Fair shares in climate action

Yann Robiou du Pont & Mark Dekker

PRISMA summer school - Wednesday July 9, 2025

	Sunday (July 6)	Monday (July 7)	Tuesday (July 8)	Wednesday (July 9)	Thursday (July 10)	Friday (July 11)
		Introduction	**Impacts and adaptation**	**Equity**	**Finance, equity and mitigation**	**Applications for integrated assessment**
8:00		Breakfast at hotel	Breakfast at hotel	Breakfast at hotel	Breakfast at hotel	Breakfast at hotel
8:30		Travel to school location	Travel to school location	Travel to school location	Travel to school location	Travel to school location
9:00		9:00-10:00 Welcome and Introduction "Need for representing impacts and equity", **Detlef van Vuuren**	9:00-10:00 Climate impacts in IAMs, **Kaj-Ivar van der Wijst** **Mathijs Harmsen**	9:00-10:00 Normative considerations in the models & actions for improvement **Elina Brutchin**	9:00-10:00 Cap & Trade, efficiency versus sovereignty, **Nico Bauer**	9:00-10:00 Climate litigation cases, **Yann Robiou du Pont**
9:30						
10:00		10:00-11:00 Deep dive in perspectives and challenges, **Nico Bauer** **Elina Brutchin**	10:00-11:00 Adaptation & adaptive capacity, **Marina Andrijevic**	10:00-11:00 Fair shares in climate action, **Mark Dekker** **Yann Robiou du Pont**	10:00-11:00 Equity impacts of climate mitigation, **Panagiotis Fragkos**	10:00-11:00 Group work
10:30						
11:00		Break	Break	Break	Break	Break
11:30		11:30-12:30 Poster presentations	11:30-14:30 Workshop: Economic climate impacts in IAMs **Kaj-Ivar van der Wijst**	11:30-12:30 Gender inequality and climate, **Marina Andrijevic**	11:30-12:30 Finance in IAM models, **Bjarne Steffen**	11:30-12:30 Group work presentations
12:00						
12:30		12:30-13:30 Lunch	12:30-13:30 Lunch	12:30-13:30 Lunch	12:30-13:30 Lunch	12:30-13:30 Lunch
13:00						
13:30		13:30-15:30 Poster presentations		13:30-15:30 Workshop: data visualisation **Kaj-Ivar van der Wijst**	13:30-17:00 Group work	13:30-15:30 Group work presentations
14:00						
14:30			14:30-17:00 Group work			
15:00						
15:30		Break	Break	Break	Break	Break
16:00		16:00-17:30 Group work		16:00-17:30 Group work		16:00-17:00 Closing session / feedback **Detlef van Vuuren**
16:30						
17:00			17:00-19:00 Social event: City bike ride		17:00-19:00 Social event: Canoeing through canals	
17:30						
18:00						
18:30						
19:00		19:00 Social Dinner **Vegitalian, Nachtegaalstraat 29B**	19:00 Social Dinner **Soia, Kanaalweg 199**	19:00 Social Dinner **Theehuis Rhijnauwen, Rhijnauwenselaan 16**		
19:30	19:30 Social Dinner **Sarban Afghaans, Oudegracht aan de Werf 161**				19:15 Social Dinner **Kitchen Bar Danel Vredenburgkade 11**	

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Bridge on how fair share analysis relates to IAMs
Notably what the role of IAMs is in this topic (and what not)

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Fair shares

History and outlook

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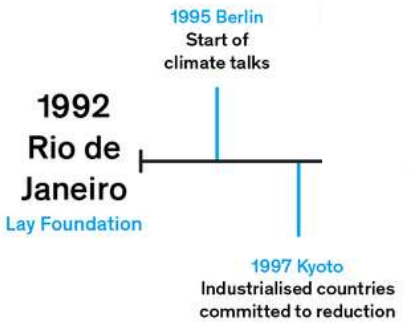
Why fair-shares?



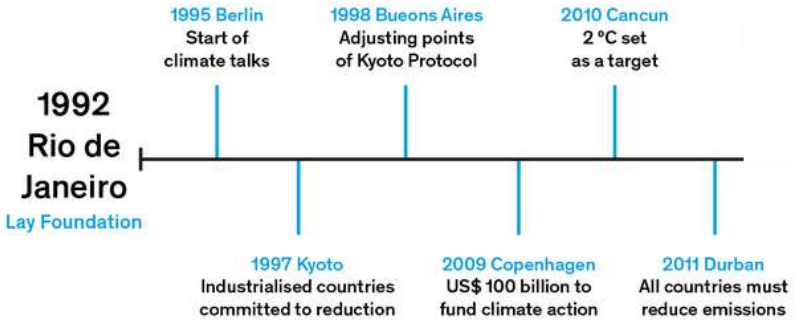
Box 13.7 The range of the difference between emissions in 1990 and emission allowances in 2020/2050 for various GHG concentration levels for Annex I and non-Annex I countries as a group[a]

Scenario category	Region	2020	2050
A-450 ppm CO_2-eq[b]	Annex I	–25% to –40%	–80% to –95%
	Non-Annex I	Substantial deviation from baseline in Latin America, Middle East, East Asia and Centrally-Planned Asia	Substantial deviation from baseline in all regions

IPCCAR4 WGIII, Box 13.7 Fair-share allocations synthesis

- How much should developed countries reduce their emissions?

Why fair-shares?



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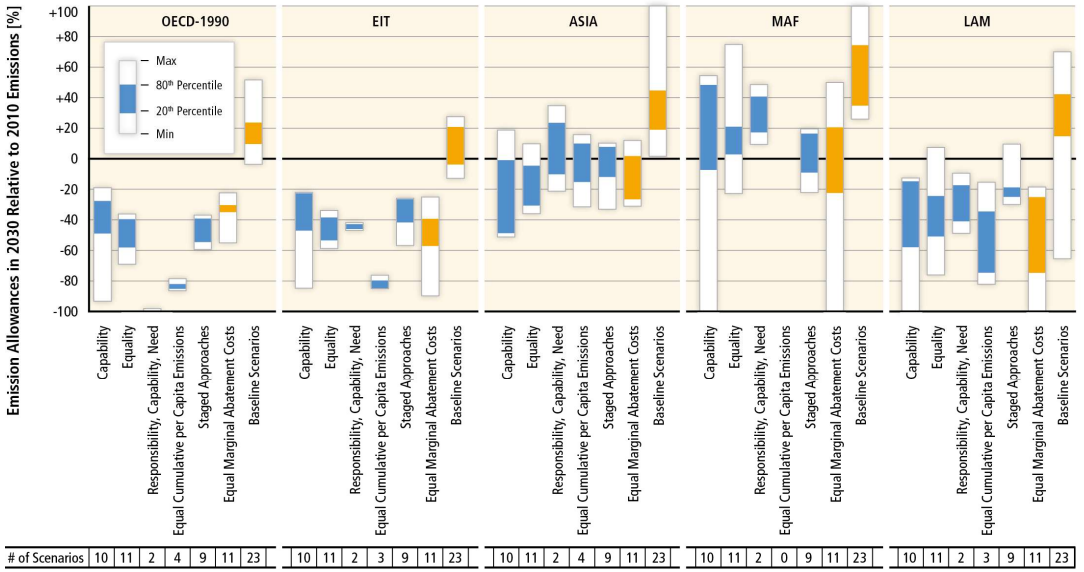

IPCCAR5 WGIII Fig.6.28, Fair-share allocations synthesis

- How much should all countries limit their emissions?
  - Modellers can suggest what could be acceptable, so somewhat fair

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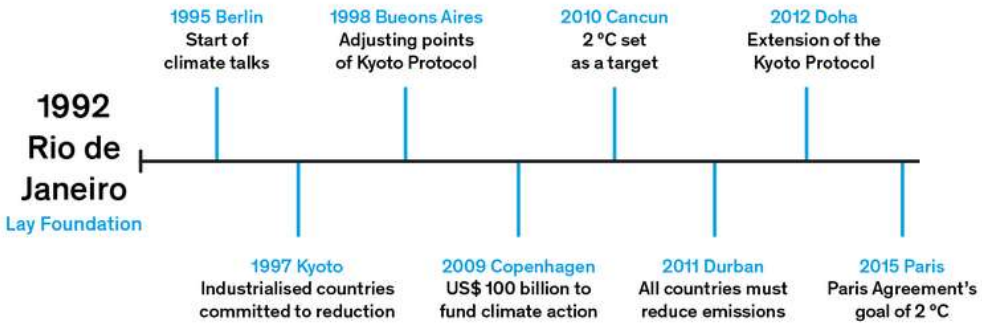
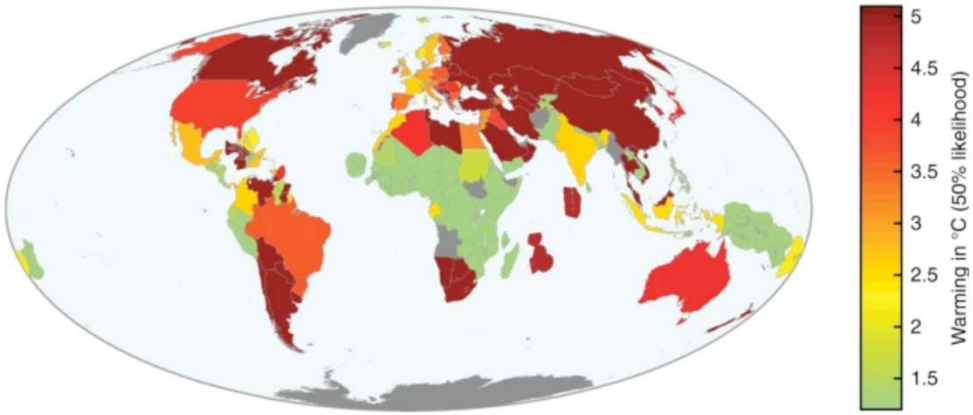
Why fair-shares?



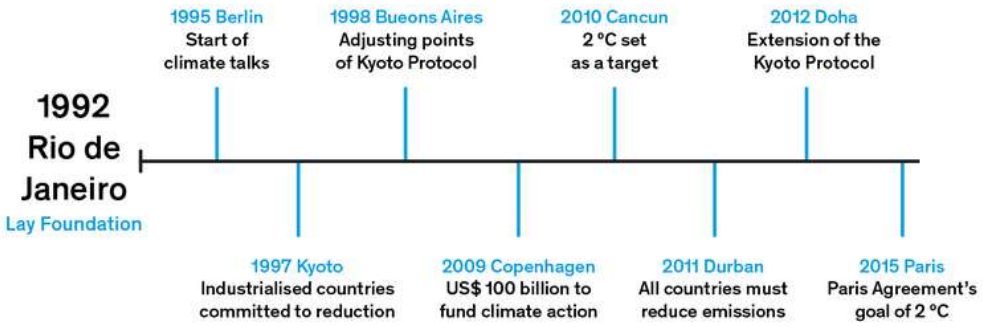


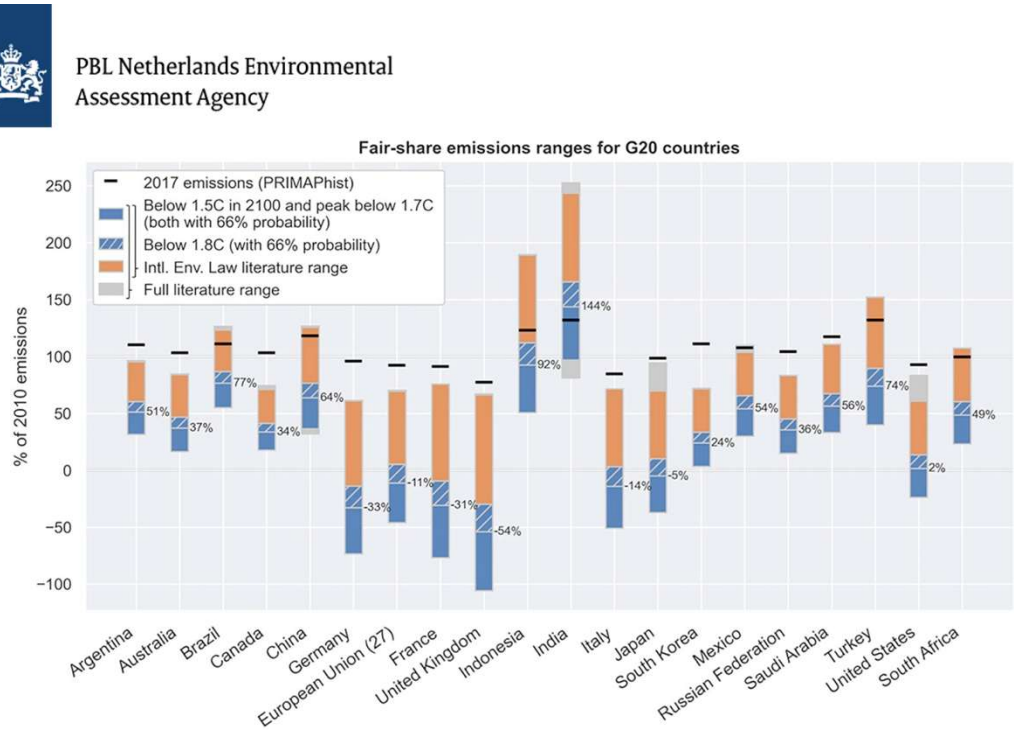
Warming assessment of countries' pledges

- How much should all countries improve & implement their commitments?
  - Ambition assessment (Robiou du Pont et al. 2018, Climate Action Tracker etc.)

"it is only in relation to such a 'fair share' that the adequacy of a state's contribution can be assessed in the context of a global collective action problem" (IPCC AR6 / Rajamani et al. 2021)"

Why fair-shares?





Rajamani et al. 2021

- How much should all countries improve & implement their commitments?
  - Ambition assessment (Robiou du Pont et al. 2018, Climate Action Tracker etc.)
  - Models can reflect legal frameworks more closely (Rajamani et al. 2021)

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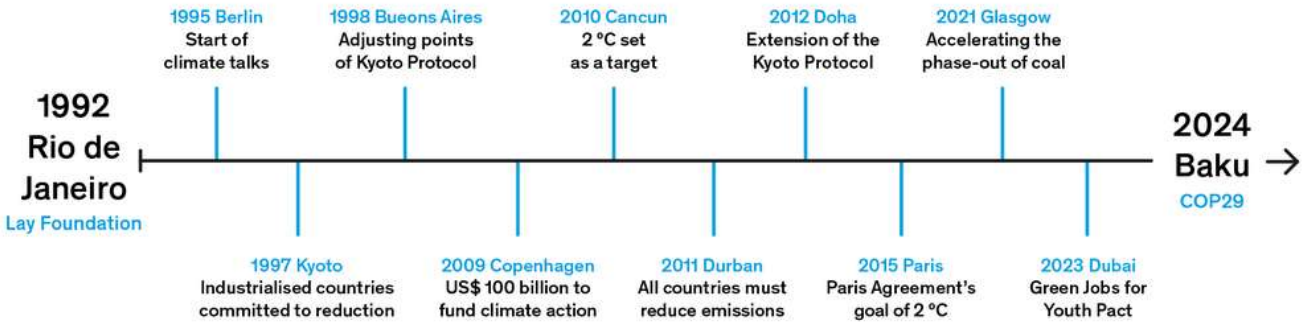
Why fair-shares?



