

The Role of Energy in Sustainable Development

Jarmo Kikstra EGU 2023

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An overview of this talk

- 1. Energy systems
- 2. Climate change
- 3. The energy transition
- 4. Eradicating poverty within climate goals
- 5. Sustainable development

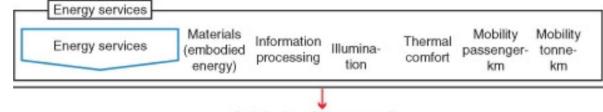


A note on the energy system

From extraction to use



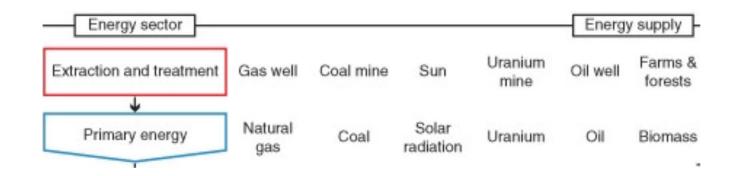
What do we need energy for?



Satisfaction of human needs



Where does energy come from?



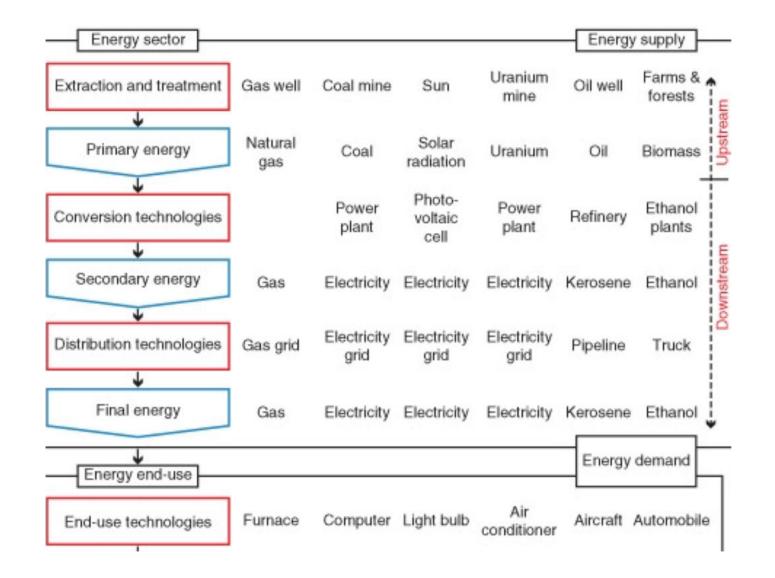


Energy sector					Energy supply	
Extraction and treatment	Gas well	Coal mine	Sun	Uranium mine	Oil well	Farms 8 forests
¥						
Primary energy	Natural gas	Coal	Solar radiation	Uranium	Oil	Biomas
¥			Dhata			
Conversion technologies		Power plant	Photo- voltaic cell	Power plant	Refinery	Ethanol plants
¥			Cell			
Secondary energy	Gas	Electricity	Electricity	Electricity	Kerosene	Ethanol



Energy sector					Energy supply	
Extraction and treatment	Gas well	Coal mine	Sun	Uranium mine	Oil well	Farms & forests
¥	-12- 11					
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4			100			
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¥			CON			
Secondary energy	Gas	Electricity	Electricity	Electricity	Kerosene	Ethanol
4						
Distribution technologies	Gas grid	Electricity grid	Electricity grid	Electricity grid	Pipeline	Truck
.L.		-	-			



