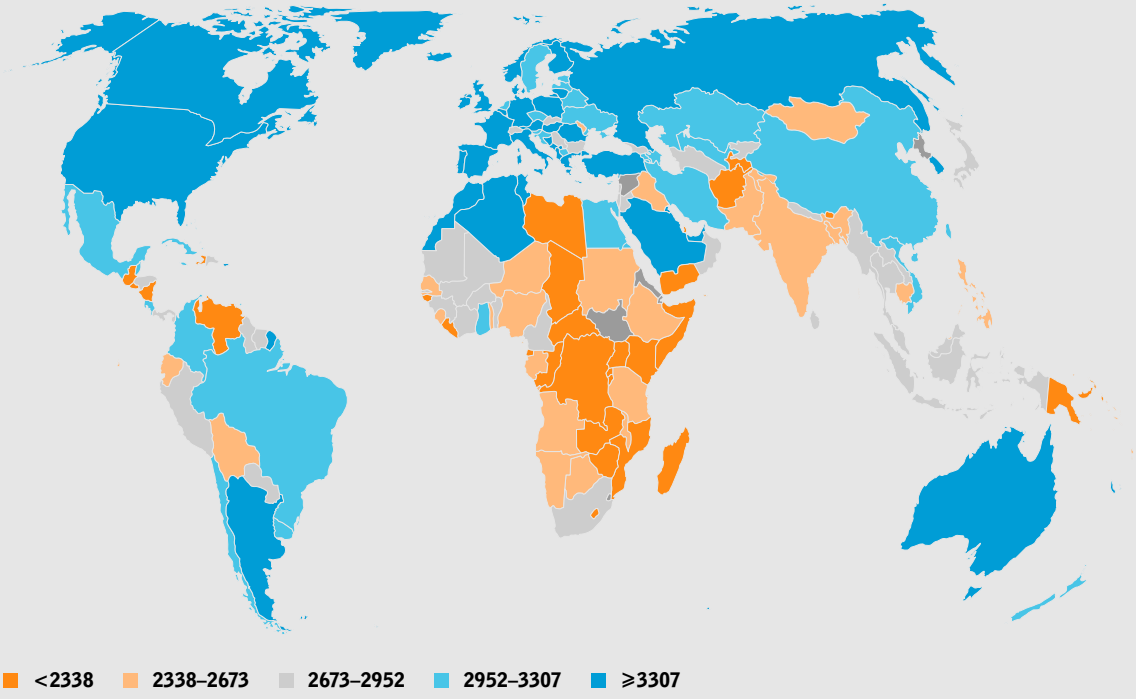


Figure 10d: Deaths due to Unsafe Sanitation in the 179 countries assessed
Deaths per 100.000 people