- How much should all countries have reduced their emissions?
  - Calculate debts over time or borders

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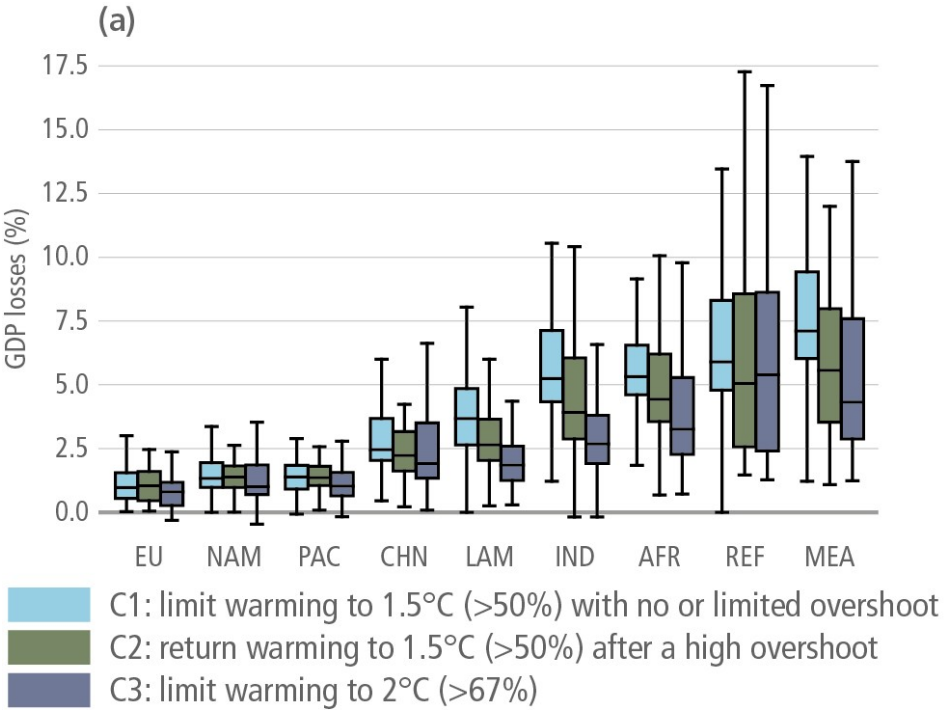
Do we need fairness?



IPCCAR6 WGIII Fig.3.35, Mitigation cost as fraction of local GDP

- Cost-optimal effort greater in countries that cannot afford it
  - Need at least access to funding
  - IAMs are about cost-optimal implementation, not fair share of efforts
  - Yet some countries used it (Norway), others use 'grandfathering' (South Korea)
- Agreements reflect powers but also some fairness considerations

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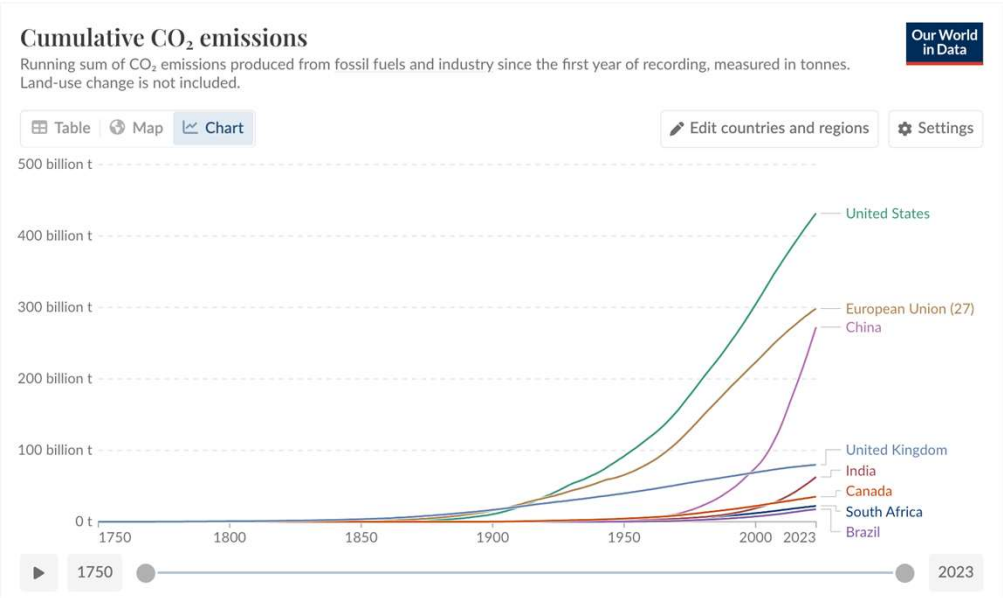
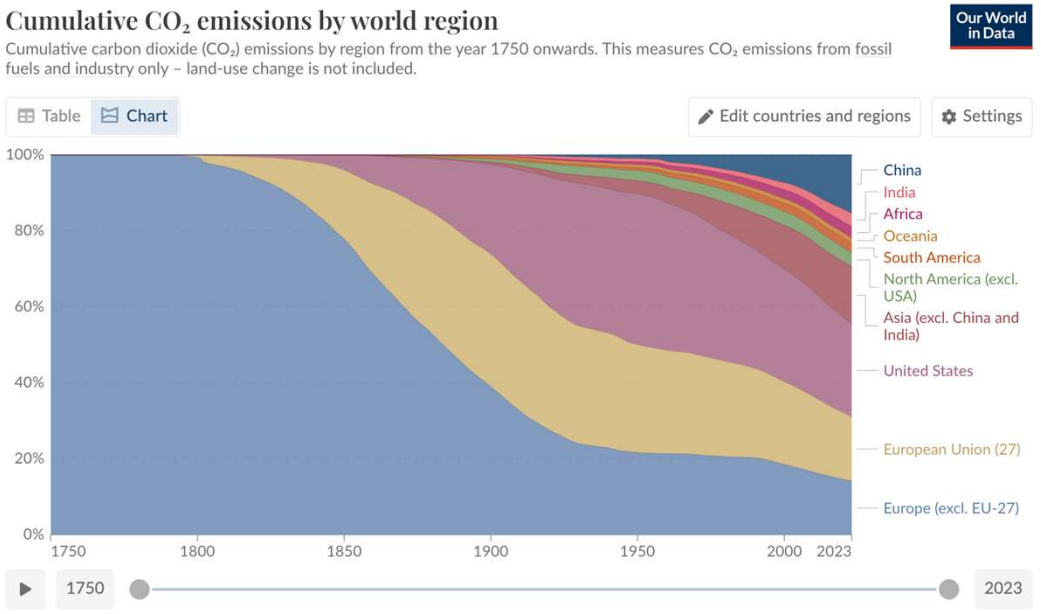
Do we need fairness?





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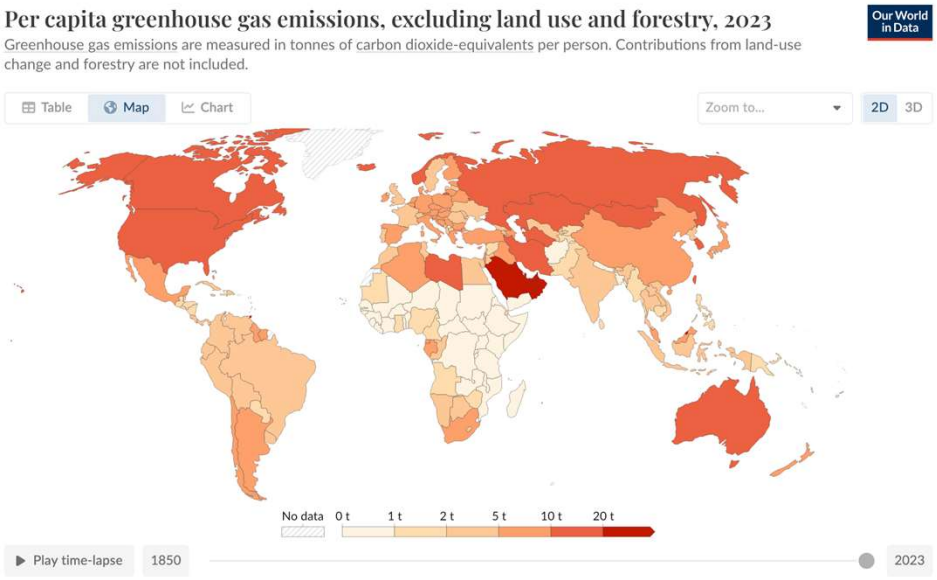
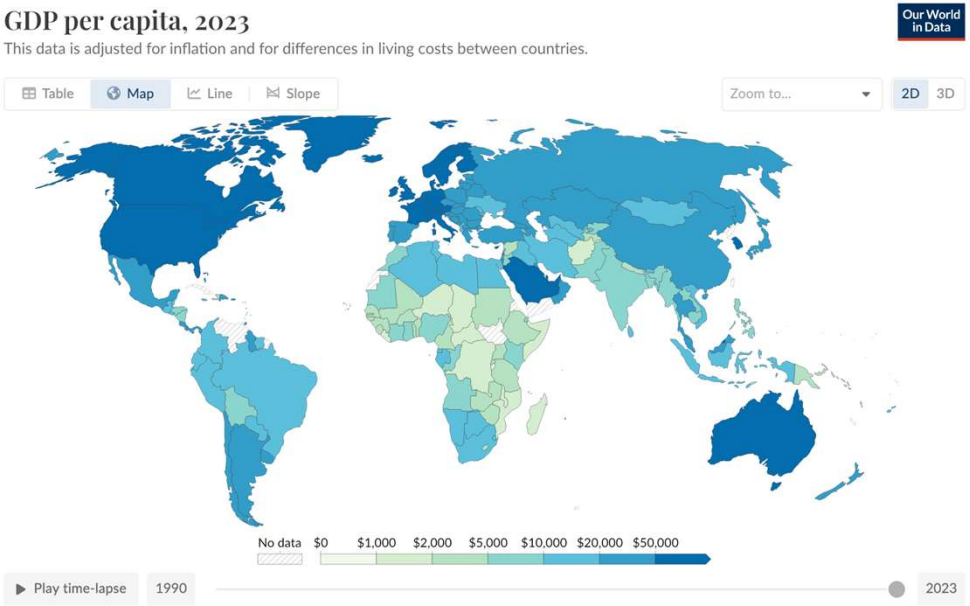
Do we need fairness?





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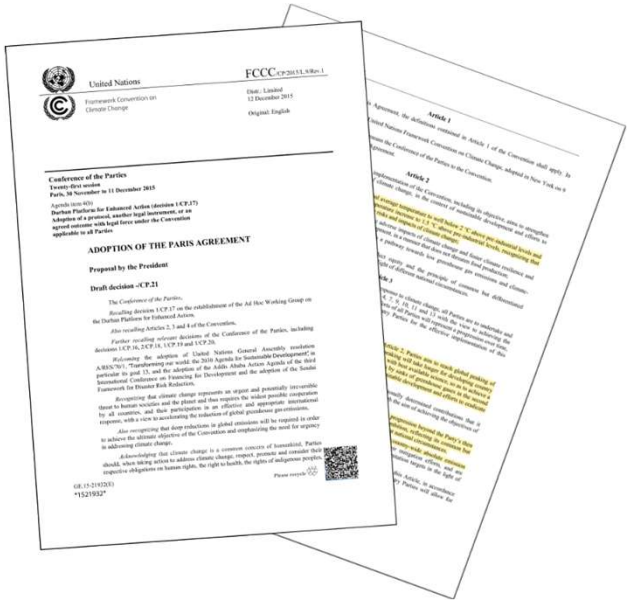
Equity in the Paris Agreement


United Nations
FCCC/CP/2015/L.9/Rev.1
Framework Convention on Climate Change
Distr.: Limited
12 December 2015
Original: English
Conference of the Parties
Twenty-first session
Paris, 30 November to 11 December 2015
Agenda item 4(b)
Durban Platform for Enhanced Action (decision 1/CP.17)
Adoption of a protocol, another legal instrument, or an agreed outcome with legal force under the Convention applicable to all Parties
ADOPTION OF THE PARIS AGREEMENT
Proposal by the President
Draft decision -/CP.21
GE.15-21932(E)
1521932
Please recycle

Paris Agreement, 2015

- "This Agreement will be implemented to reflect **equity and the principle of common but differentiated responsibilities and respective capabilities (CBDR-RC)**"
- Submit **Nationally Determined Contribution** (NDCs) of 'highest possible ambition'
- indicate how they are '**fair and ambitious**' in light of national circumstances and contributes towards achieving art. 2

Fairness (equity) is the metric for ambition / adequacy

Most countries do not explain how their targets are fair and ambitious

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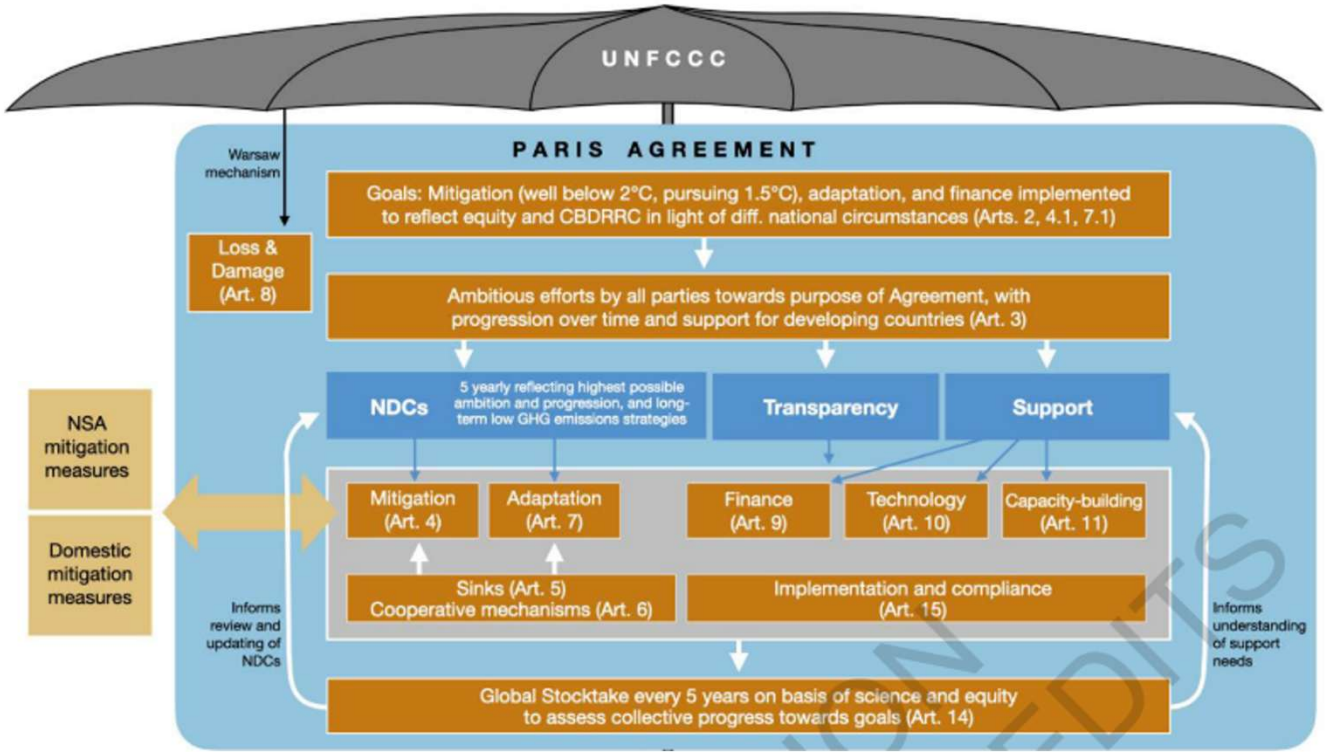
Types of climate justice



