

# Entry points for assessing ‘fair shares’ in national mitigation efforts

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## Research Article

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# Abstract

Fairness considerations have been central to the international climate change mitigation discourse, generating numerous theoretical and philosophical debates. In this article, we address the pressing need for practical guidance on navigating this landscape in assessing relative mitigation efforts. The Paris Agreement mandates that updates to Nationally Determined Contributions (NDCs) include clear and transparent considerations of fairness. This reflects a progression from previous submissions where such considerations were optional and inconsistently addressed. We propose a set of entry points for examining and revising these assertions in practice. We demonstrate the use of this approach through a case study focusing on the European Union. Our work emphasizes the importance of explicitly defining foundational principles, specifying allocation quantities, defining allocation approaches, and presenting selected indicators to operationalize 'fair shares' in mitigation efforts. By bridging the gap between scholarly debates and practical application, this study supports the integration of clear and transparent fairness considerations into climate policy commitments.

## Highlights

- We describe entry points for assessing an assertion of fairness in relative mitigation effort.
- We illustrate the importance of recognising these entry points using examples of fairness assertions in contemporary NDCs where these are inadequately described or omitted.
- A case study with focus on the European Union showcases clear and transparent consideration of these entry points in developing an assertion of fairness.

## 1. Introduction

The origins of contemporary debates over fairness in climate change mitigation can be traced back to the Stockholm Declaration of 1972, which underscored the need to balance national sovereign environmental policy with the collective obligation to avoid environmental harm beyond one's borders (Principles 21–24, UN, 1972). Principle 23, for example, refers to a differentiation in standards "[...] which are valid for the most advanced countries, but which may be inappropriate and of unwarranted social cost for the developing countries" (ibid.). This early recognition of shared but differentiated responsibilities was reinforced within the international climate negotiation regime during the 44th UN General Assembly in 1989, which noted the disproportionate contributions of 'developed' countries to the greenhouse gas (GHG) emissions driving climate change and recognised the need for international cooperation to support 'developing' countries in addressing climate change and its effects (44/207, UN, 1989). The subsequent establishment of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 enshrined the principle of 'common but differentiated responsibilities and respective capabilities' (CBDR&RC), advocating for the safeguarding of the climate system for benefit of both present and future generations, grounded in the principle of equity (Article 3.1, UNFCCC, 1992).

CBDR&RC and the broader principle of equity have since been articulated and qualified in both legal instruments under the convention, the Kyoto Protocol (1997) and the Paris Agreement (2015).

The political transition to Nationally Determined Contributions (NDCs) under the Paris Agreement in 2015 represented an evolution in global climate governance away from the prescriptive and legally binding emissions targets of the Kyoto Protocol (Rajamani & Bodansky, 2019; Depledge, 2022). This shift also substantively changed the interpretation and application of considerations of fairness in climate change mitigation (Rajamani et al., 2021). The Intergovernmental Panel on Climate Change's Working Group III has tracked this evolving conceptualisation over time through its contributions to the periodic Assessment Reports. Early iterations of these reports discuss several approaches that conceptually scaffold contemporary fairness considerations, such as equal per capita emissions allocations, proportionality of effort to historical emissions and economic strength, emissions pathways in global or staged convergence, and effort allocation in terms of equal costs, among others (see Chap. 6, Table 6.3, Page 440, IPCC, 2001, and Chap. 13, Table 13.2, p. 770, 2007). The political shift brought about by the Paris Agreement noted earlier alongside advances in scientific understanding of the near-linear relationship between cumulative carbon dioxide emissions and specific temperature thresholds spurred new efforts towards quantifying 'fair shares' of a finite remaining carbon budget (e.g. Pan & Chen, 2010; Jayaraman et al., 2012; N. Rao, 2012; Raupach et al., 2014; Gignac & Matthews, 2015). These advances were captured by the IPCC's fifth assessment report, categorizing approaches and interpretations discussed in the literature into distinct groups that remain in use today (see Chap. 4, Table 6.7, p. 458, IPCC, 2014).