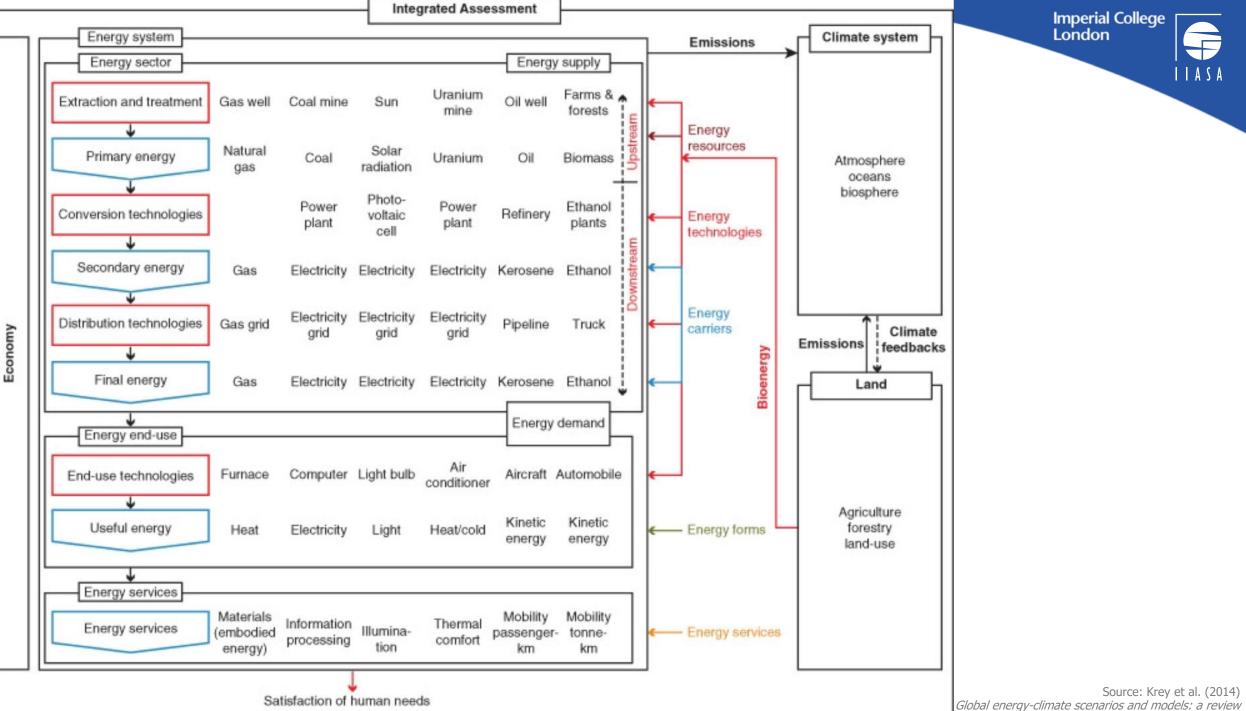


Source: Krey et al. (2014) Global energy-climate scenarios and models: a review

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↓ Final energy	Gas	Electricity	Electricity	Electricity	Kerosene	Ethanol
Energy end-use					Energy	demand
End-use technologies	Furnace	Computer	Light bulb	Air conditioner	Aircraft	Automobile
Useful energy	Heat	Electricity	Light	Heat/cold	Kinetic energy	Kinetic energy
Energy services						
Energy services	Materials (embodied energy)	Information processing	Illumina- tion	Thermal comfort	Mobility passenger km	Mobility tonne- km