- Procedural
- Corrective
- Recognitional
- Transformational
- **Distributive**
  - **Focus on mitigation efforts**

(Zimm et al. 2024)

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Intertwined justice considerations

	Key aspects of the Paris Agreement
Article 1 – Definition	
Article 2 – Purpose / Goal	Climate change is unfair. Limiting global warming is limiting unfairness.
Article 3 – NDCs	Bottom-up nature playing against least responsible countries
Article 4 – Mitigation	"recognizing peaking will take longer for developing country Parties" "Developed countries should continue to take the lead by undertaking absolute economy-wide reduction targets, while developing countries should continue enhancing their mitigation efforts […] in the light of different national circumstances."
Article 5 – Sinks / Reservoirs	Can play against populations living off natural resources and bring leakage of global ambition.
Article 6 – Cooperation	Mechanism to ensure fairness in pursuing goals – rules are key
Article 7 – Adaptation	Most needs in the Global South by low contributors to climate change
Article 8 – Loss & Damage	Most heavily impacted countres are not responsible. Issue of pricing loss of liveihoods.
Article 9 – Finance	"The Paris Agreement reaffirms the obligations of developed countries to support the efforts of developing country […]. Provision of resources should also aim to achieve a balance between adaptation and mitigation
Article 10 – Technology	Fairness considerations around technology transfer.
Article 11 – Capacity building	By nature
Article 12 – Education	By nature
Article 13 – Transparency	Transparency boths ways: in the finance provided and the
Article 14 – Global Stocktake	Importance of the representativity of reviewers and analses used for the Stocktake
Article 15 – Compliance	Non-compliance favours status-quo, which is unfair
Article 16-29 – Organisational	

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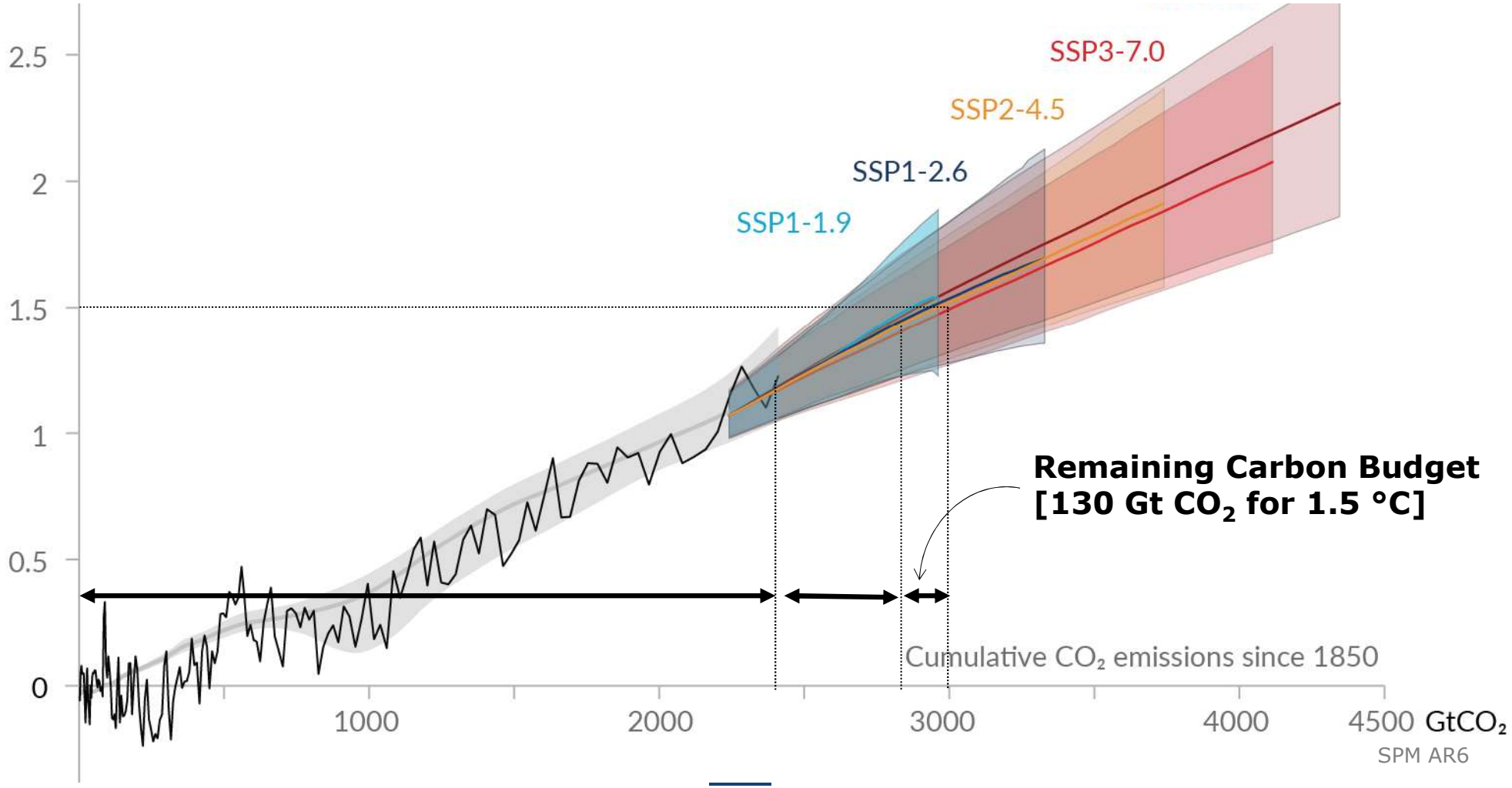
What is to be shared?


SSP3-7.0
SSP2-4.5
SSP1-2.6
SSP1-1.9
2.5
2
1.5
1
0.5
0
1000
2000
3000
4000
4500 GtCO₂
Cumulative CO₂ emissions since 1850
Remaining Carbon Budget
[130 Gt CO₂ for 1.5 °C]
SPM AR6

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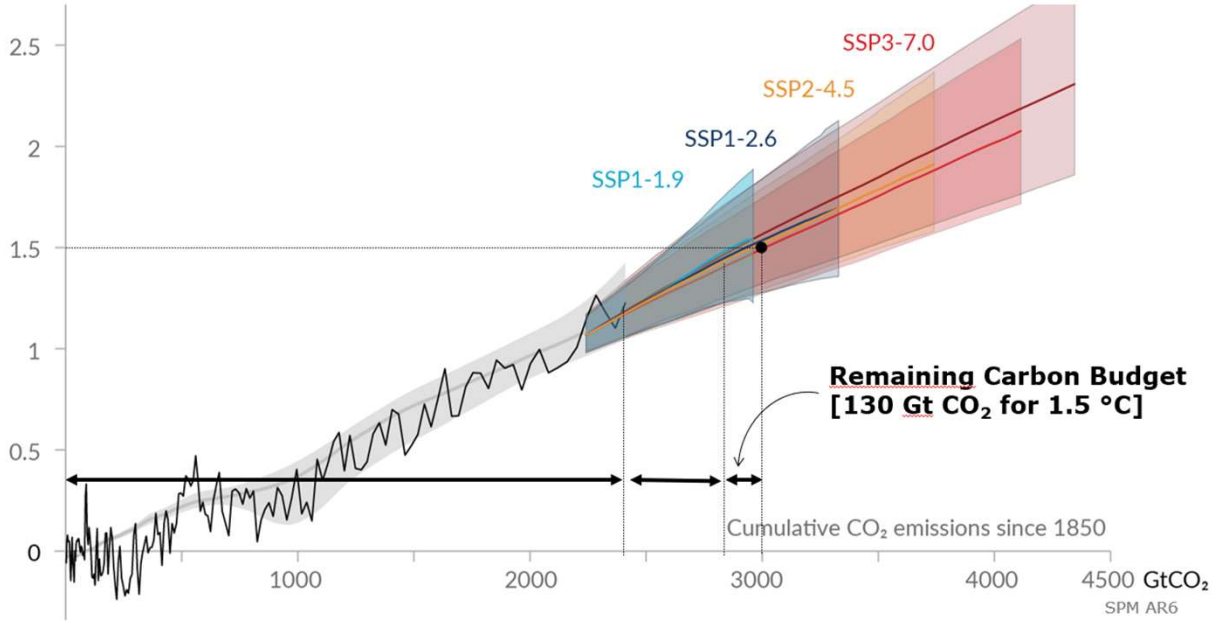
What to share?

- **Cumulative budget**
- Emissions pathways
- Investments
- Overshoot



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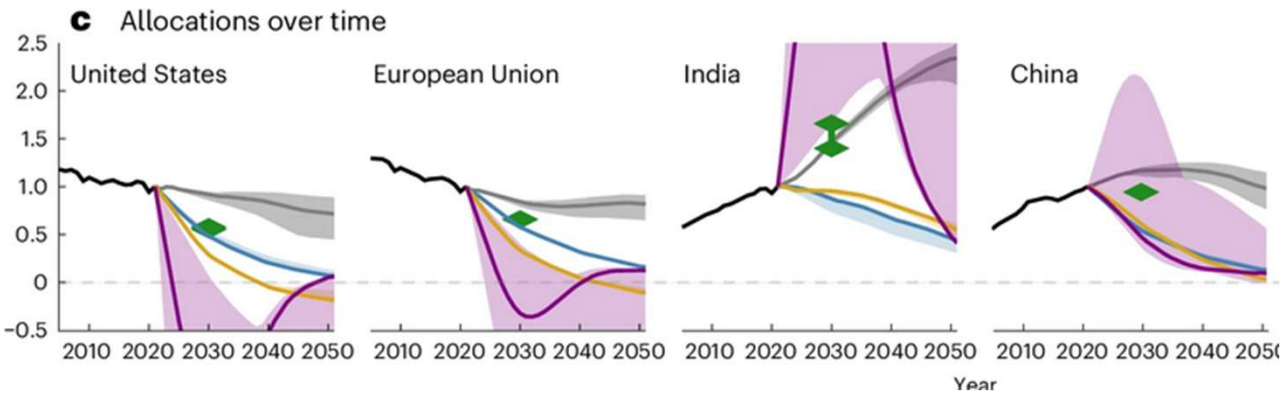
What to share?

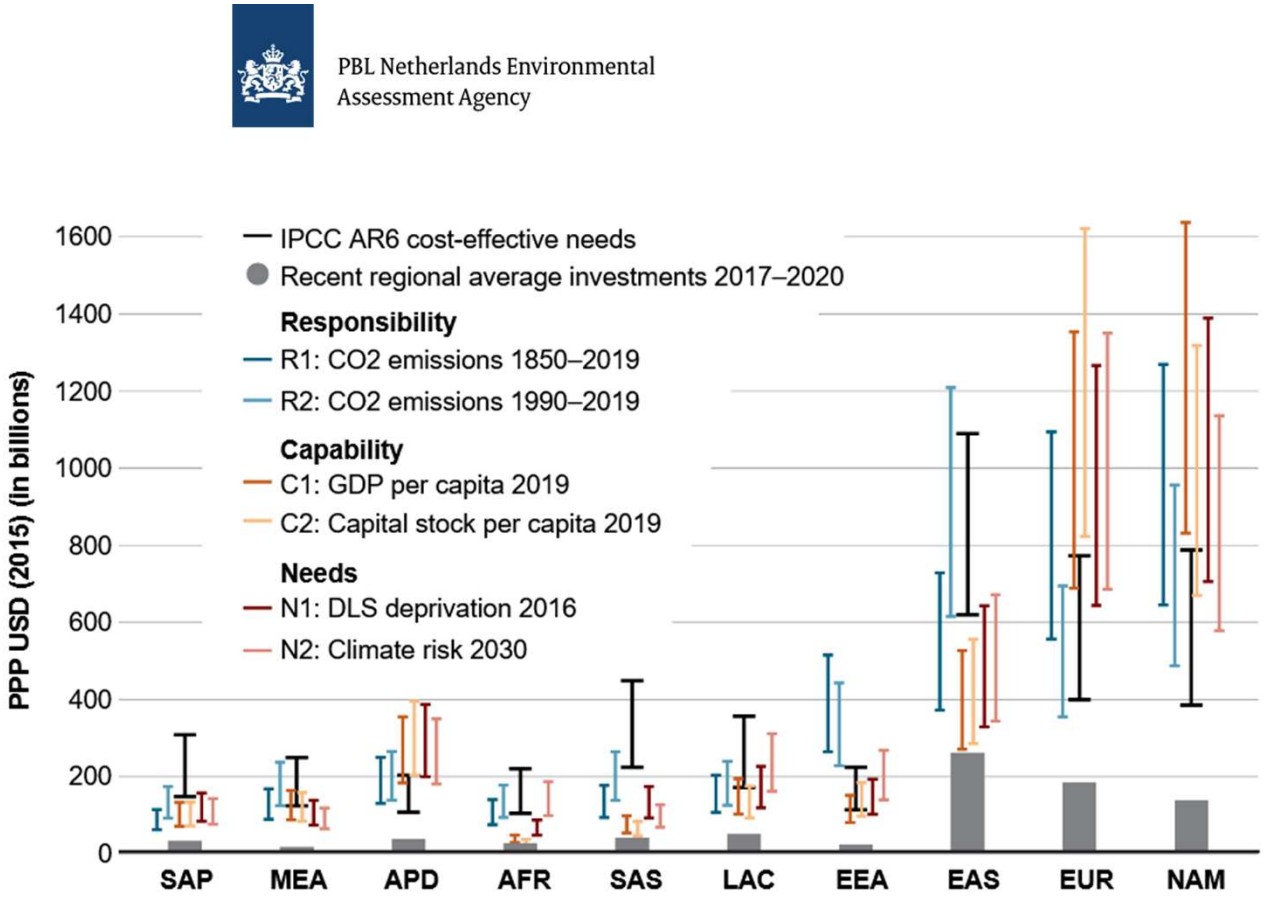
- Cumulative budget
- **Emissions pathways**
- Investments
- Overshoot



Dekker et al. (2025)

What to share?