Normative and scientific debate on considerations of fairness have been a hallmark from the beginning of the international process on mitigating climate change (see e.g. Agarwal & Narain, 1991; Grubb, 1995). Efforts to bridge the divide between countries, such as the convening of the BASIC group, have made slow progress despite the wealth of evidence collected on both sides of the science-policy interface (Pickering et al., 2012). These arguments continue to be a central albeit robustly debated element of contemporary political narratives following the shift to the Paris Agreement (Klinsky et al., 2017). In this work, we broadly delineate these debates across two levels, a relatively more abstract level of theory and a relatively more pragmatic level of practice, focussing our efforts on the latter. The former concerns itself with theoretical debates over the interpretation of principles and their function within the international climate regime. The latter concerns itself with the practical application of these concepts in evaluating relative mitigation efforts. Motivating our focus on the latter are several recent scholarly interventions that have called for more rigour and an explicit recognition of the value judgments underpinning analytical decisions in 'fair share' assessments of climate change mitigation effort (Kantha et al., 2018; Winkler et al., 2018; Dooley et al., 2021; Rajamani et al., 2021). Winkler et al. (2018) and Rajamani et al. (2021) specifically discuss these issues in the context of parties' submissions of NDCs under the Paris Agreement, finding largely incomplete or inconsistent descriptions of the analysis underlying assertions of equity and fairness contained therein. We interpret these critiques through our lens of practice, understanding that those conducting 'fair share' assessments must demonstrate a more

direct linkage between foundational principles and their translation into applied considerations of fairness.

Undergirding these critiques is the Paris Rulebook itself (Rajamani & Bodansky, 2019). While transparent and clear assertions of fairness were not mandatory in the first submissions of NDCs, this changed for subsequent submissions as discussed in the outcomes of the first global stocktake to the Paris Agreement, drafted during the 28th Conference of Parties (COP) (Decision 1/CMA.5, UNFCCC, 2024). This latest decision recalls that subsequent NDCs “... *will represent a progression beyond the Party’s current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances*” (Paragraph 167, *Ibid.*). It then goes further to recall that subsequent NDCs “... *shall provide the information necessary for clarity, transparency and understanding contained in annex I to decision 4/CMA.1*” (Paragraph 168, *Ibid.*). Thus, while countries are free to choose their own qualitative or quantitative indicators, the relevant annex to the decision referenced specifically notes the requirement to describe “... *[h]ow the Party considers that its nationally determined contribution is fair and ambitious in the light of its national circumstances*” (Decision 4/CMA.1, UNFCCC, 2018).

Considering these requirements and their practical implications, we discuss entry points along the process to develop a Party’s normative stance on fairness in domestic mitigation efforts. This focusses primarily on quantitative assertions of ‘fair shares’, recognising that such assessments only cover part<sup>[1]</sup> of the full scope of fairness considerations deliberated under the UNFCCC and the Paris Agreement. The article begins by drawing illustrative examples from current NDCs to motivate consideration of the entry points we identify. We then demonstrate the evaluation of identified entry points using an illustrative case study of the European Union. We conclude by calling for a clear definition of foundational principles in any practical assertion of fairness, and in the specific case of ‘fair share’ quantification, following this with a specification of the allocation quantity, definition of the allocation approach and presentation of indicators selected to operationalise this. We argue that this approach provides a level of clarity and transparency both in line with the mandate of the Paris Agreement and in support of necessary global stocktaking and assessment.

## **2. Assessing entry points for assertions of fairness in contemporary NDCs**

We begin with describing entry points in the practice of quantifying ‘fair shares’. These entry points represent decisions that may be made at different times by different groups of people during the formulation of a fairness assertion. The definition of these entry points bridges theoretical and normative critiques (see e.g. Dooley et al., 2021; Rajamani et al., 2021) to provide simple heuristics guiding the development or assessment of a party’s assertion of fairness, which can be applied by policy analysts and policymakers. We describe these entry points using selected examples from contemporary NDCs that serve as illustrations rather than demonstrations of issue prevalence (for the latter, see Winkler et al. (2018)). Each example we use reflects as far as possible the full fairness assertion text

identified in the respective NDC, which we do not trace back to a specific party since that is not the purpose of this exercise. Table 1 summarises the entry points we discuss, listing a series of questions for self-reflection that aid in the clear and transparent communication of decisions taken in practice during the quantification of a ‘fair share’. Alongside the entry points we discuss here, we also recognise the importance of communicating implications of a specific assertion for all others (Meinshausen et al., 2015; Dooley et al., 2021; Lecocq & Winkler, 2024). Omission of this final element leaves the fairness assertion incomplete, as it does not recognise how the party’s assertion affects the available quantity for all others, nor what this would mean for the collective feasibility to achieve the global climate targets.