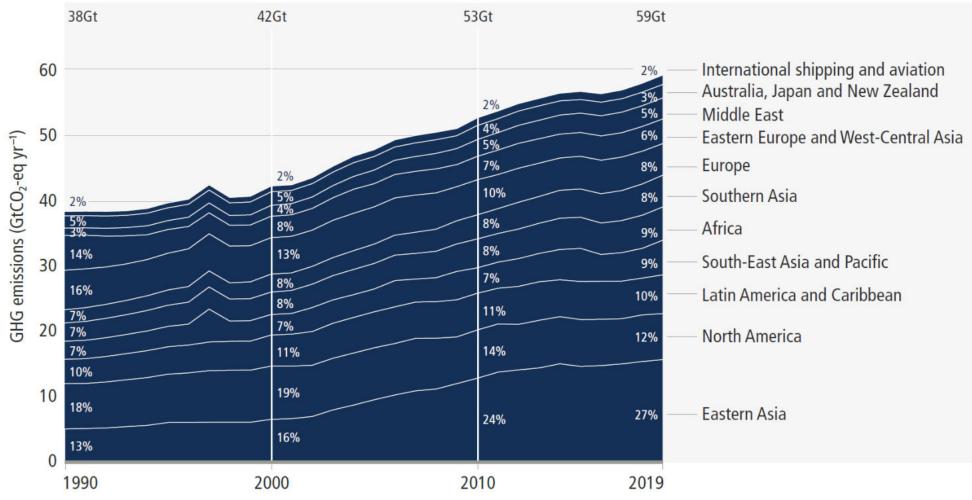


A background note on climate change What happened? What is to be done?



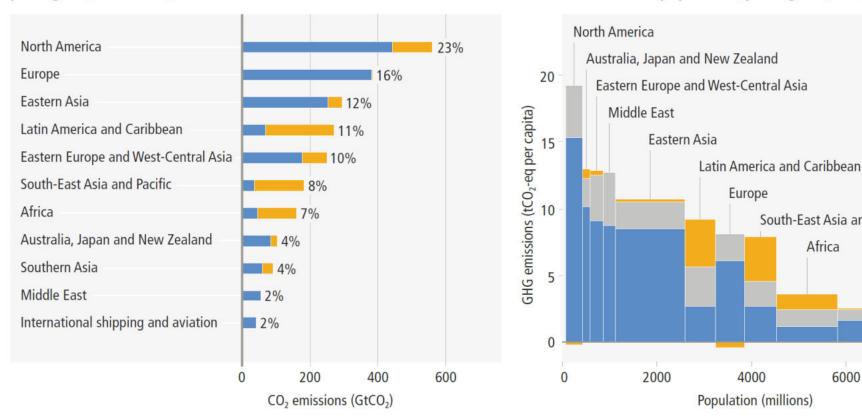
Emissions have been going up

a. Global net anthropogenic GHG emissions by region (1990–2019)



Emissions by region and by source

b. Historical cumulative net anthropogenic CO₂ emissions per region (1850–2019)



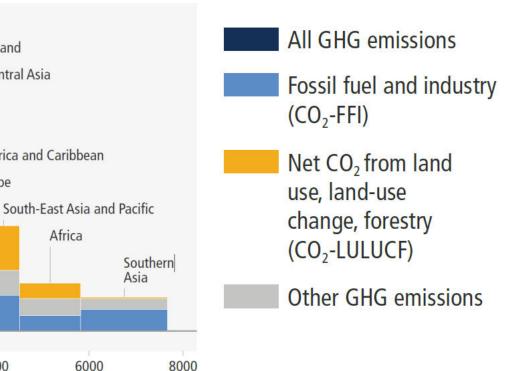
c. Net anthropogenic GHG emissions per capita and for total population, per region (2019)

Europe

4000

Africa

6000

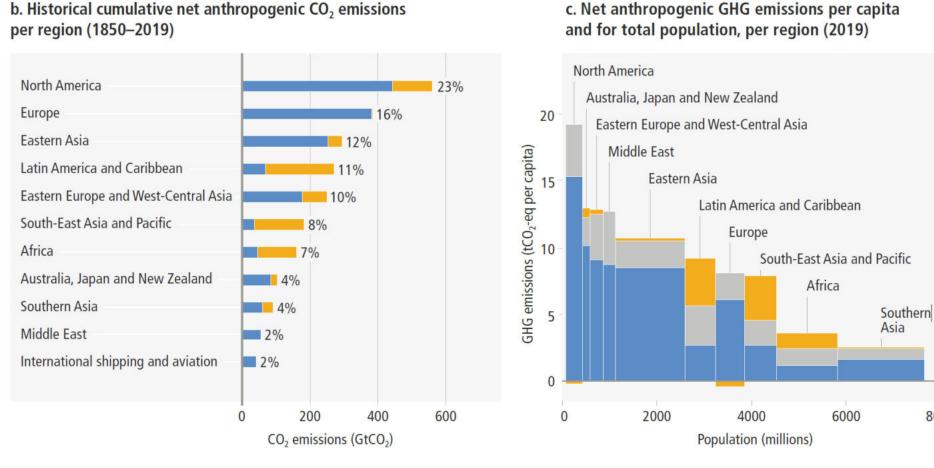


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Emissions by region and by source