- Cumulative budget
- Emissions pathways
- **Investments**
- Overshoot



Pachauri et al. (2022)

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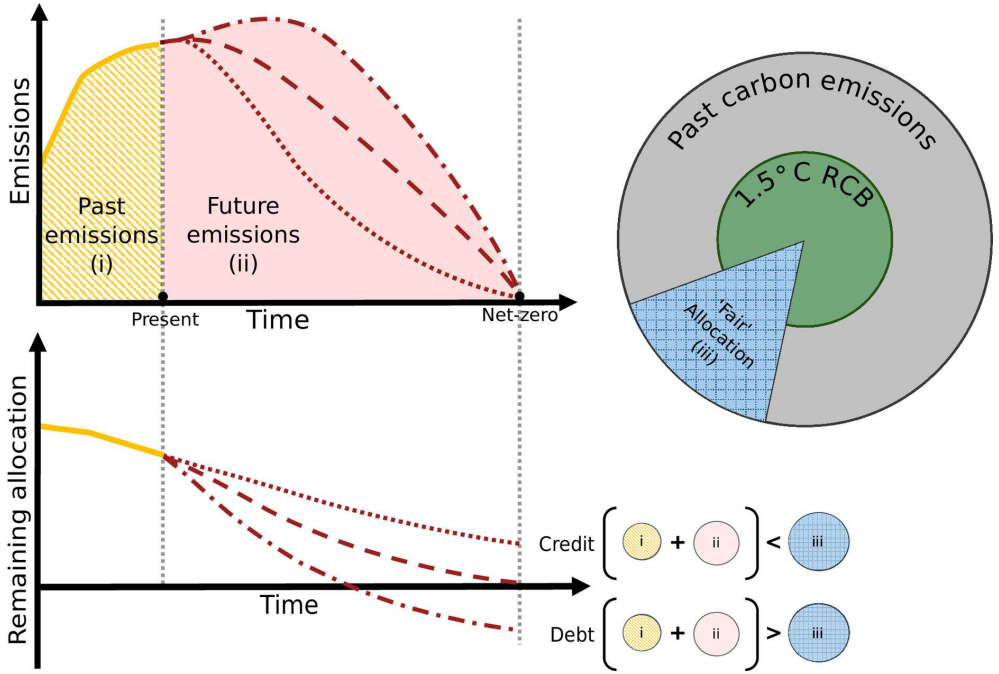
What to share?

- Cumulative budget
- Emissions pathway
- Investments
- **Overshoot**



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On what basis do we ‘share’?

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"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"

(UNFCCC Art. 3)

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(UNFCCC Art. 3)

- Inter-generational

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- Inter-generational
- Differentiated responsibilities

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"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"

(UNFCCC Art. 3)

- Inter-generational
- Differentiated responsibilities
- Respective capabilities

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"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"

(UNFCCC Art. 3)

- Inter-generational
- Differentiated responsibilities
- Respective capabilities
- Developed countries taking lead (also impacts)

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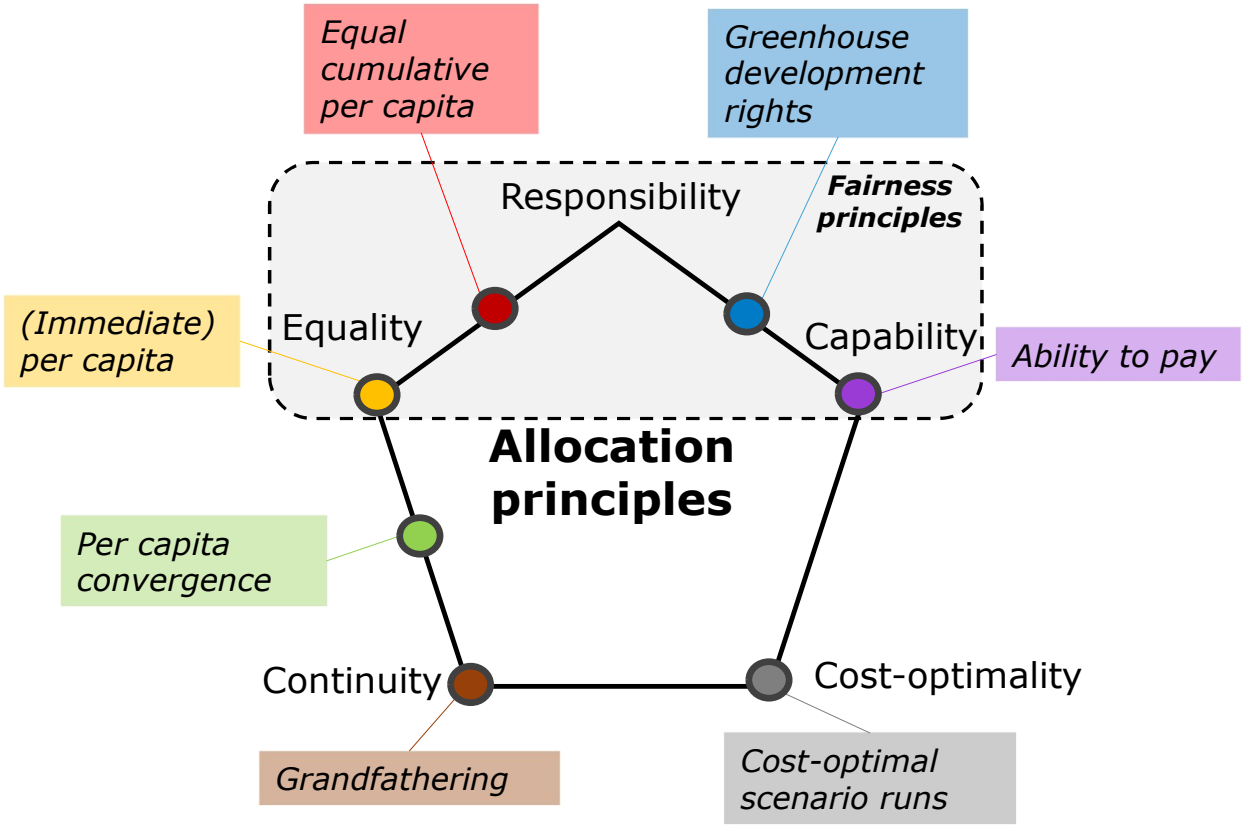

Modified from Van den Berg et al. (2020)

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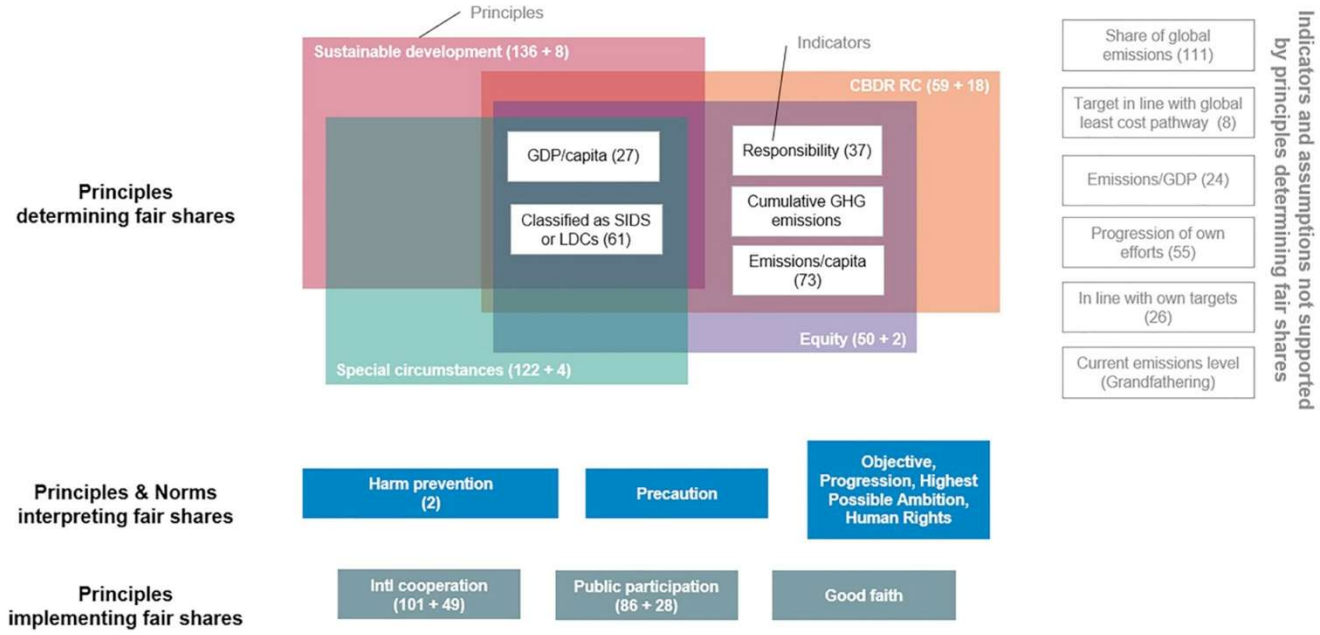
In case you're interested, here is the figure from rajamani et al. On the relation of the principles to NDCs: https://www.tandfonline.com/doi/full/10.1080/14693062.2021.1970504

Figure 1. Mapping of principles and norms of international environmental law (coloured boxes) and indicators (white boxes). Numbers in brackets indicate the number of NDCs in which a principle or indicator is mentioned. Where two numbers are given, the first is an explicit reference and the second, implicit.



Modified from Van den Berg et al. (2020)