Table 1

– Entry points for establishing and operationalizing a normative position regarding quantitative ‘fair shares’ in NDCs.

Entry point	Description	Self-reflection
Principle	The foundational principles and their interpretation.	Have the principles and their sources been clearly defined?
		Has the consistency (or lack thereof) across principles been communicated?
Allocation quantity	The object to be allocated, whether fixed over some period or considered annually.	Has the allocation quantity been reported?
		Have all parameters necessary to replicate this quantity with publicly available data been provided?
		Has its alignment with the principles considered been clearly explained?
Allocation approach	The approach used for distributing or allocating the quantity.	Have the allocation approaches been defined?
		Have clear mathematical representations enabling replication been provided?
		Has their alignment with the principles considered been clearly explained?
Indicators	The measurable data used to operationalise the allocation approach.	Have all indicators and their publicly available sources been provided?
		Has their alignment with the principles considered been clearly explained?
Implications for all others	The consequences of the allocation process for all other parties.	Has the remaining quantity available to all other parties been clearly communicated?

## 2.1. Principles

The first entry point in an assertion of fairness involves identifying relevant foundational principles. These principles establish what is considered ‘fair’ and form the basis of any subsequent assertion. A

common challenge here lies in the indeterminate nature of principles established through international treaties, which often allow for varied interpretations that may change over time, either by design or as a compromise to achieve consensus (Geden, 2016; Rajamani, 2016). To address this, principles may be drawn upon from other relevant sources to clarify a given interpretation. For example, principles formalised in international environmental law have been applied to inform the interpretation and operationalisation of ‘fair shares’ of mitigation effort (Rajamani et al., 2021). Philosophical and climate justice literature also provides guidance in defining and interpreting foundational principles (Shue, 2014; Meyer, 2017; Caney, 2021). National constitutions and legislation may also be relevant in contextualising the domestic interpretation of principles invoked in international agreements (Kingston, 2020).

Principles can be interpreted either in isolation or in combination, reflecting different theories of justice. However, combining conflicting principles can be problematic and may not yield practical solutions. For example, Dooley et al. (2021) discuss such contradictions in the equity literature, illustrating challenges that arise when principles such as guaranteeing a minimum standard of living for vulnerable populations conflict with principles like grandfathering, which protect the existing advantages of the wealthy. Such contradictions can deny vulnerable groups the resources needed to meet their basic needs (Dooley et al., 2021). Rajamani et al. (2021) extend this critique from a legal perspective, emphasizing the importance of not only maintaining consistency between principles but also aligning them with principles of international law. They highlight issues in contemporary NDCs where the chosen indicators, and their justifications or lack thereof, fail to meet these criteria. Examples include justifications based on small shares of global emissions for countries that are not LDCs or SIDs, reliance on least-cost pathways, or emissions per GDP, as well as considerations of peak year and progression of effort (Rajamani et al., 2021). In all cases, clearly communicating the source of a principle is crucial to avoid confusion. For example, the qualifier ‘...in light of different national circumstances’ added to the Common but Differentiated Responsibilities and Respective Capabilities (CBDR&RC) principle in the Paris Agreement could be interpreted as a substantive shift from its original meaning in the Kyoto Protocol (Rajamani, 2016).