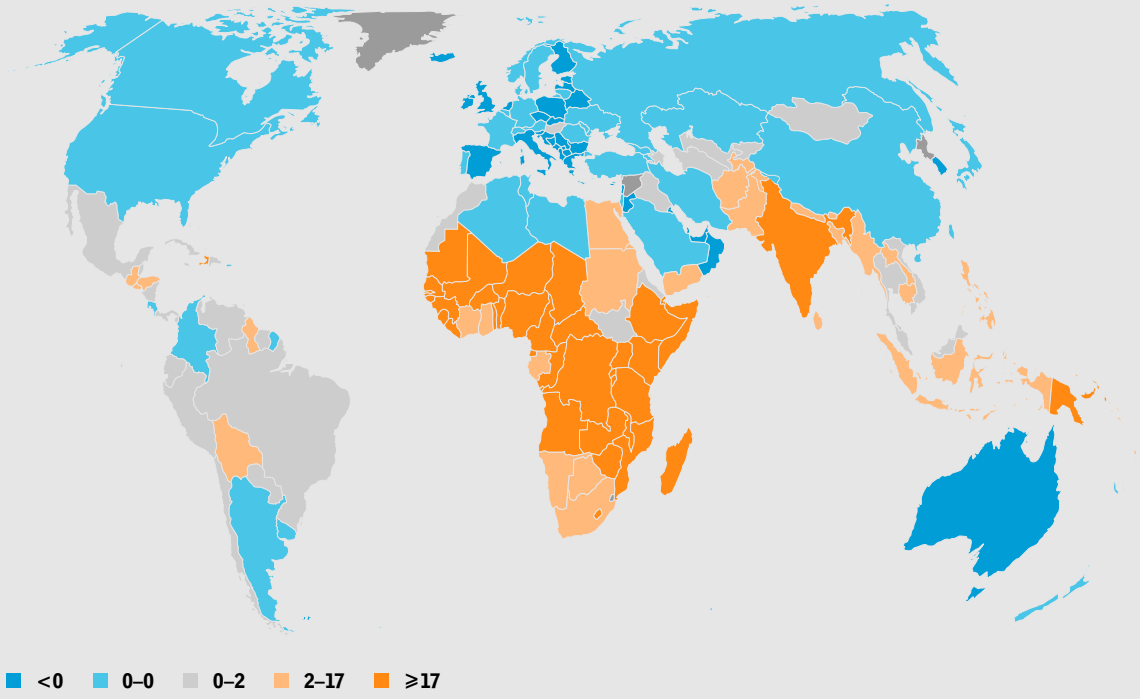
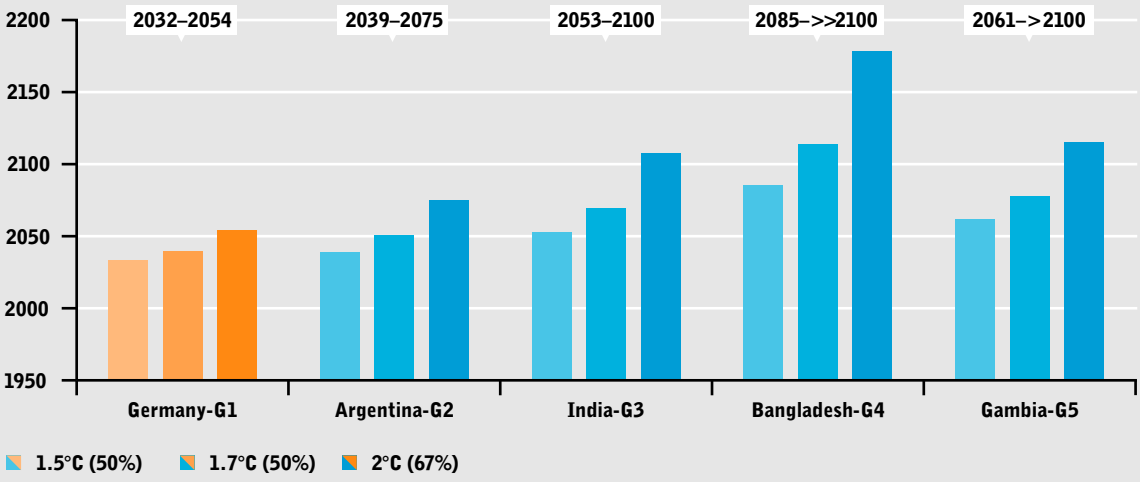


Figure 11: Years to reach net-zero emissions for countries at different levels of development based on assumptions for convergence in primary energy convergence to 75 GJ by 2050 for all, and cumulative emissions limited to the fair share of the remaining carbon budget



Our results show that, although achieving the temperature goals of the Paris Agreement requires greater effort across all regions, the effort required by developed countries is significantly higher if climate equity is considered, as compared to scenarios in which climate equity is compromised. This is true even when the actual reduction in emissions is made easier due to reductions in energy use in developed countries through the application of sufficiency thresholds. See Figure 11 for illustrative results reaching net-zero emissions for five countries belonging to five different development groups in ascending order of performance on development indicators.