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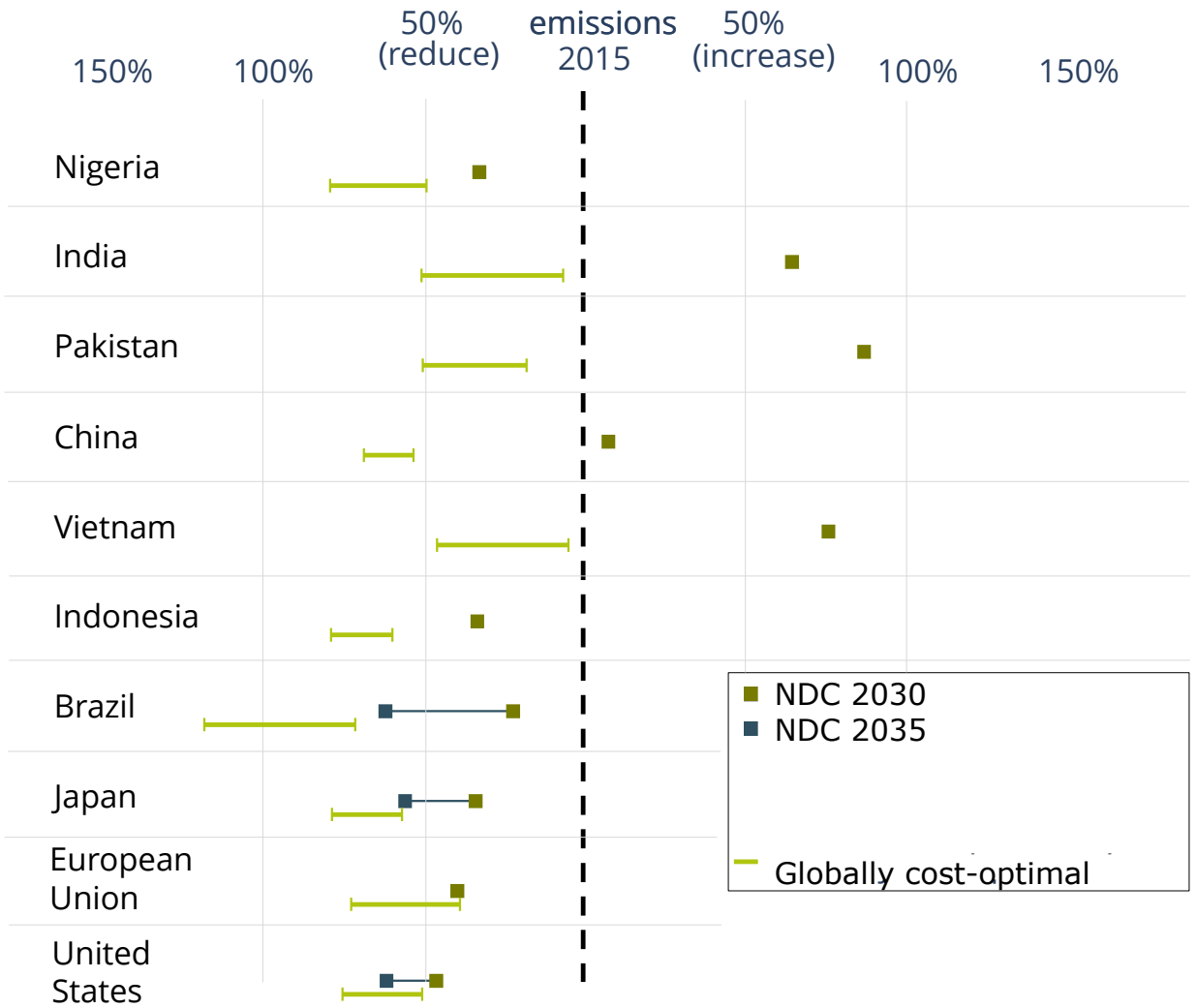
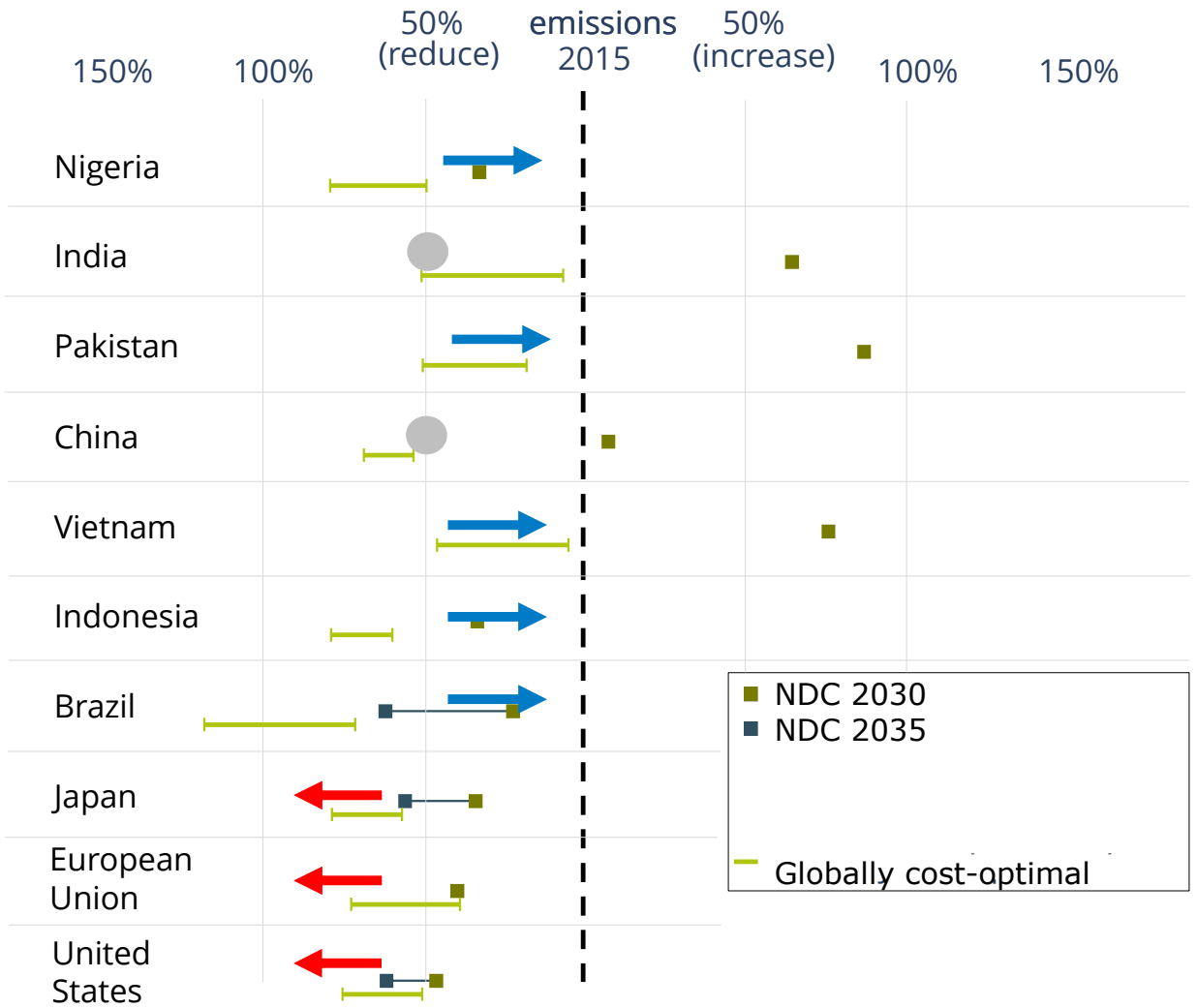
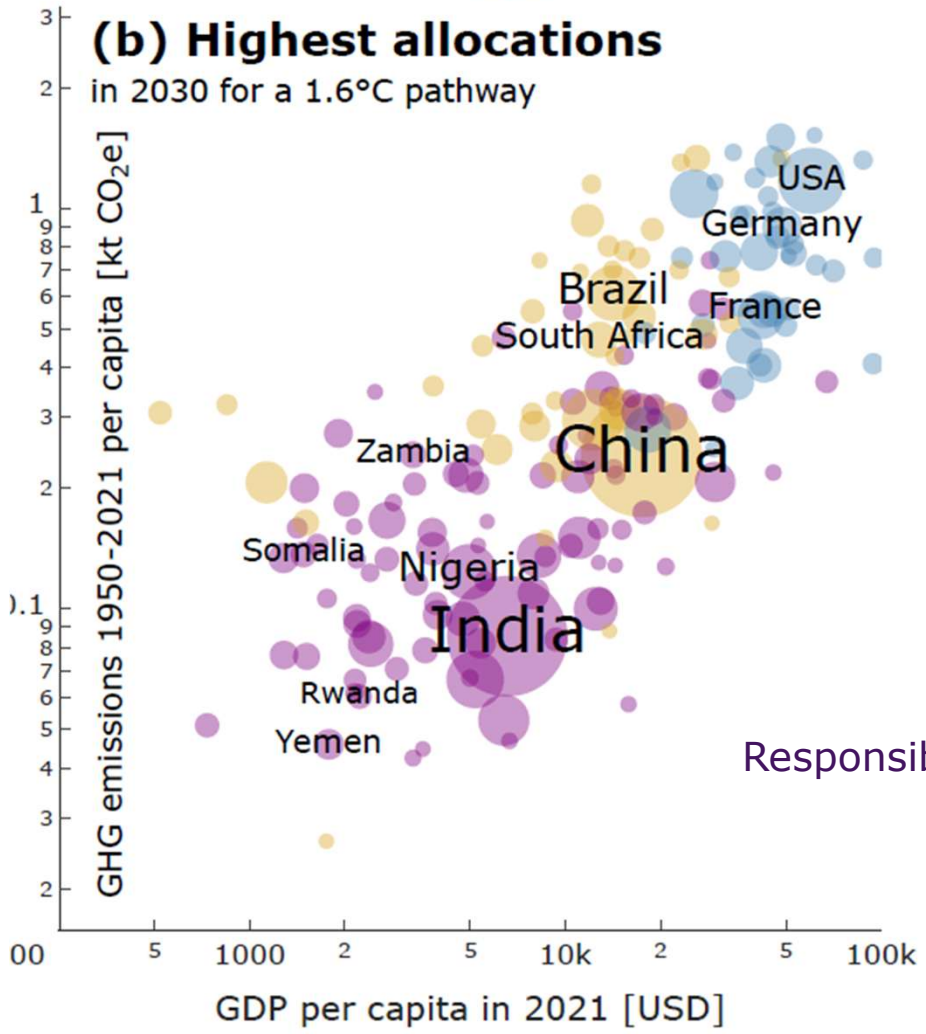
Fair share numbers
and their (huge) uncertainty



Data from IPCC AR6 and PBL NDC tool



Data from IPCC AR6 and PBL NDC tool

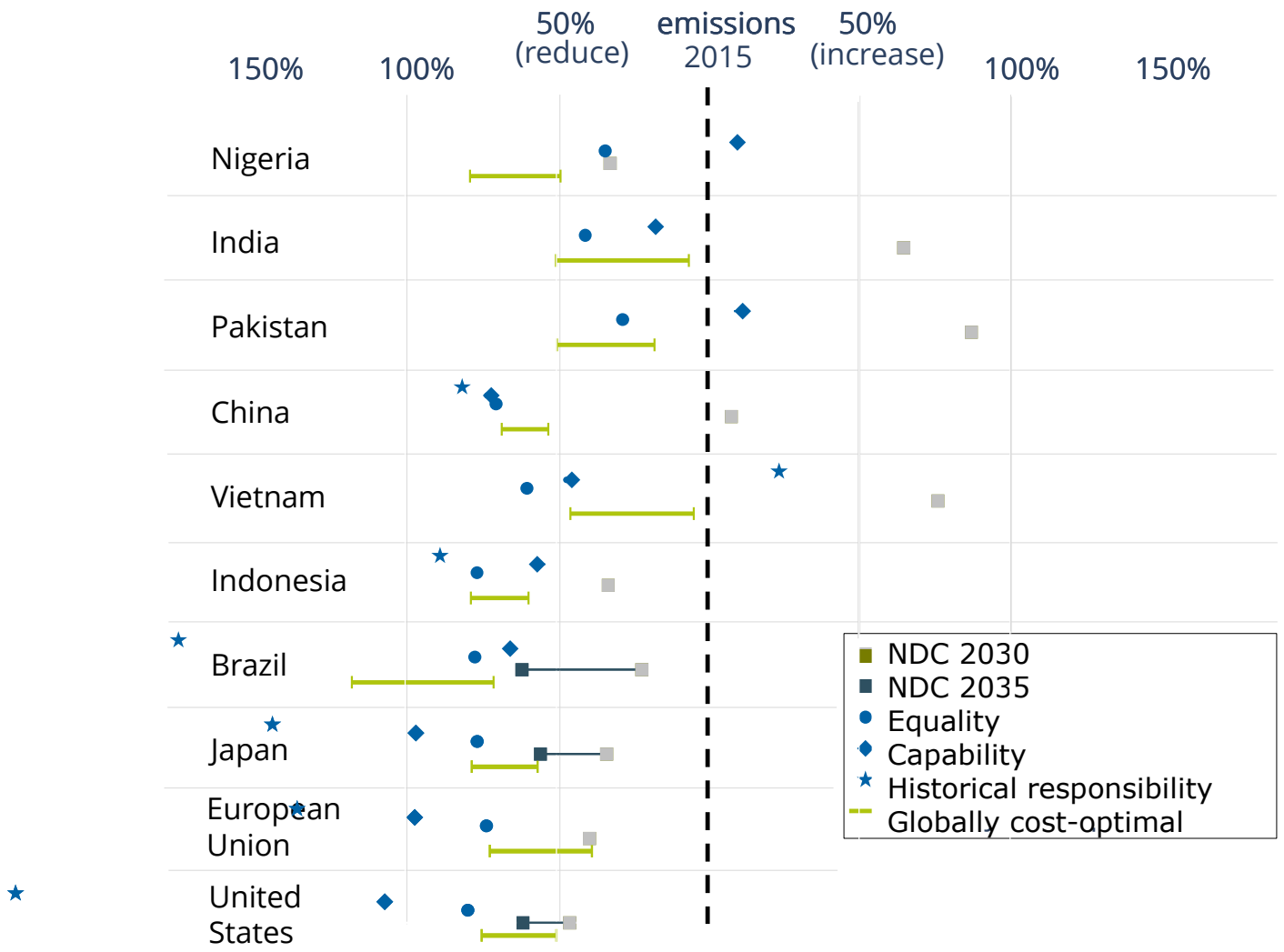


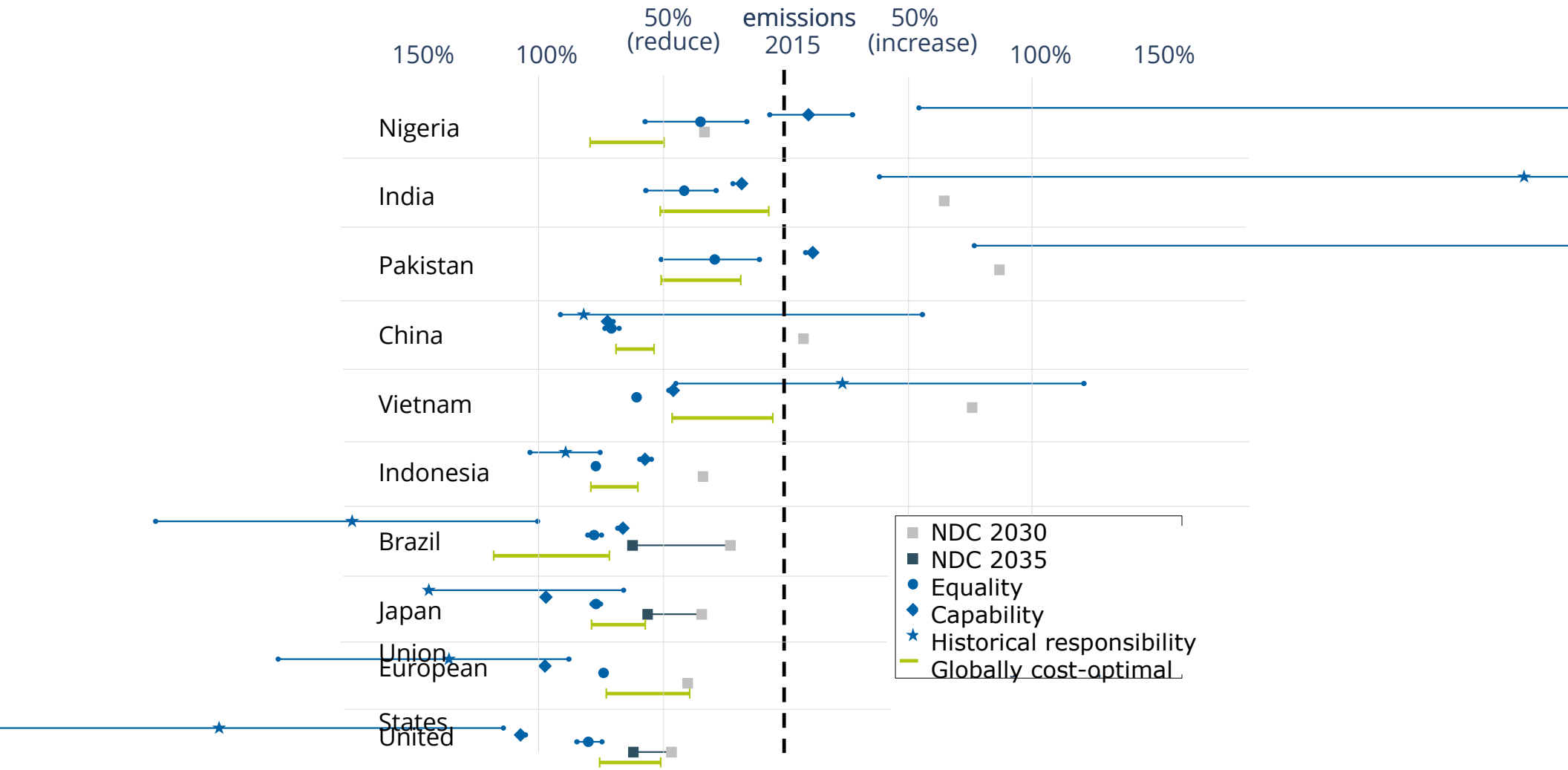
Equality

Capability

Responsibility

Dekker et al. (2025)