<i>Example Set 1</i>	<i>"The [party] NDC exceeds a straight-line path to achieve net-zero emissions, economy-wide, by no later than 2050."</i>	<i>Ex. 1.1</i>
	<i>"This NDC reflects the [party's] efforts in the context of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances. ... As a developing country with limited sources economy and historically low GHG emission contribution, the [party] considers its 2030 ambition as fair, given that the sum of the contributions leads to a significant deviation from a business-as-usual scenario emission."</i>	<i>Ex. 1.2</i>
	<i>"[assessment is conducted using independent tools that consider] ... equity principles [the party] values and prioritises – taking into account responsibility and capability, as well as the right to promote sustainable development and the need to prioritise development for those living in poverty."</i>	<i>Ex. 1.3</i>

In Example 1.1, the assertion of fairness rests on the pursuit of ambition in line with own targets (exceeding the pace set by a self-determined benchmark). The omission of a principled basis defining

the objective of this fairness assertion makes it impossible to infer how this relates to principles discussed in the Paris Agreement and the UNFCCC. In Example 1.2, the principle of CBDR&RC is referenced in a preamble, followed by an assertion of fairness in the subsequent text. While the source of the referenced principle is not provided, one may infer this refers to the text in Article 4.3 of the Paris Agreement, which includes the caveat regarding national circumstances. Issues arise here due to the subsequent qualification in the fairness assertion (effort reflecting a deviation from business-as-usual). This is arguably in contradiction with CBDR&RC it no longer reflects an assessment in relation to other parties (see the importance of “relative fair shares” in Winkler et al., 2018), but rather an assessment in relation to one’s own ambition. In Example 1.3, foundational principles are transparently communicated and sourced (referencing independent assessment tools not included in this excerpt) allowing them to be critically evaluated. These examples illustrate how conceptual ambiguities in underlying principles, whether omitted or invoked but not applied in practice, can lead to a lack of clarity and transparency in fairness assertions at this foundational entry point.

## 2.2. Allocation quantity

The allocation quantity defines what is to be distributed and is related in a robust manner to meeting global climate targets. This can be a finite carbon budget underlying a global mitigation pathway, the pathway itself or another measurable finite quantity. In all cases, this requires several value judgments such as choosing the intended climate target, the probability of meeting the target, the estimated contributions of non-CO<sub>2</sub> emissions, emissions and sinks from land-use and land-use change and forestry (LULUCF), or the historical period considered, among other considerations (Robiou du Pont et al., 2017; Nauels et al., 2019; Rogelj et al., 2019; Matthews et al., 2020). Here the allocation quantity may also consider cases where benefits are folded into the consideration (N. D. Rao, 2022), quantities beyond carbon budgets and emissions pathways such as scenario-derived mitigation investment needs (S. Pachauri et al., 2022) or carbon dioxide removal obligations (Fyson et al., 2020).

The allocation quantity is fundamental to quantitative assessments of relative fairness underlying an assertion of a ‘fair share’ (Winkler et al., 2018). A lack of clarity and transparency may arise here when decisions made in its definition are not clearly communicated, or when it is omitted altogether. For instance, translating the long-term temperature goal of the Paris Agreement to keep global warming well-below 2°C and pursue efforts to limit it to 1.5°C relative to preindustrial levels to a remaining carbon budget or an emissions pathway is a value-laden exercise that may result in substantively different aggregates, aside from associated scientific uncertainties (Lamboll et al., 2023). Fairness assertions that do not clearly define the choices informing the allocation quantity do not provide sufficient clarity. This is an intuitive but nevertheless important issue, given that NDCs typically discuss only a single party’s future emission pathway and a single party’s ‘fair share’ (if at all). In the following illustrative examples, we explore cases where a lack of clarity and transparency in the allocation quantity leads to a relative assessment of fairness that is uninformative, irrespective of whether decisions at other entry points are clearly reported.