Even for a temperature target of limiting warming to 1.7°C with a 50% probability, Germany – the Annex-I country listed in Figure 11 – has to reach net-zero emissions by 2039, which is significantly earlier than its declared net-zero target year. Further work to explore the trade-offs between achieving certain specific temperature targets, equitable distribution of the mitigation burden, and energy for sustainable development for all needs to be undertaken. However, these scenarios demonstrate that it is far from impossible to construct scenarios that foreground questions of equity, even while exploring ways to achieve sustainable, climate-compatible futures.

The way forward for AR7

It is a welcome sign that the IPCC has already begun the conversation on how scenario generation and assessment must be improved. However, this process must be strengthened to ensure that the problems of AR6 are not repeated in AR7. Indeed, there have been multiple calls for this from the scientific communities of the global South. There are a few recommendations regarding the way forward.

First, if the IPCC is to remain a credible source of policy-relevant scientific information for a large part of the world, **then it must make conscious and serious efforts to foreground the concerns and perspectives of the global South in its assessment**. This goes beyond the adequate representation of Third World scholars in the authorship of IPCC reports. In the scenarios literature specifically, this means foregrounding the need for industrial development, material well-being, and income growth in developing countries. **The scenarios in AR7 must consciously explore equitable scenarios for the future**, including equity in sharing the carbon budget and the mitigation burden, equity in energy access, and equity in growth and consumption for the well-being of the populations of all countries.

The AR6 is marked by perspectives that, on the one hand, are extremely optimistic on technology, indeed sometimes fantastically so if we consider the amount of CO_2 capture and storage that is assumed in the scenarios through the assumption of speculative technological development. However, on the other hand, the same scenarios represent a deep pessimism when it comes to questions of social and economic development, and they often assume that even the basic goals of poverty eradication and ending hunger will not be met. Radical technological transformation is assumed to take place amidst «business-as-usual» economics (at best), even in the face of the growing risks of hunger and global inequality in the most optimistic mitigation scenarios. Many governments of the global South have repeatedly raised these issues across multiple forums, which is a clear indication of their policy-relevant nature. In the AR7, therefore, the IPCC must make every effort to address these concerns.

Second – and related to the process of scenario assessment in the IPCC – there must be a **separation between scenarios and models**. Both are tools that allow for the mathematical simulation of potential future trends, but one need not depend on the other. There can be scenarios that are not based on underlying optimisation models but are instead analytical or conceptual in nature. Constructing illustrative scenarios is not tied to the use of IAMs. This is especially true of IAMs in their current form, as they follow a particular economic narrative.

Third, the IPCC must not restrict its assessment based on arbitrary vetting criteria that exclude any section of the literature on this subject. It must reflect fairly the diversity in the literature in its assessment.

Fourth, the **assessment of scenarios must be transparent and based on the use of robust and fit-for-purpose analytical tools**. The easy route of reporting medians and averages for collections of scenarios that do not represent statistical distributions is not an approach that is scientifically robust – a fundamental requirement of IPCC assessments.

Fifth, all the **underlying assumptions – including those relating to regional projections; the extent of accounting for or incorporating differentiation, uncertainties, and gaps in datasets that are used; and other scientific qualifications and caveats under which the findings are valid – must be clearly communicated.** The AR7 Reports, their SPMs, and most importantly the outreach following the approval of the SPMs, must provide a visible and transparent account of these assumptions and caveats.

In summary, **restoring the perspective of seeking equitable and sustainable futures in climate science and climate policy, and emphasising well-being for the entire world – especially the global South – requires coordinated effort from all actors committed to equity from both the North and the South.** Such effort also requires adequate time and resources to enable scholars from the global South to make their mark in the scientific literature. **It is precisely by restoring such a perspective in the work of the upcoming AR7 that the ideal of the IPCC as one of the key sources of the «best available science» will be realised.**

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