150%
100%
50% (reduce)
emissions 2015
50% (increase)
100%
150%
Nigeria
India
Pakistan
China
Vietnam
Indonesia
Brazil
Japan
European Union
United States
NDC 2030
NDC 2035
Equality
Capability
Historical responsibility
Globally cost-optimal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United States
NDC 2030
NDC 2035
Equality
Capability
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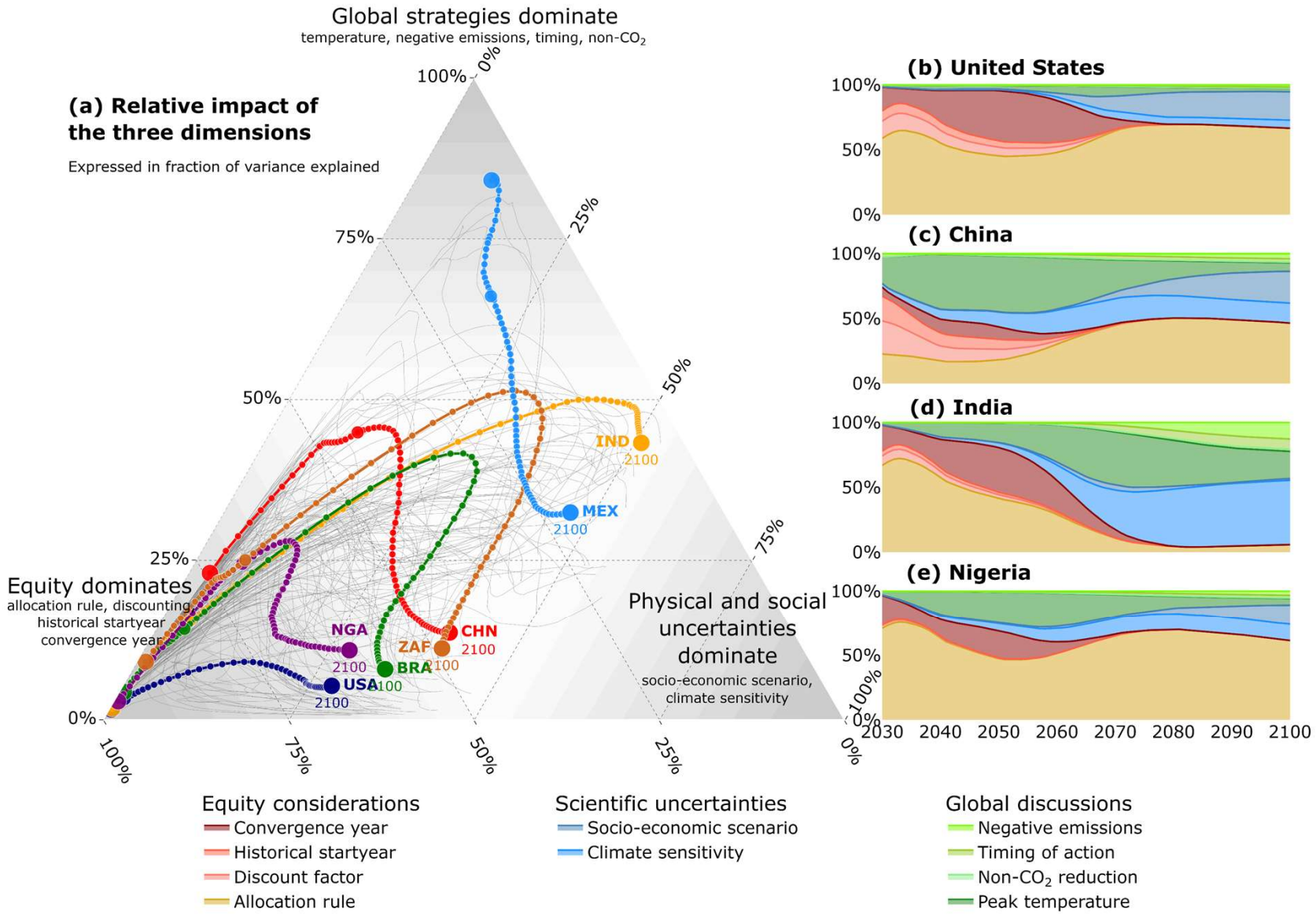
Global strategies dominate
temperature, negative emissions, timing, non-CO2
(a) Relative impact of the three dimensions
Expressed in fraction of variance explained
Equity dominates
allocation rule, discounting, historical startyear, convergence year
Physical and social uncertainties dominate
socio-economic scenario, climate sensitivity
IND 2100
MEX 2100
CHN 2100
ZAF 2100
BRA 2100
NGA 2100
USA 2100
(b) United States
(c) China
(d) India
(e) Nigeria
2030 2040 2050 2060 2070 2080 2090 2100
Equity considerations
Convergence year
Historical startyear
Discount factor
Allocation rule
Scientific uncertainties
Socio-economic scenario
Climate sensitivity
Global discussions
Negative emissions
Timing of action
Non-CO2 reduction
Peak temperature

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Carbon Budget Explorer
[5 mins]
www.carbonbudgetexplorer.eu

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Carbon Budget Explorer

This website has been updated in March 2025 (see About page).

ABOUT

Remaining carbon budget
1126
Gt CO_2

That amounts to
28x
the current annual emissions

Global settings

The remaining emissions are determined by:

Limit global warming to (°C)
1.5 1.6 1.7 1.8 1.9 **2**

Acceptable risk of exceeding global warming limit
0.17 0.33 **0.5** 0.67 0.83

Reduction of non-CO_2 emissions
0.17 0.33 **0.5** 0.67 0.83

The allocation of these emissions over time is determined by:

End-of-century negative emissions
0.17 0.33 0.5 **0.67** 0.83

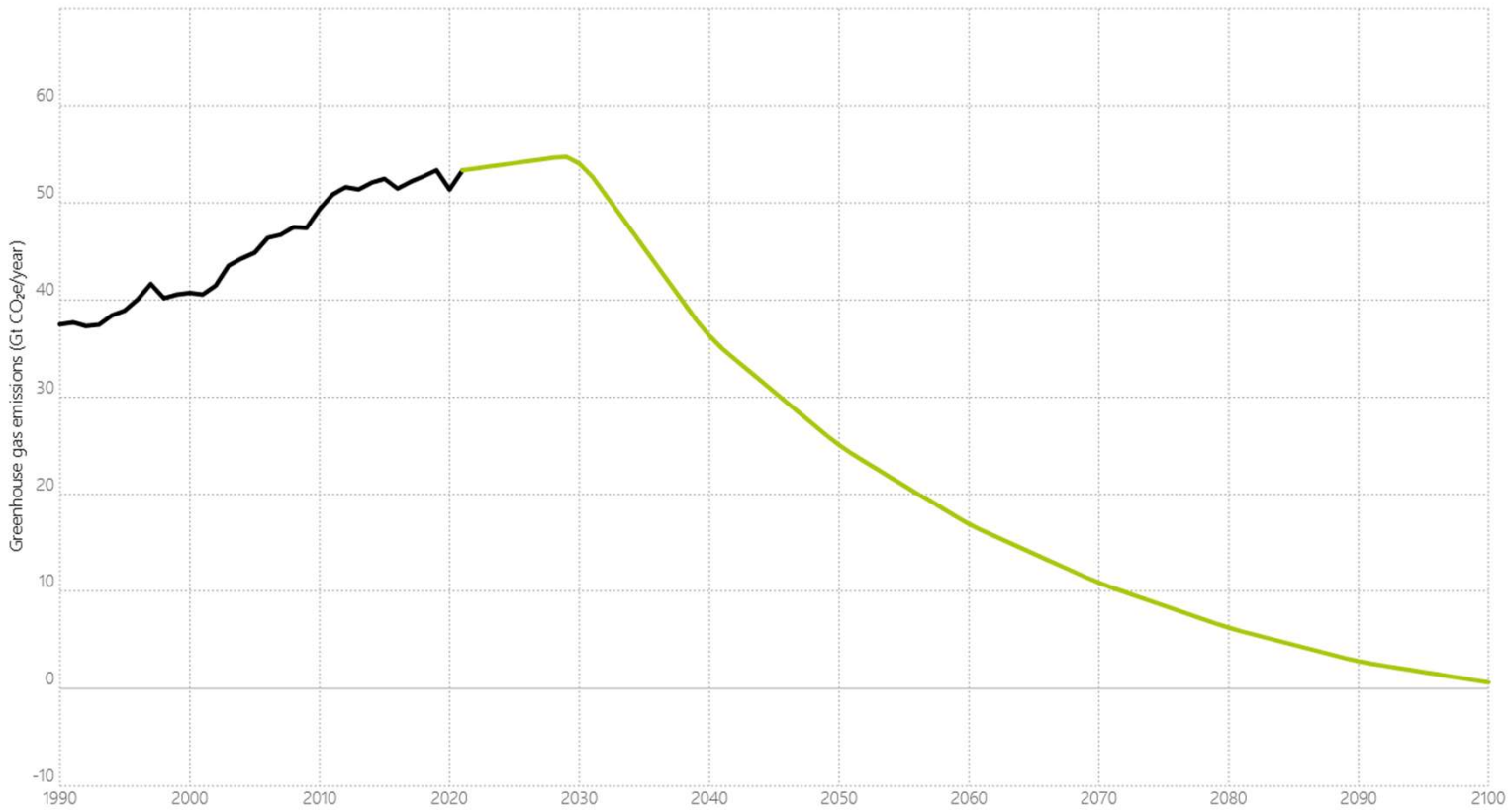
Timing of early-century mitigation
Immediate **Delayed**

Policy pathways

Compare your pathway to projections of various policy levels. Of particular interest is the implementation gap.

- Your pathway
- Current policies
- Nationally determined contributions (NDCs)
- Net-zero pledges

Global pathway | **World map with allocations**



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What do the results mean?

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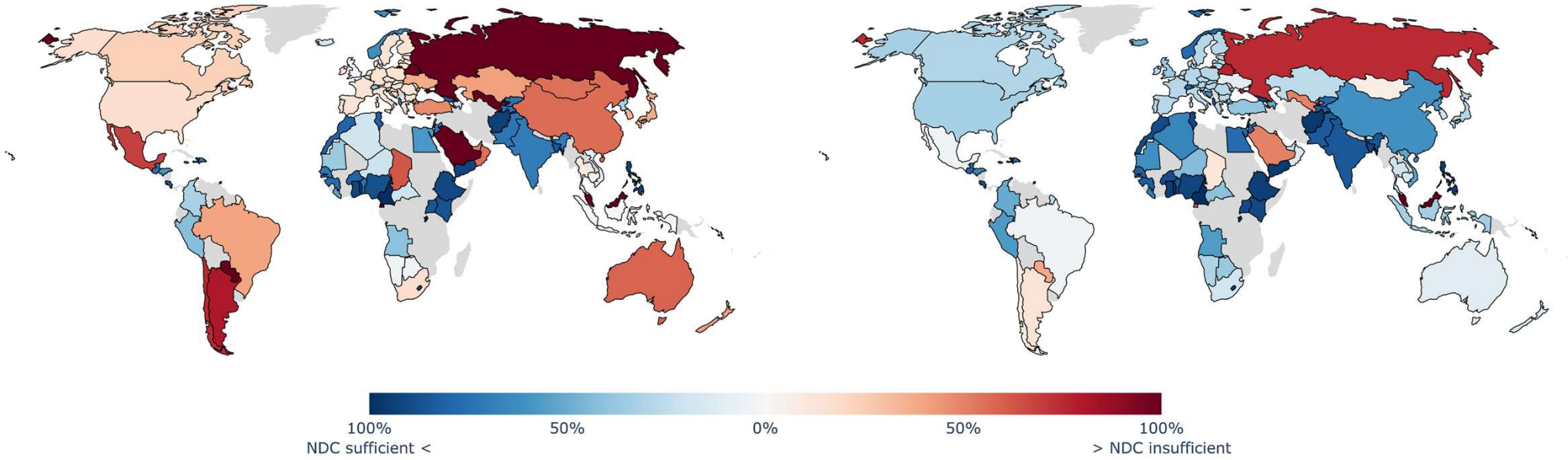
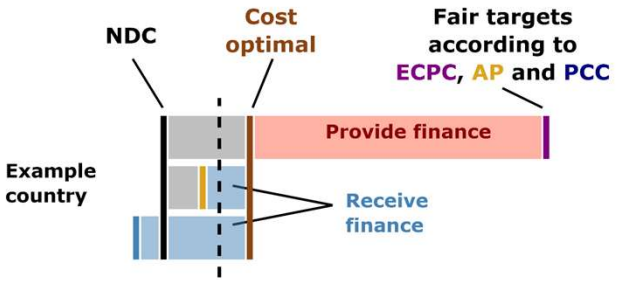
Least stringent allocations

Least stringent allocations + least stringent parameters



Do fair targets align with current pledges?
Red -> pledge insufficient
Blue -> pledge more than sufficient