Example Set 2	<i>"[The party's] updated NDC is a progression on our previous 2030 target and a significant increase in ambition, committing [the party] to reduce greenhouse gas emissions by 43% below 2005 levels by 2030 – half as much again as the previous target of 26–28% – and achieve net zero emissions by 2050."</i>	Ex.2.1
	<i>"[The party] would be contributing with a reduction in the order of magnitude of what the IPCC says countries must achieve to keep the 1.5°C target on track."</i>	Ex.2.2
	<i>"... NDC is consistent with global mitigation efforts to limit global warming to well-below 2°C and [the party] considers it to be a fair contribution ..."</i>	Ex.2.3
	<i>"To not exceed 1.5 degree temperature [sic] by 2050, the budget set by the Intergovernmental Panel on Climate Change (IPCC) is 650 GtCO<sub>2</sub>."</i>	Ex.2.4

In Example 2.1, the allocation quantity (in terms of a reference pathway) is not provided, such that assertions of fairness can only be discussed in terms of a progression of earlier effort. While targets are given, they have no substantive link to global climate goals. It is therefore impossible to relate the ambition shown here with that of other parties and thus assertions of relative fairness are effectively mute. In Examples 2.2 and 2.3, the allocation quantities are discussed ambiguously, such that the likelihood of achieving the temperature target and the resulting pathway or budget corresponding to this cannot be reliably inferred. This is critical as remaining carbon budget quantities and associated assumed emissions pathways shift substantially with the likelihood of achieving a temperature target (see e.g. Rogelj et al., 2017). The text in this example does not provide sufficient clarity, despite noting a temperature target, such that allocations thereof used to assess party effort can substantively vary, possibly resulting in contradictory assessments of fairness. In Example 2.4, the allocation quantity reflects a remaining carbon budget (from the year 2010, discussed in the full text) and draws on the available science at the time given a specified temperature increase goal. While the corresponding likelihood considered is not clearly communicated, it can be inferred from the cited underlying report to which the NDC refers using the provided absolute budget, as can the global emissions pathway implied by this budget. These examples show that the lack of a clear and transparent allocation quantity not only hinders the comparative assessment of mitigation effort reported in submitted NDCs but also obscures the pathway towards achieving global climate targets. A well-defined allocation quantity, supported by the best available science as required under the Paris Agreement, is crucial to enable assessments of how assertions of fairness in NDCs relate to collective climate goals.

## 2.3. Allocation approach

The allocation approach specifies how the quantity (for example, the remaining carbon budget) is allocated. Several approaches and their derivatives exist in the literature (see Chap. 4, Table 6.7, p. 458, IPCC, 2014), and new allocation approaches are likely to arise, for example through the need to address quantities informing loss and damage, adaptation and differentiated climate vulnerability more broadly (J. Chalifour, 2021). Allocation approaches distribute a quantity across some set of parties, typically but not necessarily at the state level, and may or may not consider sub-national differentiation. They are usually qualified with a timeframe over which the quantity is to be allocated, clearly stipulating the period



of consideration. Broad conceptualisations of allocation approaches may lend themselves to multiple possible interpretations. In the following illustrative examples, we show that this can result in substantively different quantifications of ‘fair shares’ such that a comparison of the resulting allocations to a party’s intended emissions pathway is likely uninformative.

<p><i>Example Set 3</i></p>	<p><i>“[The party’s] updated NDC is a progression on our previous 2030 target and a significant increase in ambition, committing [the party] to reduce greenhouse gas emissions by 43% below 2005 levels by 2030 – half as much again as the previous target of 26–28% – and achieve net zero emissions by 2050.”</i></p>	<p><i>Ex.3.1</i></p>
	<p><i>“It is considered fair, given that [party a’s] contribution to global emissions is 1.3% of the global total, with per capita emissions of 3.7 tons, which is below the average global emission of 5 tons per capita, that is, 4.4 times less than that of our main trading partner, [party b], with 16.5 tons per capita.”</i></p>	<p><i>Ex.3.2</i></p>
	<p><i>“[Using an index to determine allocations of a carbon budget that reflects ...] Historical responsibility. Includes responsibility for the cumulative emissions since the pre-industrial era (1750–2010). ... [followed by other factors and subsequently by a mathematical representation of the index].”</i></p>	<p><i>Ex.3.3</i></p>

In Example 3.1, the allocation approach includes several possible facets of differentiation that require value judgements in their operationalisation. The text does not expand on how to apply this to assess temperature increase responsibility, nor does it expand on how this is to be related to a ‘fair’ future emissions pathway for the party in question. As such, it is impossible to infer which of the possible operationalisations have informed the assertions of fairness made. In Example 3.2, while the allocation approach references two facets of differentiation – namely ‘small share’ of historical responsibility and per-capita emissions relative to the global average (and one reference party), it does not define how these are used to define a forward looking relative ‘fair share’. The ‘small share’ approach was the most commonly reported equity consideration in INDCs assessed by Winkler et al. (2018), who discuss issues of a lack of consistency in its use. In this case, its applicability to assess other party’s relative mitigation efforts is unclear, as the assertion rests on a binary ‘below the average’ per capita historical emissions status, suggesting no differentiation between parties in this group. In Example 3.3, the allocation approach is clearly and transparently described including the provision of a mathematical representation (in the subsequent text) that can be critically evaluated, alongside clear statements regarding the period of consideration. This fosters replication by other parties to increase mutual understanding. These examples highlight the importance of a clearly and completely defined allocation approach in assessments of fairness. This is essential to enable parties to understand and evaluate the basis of each other’s contributions, facilitating the assessment of NDCs in relation to each other and to global climate goals.

## 2.4. Indicators

Indicators represent the quantitative data used to operationalise an allocation approach. Indicators may be characteristics of regions, countries, or populations, and require choices about how they are reflected. Selecting appropriate indicators necessitates navigating debates within the literature, such as the

selection of gases to consider, the accounting approach for distinct gases, the time period over which indicators are considered and the role and allocation of specific sectoral emissions sources and sinks (Steininger et al., 2014; Meinshausen & Nicholls, 2022; Dhakal et al., 2022; Matthews et al., 2023). The application of indicators may also require their transformation to a suitable (inverse) range for allocation, requiring another set of value judgements.

A lack of clarity at this initial stage can arise when ambiguously defined assertions of fairness allow for multiple plausible indicators, leading to substantively different allocations. Given the widespread omission of specific indicators in current NDCs, we focus on the common example of ‘capability’ to illustrate this issue. Many fairness assertions in contemporary NDCs reference relative capabilities without clearly defining the indicators used to measure this concept. The choice of indicator can significantly affect allocations; for example, using gross domestic product (GDP) without specifying whether it is measured by purchasing power parity (PPP) or market exchange rates (MER) can result in quite different outcomes. This issue is compounded when the selected indicators are arbitrarily transformed, such as being mapped onto an inverse range, without a clear explanation of the function used or the rationale behind the choice. Such opaque decisions can lead to allocations that deviate significantly from the original intent of representing the differences between parties as measured by the selected indicator. Without transparency, these hidden choices undermine the fairness of the allocation approach. At a minimum, the indicators and methodological choices made at this entry point must be explicitly stated to allow for replication and critical assessment. Given the limited evidence that such considerations have been systematically addressed in current NDCs, improving transparency at this stage represents a critical area for improvement in the next round of submissions.

### **3. Case study illustrating ‘fair share’ quantifications for European Union**

We now demonstrate the consideration of each entry point using a case study of the European Union (EU27), a geopolitical region comprised of 27 member countries. This case study was selected in light of a contemporaneous science-policy process in the region that has considered the implications of relative ‘fair shares’ in informing climate targets (see European Scientific Advisory Board on Climate Change, 2023). Table 2 summarises the entry points underlying our illustrative fairness assertion for the region, as well as the resulting allocations. For the sake of conciseness, we provide only a bare minimum synthesis of the necessary value judgements and decisions taken at each entry point here. A detailed discussion of each entry point can be found in the Supplementary Information.

Table 2

– Approach application to allocate a remaining carbon budget for the European Union