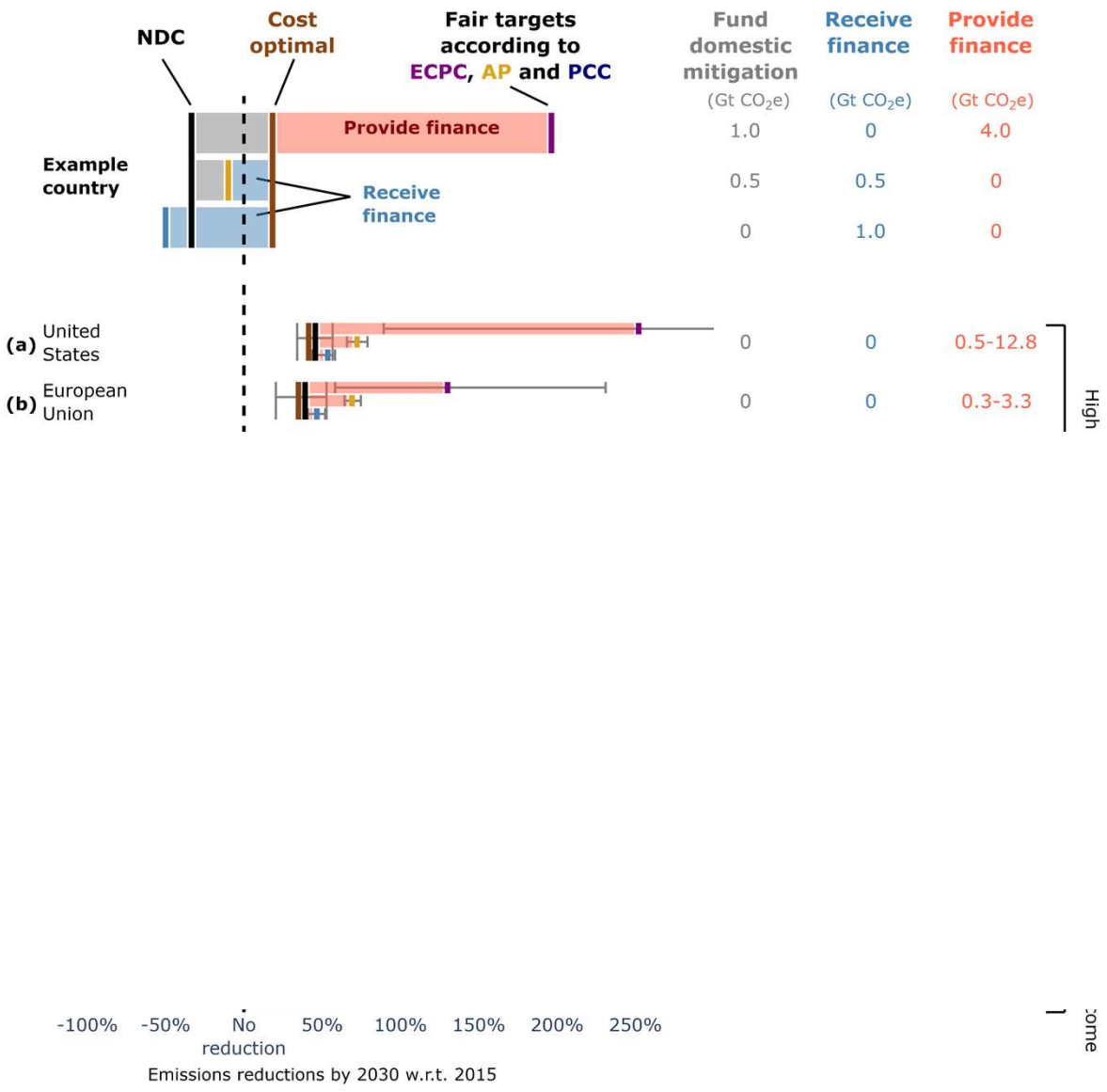


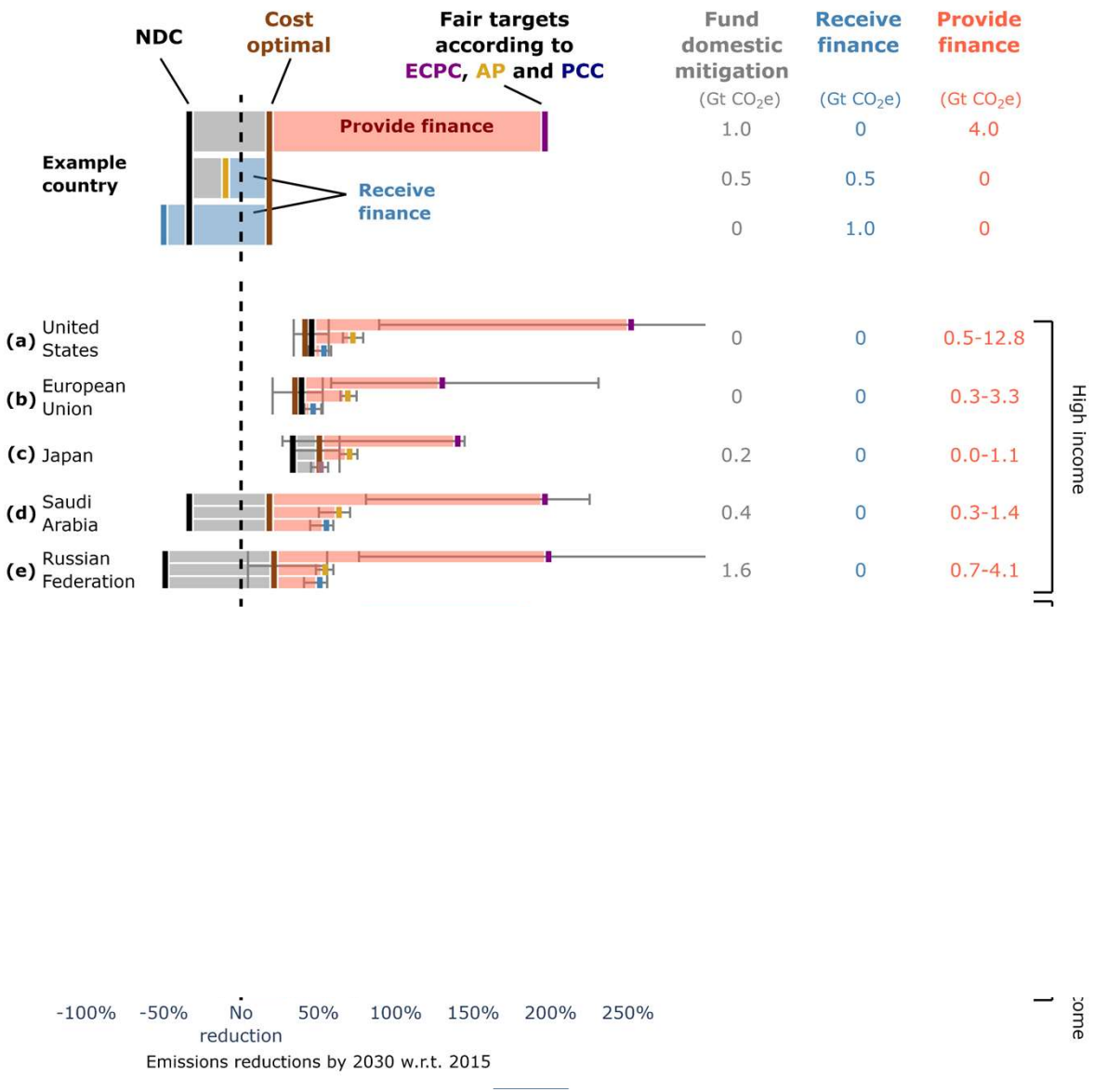
Fund domestic mitigation	Receive finance	Provide finance
(Gt CO_2e)	(Gt CO_2e)	(Gt CO_2e)
1.0	0	4.0
0.5	0.5	0
0	1.0	0

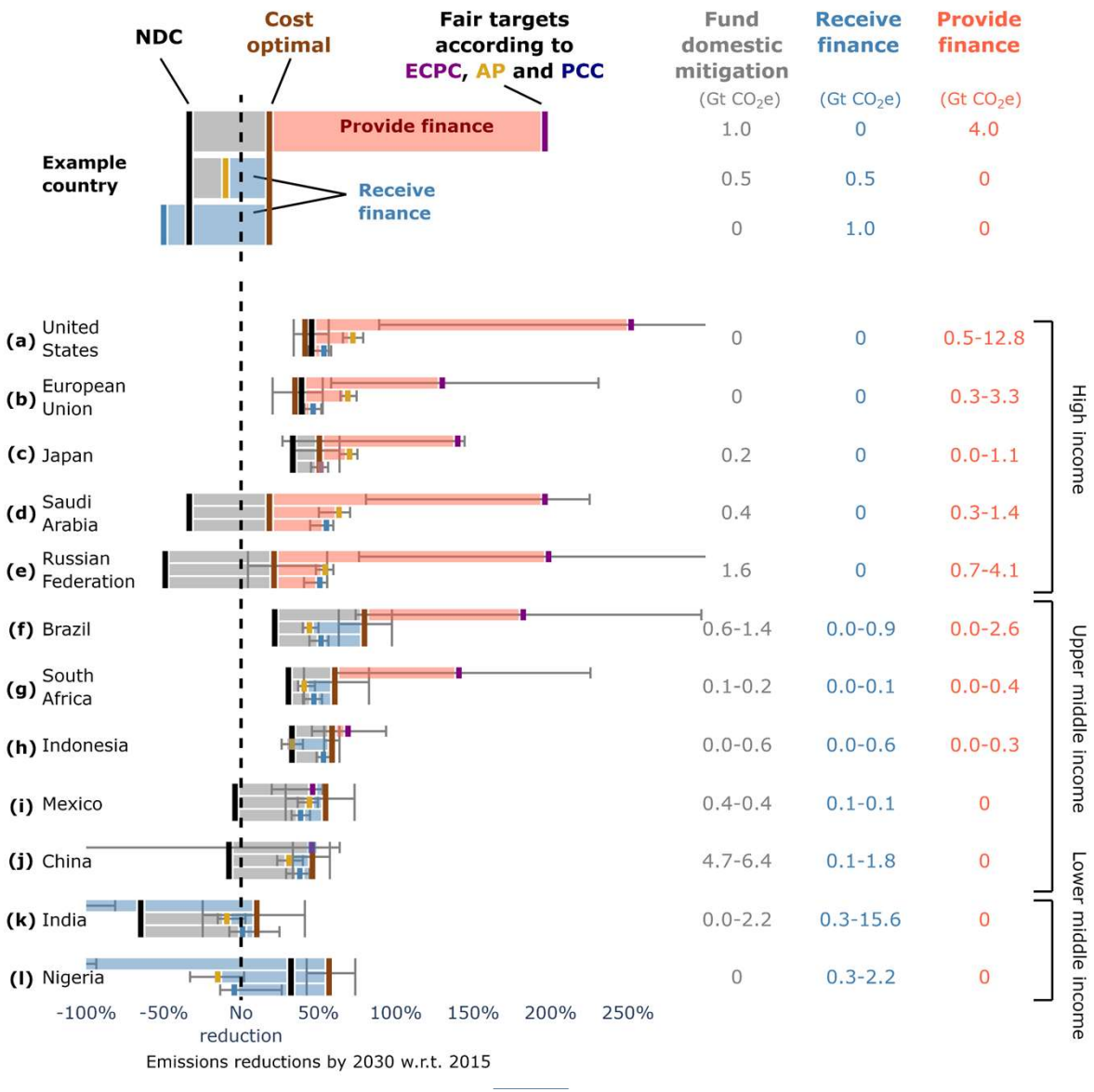
-100% -50% No reduction 50% 100% 150% 200% 250%

Emissions reductions by 2030 w.r.t. 2015

ome


NDC
Cost optimal
Fair targets according to ECPC, AP and PCC
Fund domestic mitigation
(Gt CO_2e)
Receive finance
(Gt CO_2e)
Provide finance
(Gt CO_2e)
Example country
Provide finance
Receive finance
1.0
0
4.0
0.5
0.5
0
0
1.0
0
(a) United States
(b) European Union
0
0
0.5-12.8
0
0
0.3-3.3
High
-100%
-50%
No reduction
50%
100%
150%
200%
250%
Emissions reductions by 2030 w.r.t. 2015
ome


NDC
Cost optimal
Fair targets according to ECPC, AP and PCC
Fund domestic mitigation
Receive finance
Provide finance
(Gt CO2e)
(Gt CO2e)
(Gt CO2e)
Example country
Provide finance
Receive finance
1.0
0
4.0
0.5
0.5
0
0
1.0
0
(a) United States
(b) European Union
(c) Japan
(d) Saudi Arabia
(e) Russian Federation
0
0
0.5-12.8
0
0
0.3-3.3
0.2
0
0.0-1.1
0.4
0
0.3-1.4
1.6
0
0.7-4.1
High income
-100%
-50%
No reduction
50%
100%
150%
200%
250%
Emissions reductions by 2030 w.r.t. 2015


NDC
Cost optimal
Fair targets according to ECPC, AP and PCC
Fund domestic mitigation
Receive finance
Provide finance
(Gt CO2e)
(Gt CO2e)
(Gt CO2e)
Example country
Provide finance
Receive finance
1.0
0
4.0
0.5
0.5
0
0
1.0
0
(a) United States
0
0
0.5-12.8
(b) European Union
0
0
0.3-3.3
(c) Japan
0.2
0
0.0-1.1
(d) Saudi Arabia
0.4
0
0.3-1.4
(e) Russian Federation
1.6
0
0.7-4.1
(f) Brazil
0.6-1.4
0.0-0.9
0.0-2.6
(g) South Africa
0.1-0.2
0.0-0.1
0.0-0.4
(h) Indonesia
0.0-0.6
0.0-0.6
0.0-0.3
(i) Mexico
0.4-0.4
0.1-0.1
0
(j) China
4.7-6.4
0.1-1.8
0
(k) India
0.0-2.2
0.3-15.6
0
(l) Nigeria
0
0.3-2.2
0
High income
Upper middle income
Lower middle income
-100%
-50%
No reduction
50%
100%
150%
200%
250%
Emissions reductions by 2030 w.r.t. 2015

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Limits and the future
of fair shares

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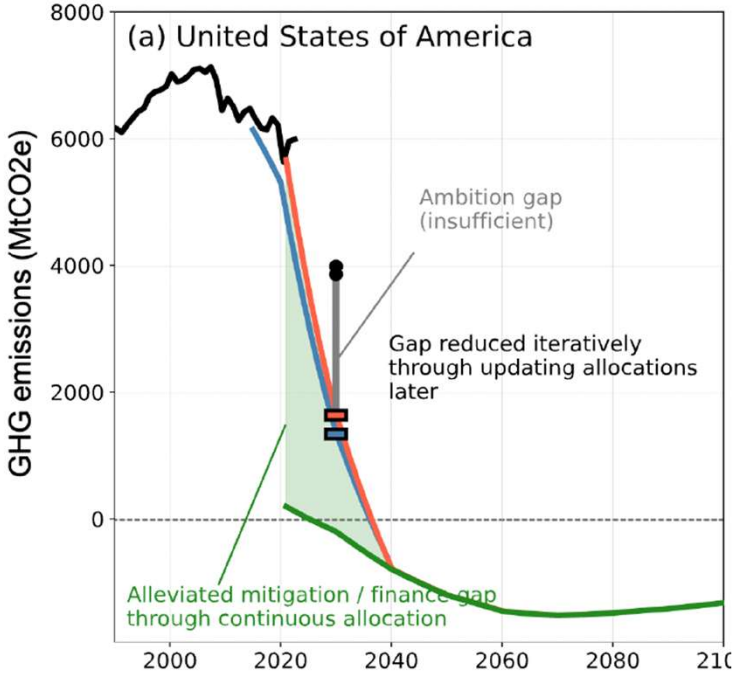
Limitations of fair-shares

- Issue with fairness: grandfathering



Robiou du Pont, Dekker, van Vuuren, Schaeffer (Nature Communiations 2025?)