Principle	Allocation quantity	Allocation approach	Indicators	Allocation Remaining
EU Climate Law: Polluter Pays, Do no harm, Precaution Paris Agreement: CBDR-RC	A remaining carbon budget consistent with a target limiting warming to 1.5°C with a 50% likelihood, estimated at 247 GtCO <sub>2</sub> from 2023 onward.  To this we add known CO <sub>2</sub> emissions from 2020–2022.  From this aggregate we then subtract projected median international bunker emissions from 2020 under C1 scenarios from IPCC AR6.  To define a total remaining carbon budget from 1990 we then add to this aggregate known CO <sub>2</sub> -FFI emissions from 1990 to 2019 inclusive.	1_ECPC1990,  An allocation in the year 1990, assuming:  equal cumulative per capita allocation 1990–2050.        2_CPC1990adjCAP,  An allocation in the year 1990, assuming:  equal cumulative per capita allocation 1990–2050, scaled in inverse proportion to cumulative per capita 1990–2019 GDP (latest consistent period).	Population 1990–2019 (Hist.)  GDP MER 1990–2019 (WDI)  CO <sub>2</sub> -FFI 1990–2022 (GCP)  Population 2020–2050 (SSP2)      Population 1990–2019 (Hist.)  GDP MER 1990–2019 (WDI)  CO <sub>2</sub> -FFI 1990–2022 (GCP)  Population 2020–2050 (SSP2)	1990: 64.1 GtCO <sub>2</sub> -FFI  2023: -35.4 GtCO <sub>2</sub> -FFI        1990: 14.4 GtCO <sub>2</sub> -FFI  2023: -85 GtCO <sub>2</sub> -FFI

The decisions we take here are not definitive interpretations of underlying principles but rather demonstrate the practical value of communicating each of the identified entry points, inviting critique. The level of clarity and transparency achieved is a natural result of the necessary assessment and self-reflection at each stage of the assertion. Following such an assertion, it would be possible for example to conduct sensitivity assessments of the implications of alternative choices to those made. The use of these entry points may also guide discourse across groups and over time, as the assertion is developed and revised in consultation with all relevant stakeholders. Importantly, it maintains focus on the selection of foundational principles and their faithful representation in quantitative assessments, rather than suffering under the weight of all possible allocation approaches available in the literature. It is this distinction that separates such a principled approach from one that starts with all possible allocations and works backward to select that which is most favourable.

## 4. Conclusion

In this article we engage with the practice of ‘fair share’ quantification informing assertions of fairness in domestic mitigation targets. Our work translates theoretical and normative critiques in the literature to practice, identifying key entry points in assessing an assertion of fairness. We illustrate and motivate these entry points through examples from contemporary NDCs. In anticipation of the upcoming revision cycle and the reiterated call for enhanced ambition in the recent decision under the UNFCCC (2024), this work offers a pragmatic approach designed to assist policymakers and analysts. Its application can guide ongoing NDC revision and assessment processes, aligning efforts with evolving international expectations.

The central theme in this work is the importance of transparently communicating foundational principles considered, their interpretation and their practical application in quantitative assessments of relative effort. This transparency can enrich cross-party dialogue regarding ambition and perceived fairness that may be lost in translation. We advocate for a principled self-assessment and reflection by individual parties, encouraging them to consider the broader implications of their positions without mandating a uniform allocation of effort. Our case study illustrates a possible consideration of identified entry points to investigate allocations of a remaining 1.5°C carbon budget for the EU, in line with principles of European Climate Law and the Paris Agreement. This exercise showcases the value of clear and transparent communication of the decisions made at each entry point, inviting and enabling critical assessment and replication.

Fairness considerations in climate change mitigation are dynamic, requiring periodic updates to reflect bidirectional domestic and international information flows and reactions to collective ambition enhancement (Holz et al., 2023) as well as the latest scientific insights on the required efforts (see e.g. Lamboll et al., 2023; Rogelj & Lamboll, 2024; Zickfeld et al., 2023). The entry points and approach we outline ensure that quantitative assessments supporting fairness assertions are both replicable and adaptable to evolving circumstances.

Recognizing these entry points is essential for advancing the discourse around equity in global climate action. By addressing recent theoretical and normative critiques, our approach fosters greater transparency in fairness assessments. Achieving this in turn requires concerted effort by parties to clarify their positions and enhance collective understanding, ultimately supporting the ambitious goals of the Paris Agreement and the broader UNFCCC process.

## Declarations

### Disclosure statement:

*No potential competing interest were reported by the authors*

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## Footnotes

1. We recognise here the adjacent scholarship that has critically engaged with modelled socioeconomic trajectories (Klinsky & Winkler, 2018) and qualitative considerations of just transitions and sustainable development pathways more broadly (Foster et al., 2024).

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