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Limitations of fair-shares

- Issue with fairness: grandfathering leads to iterative bias

FairShareNow.org

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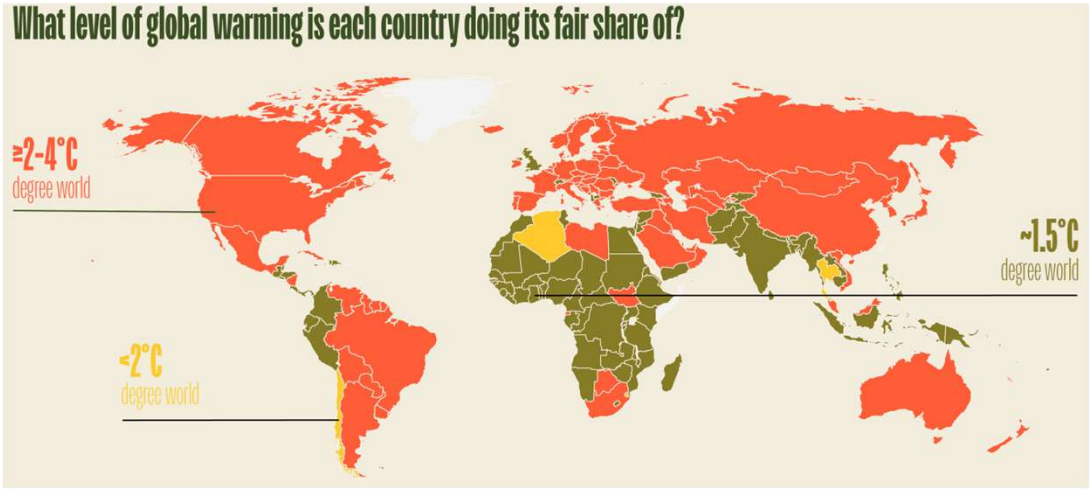
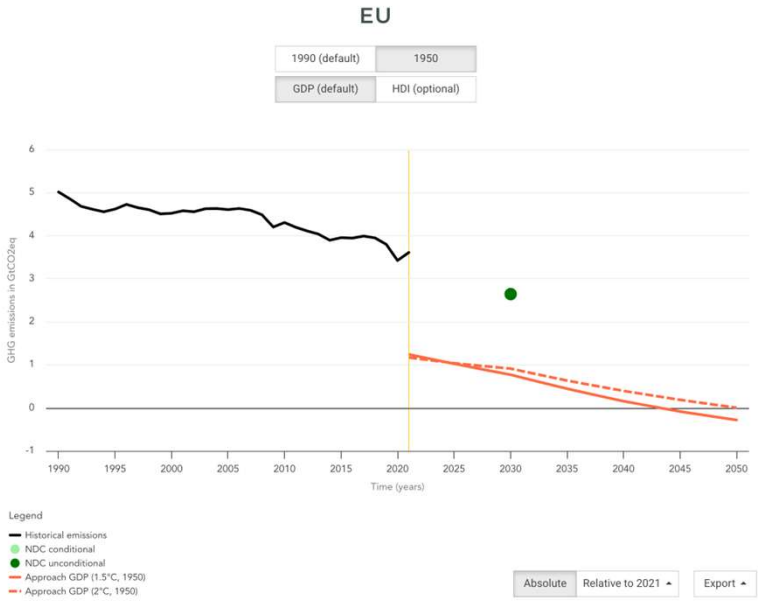
Limitations of fair-shares

- Issue with fairness: discontinuous allocations as a way forward?





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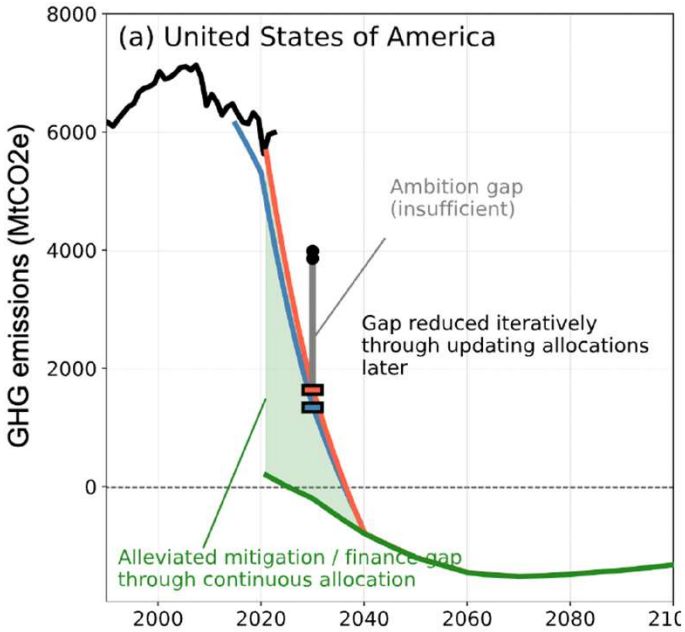
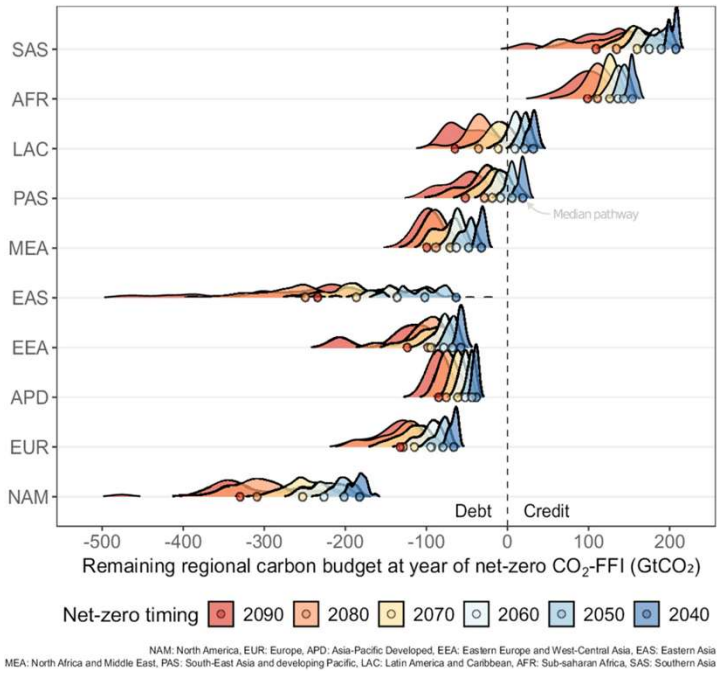
Why fair-shares?

- How much should all countries have reduced their emissions?
  - Calculate debts over time or borders





Pelz et al. PNAS 2024

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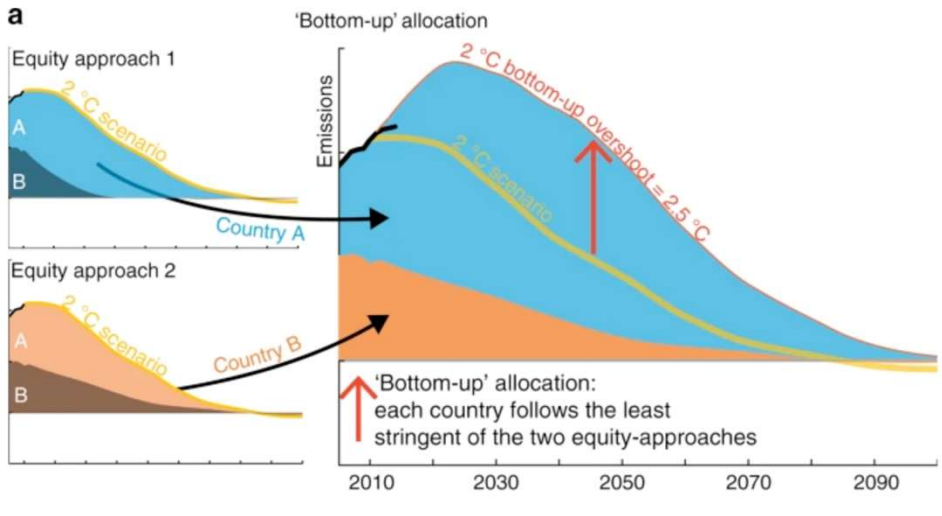
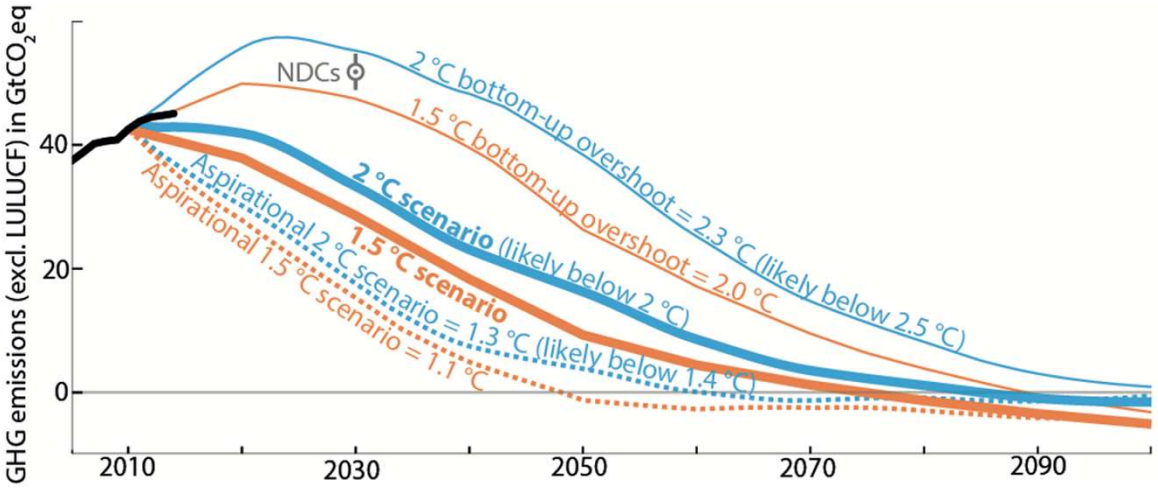
Limitations of fair-shares

- Issue with fairness (reducing to a number, grandfathering, subjective)
- Combining principles (averaging, range positioning, combination...)





Robiou du Pont, Meinshausen, Nature Communications 2018

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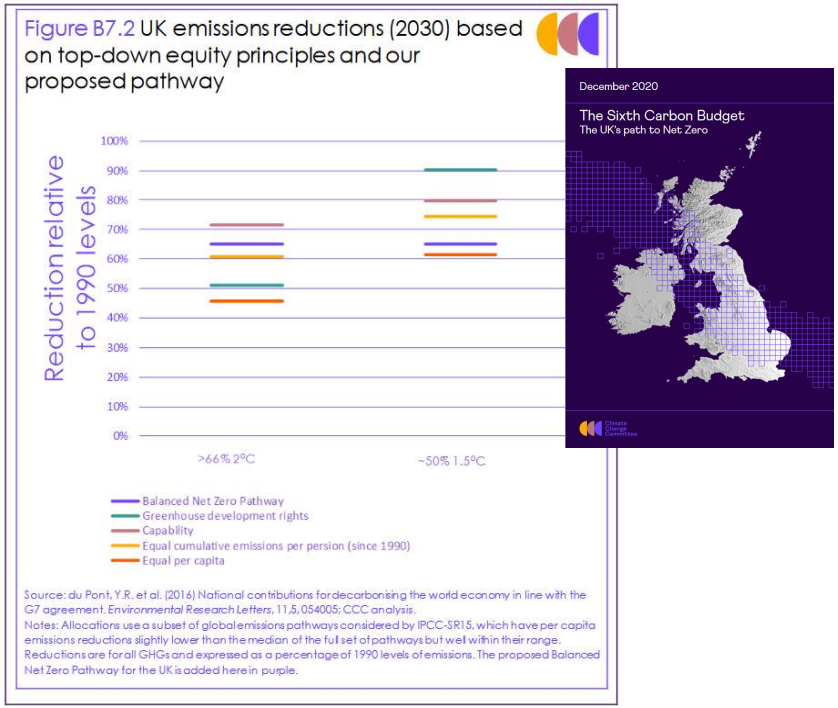
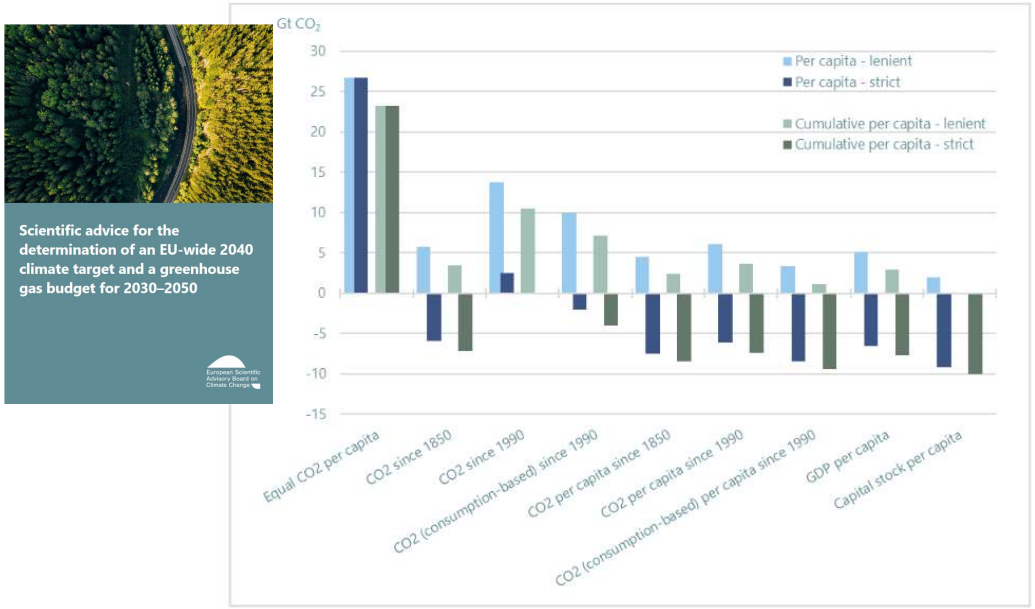
Role of fair-share (negotiations, legislation, litigation)



Committee on Climate Change, 2020

Figure 3 EU fair share carbon budget estimates from 2020, according to different principles and allocation methods



European Scientific Advisory Board on Climate Change, 2023

- **Highest possible domestic action**
- **Complemented with international support to meet fair share**

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Limitations of fair-shares

- Extreme financial flows (conditionalities with economic growth)
- Missing:
  - L&D
  - Adaptation
  - Within-country inequality

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Thank you for listening!

yann.rdp@climate-energy-college.org and mark.dekker@pbl.nl


Navigating the black box of fair national emissions targets

Current national emissions targets fall short of meeting the Paris Agreement climate goals, prompting increased attention on equitable ways to closing this gap in international climate negotiations. Fair emissions allocations are often determined using effort-sharing formulas based on principles of fairness, yielding diverse outcomes. This diversity in equity-based emissions allocations complicates efforts by policymakers and courts to discern the effects of assumptions and uncertainties from normative decisions. Here, we provide up-to-date fair emissions allocations in a comprehensive framework, accounting for considerations across three dimensions: physical and social uncertainties, global strategies and equity. The relative impact of these considerations is assessed using Sobol's method, quantifying for which countries discussions on equity and socio-economic projections are important, and for whom global targets dominate. The fair emissions allocations are compared to NDCs and cost-optimal scenario output, identifying countries that have insufficient ambition and those for which – from a globally cost-optimal perspective – it is appealing to invest in mitigation abroad.

Paper

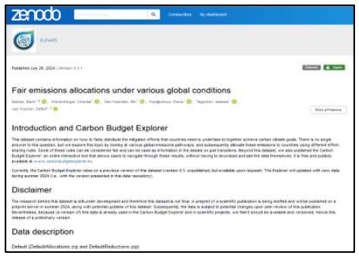
https://www.nature.com/articles/s41558-025-02361-7

Dekker et al. 2025 (Nature Climate Change)

Webtool

Carbon Budget Explorer

www.carbonbudgetexplorer.eu


zenodo

Fair emissions allocations under various global conditions

Introduction and Carbon Budget Explorer

Disclaimer

Data description

Data

https://doi.org/10.5281/zenodo.12921185