Mostly energy

All GHG emissions Fossil fuel and industry $(CO_2 - FFI)$

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Net CO₂ from land use, land-use change, forestry (CO₂-LULUCF)

Other GHG emissions

Source: IPCC Working Group III, Sixth Assessment Report (2022)

Asia

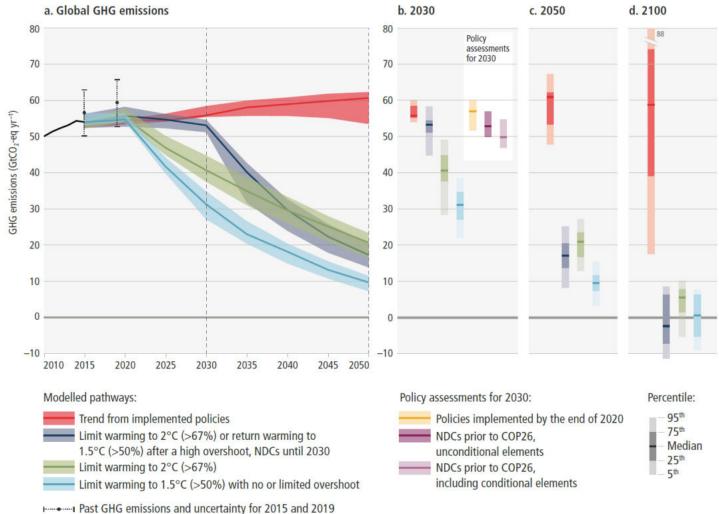
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(Far) too little is being done. But not nothing.

(dot indicates the median)

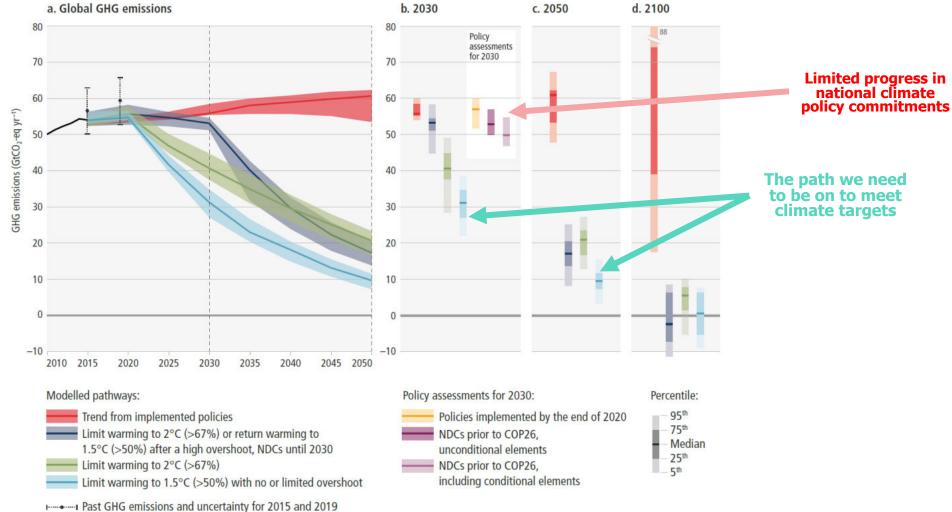
Projected global GHG emissions from NDCs announced prior to COP26 would make it *likely* that warming will exceed 1.5°C and also make it harder after 2030 to limit warming to below 2°C.



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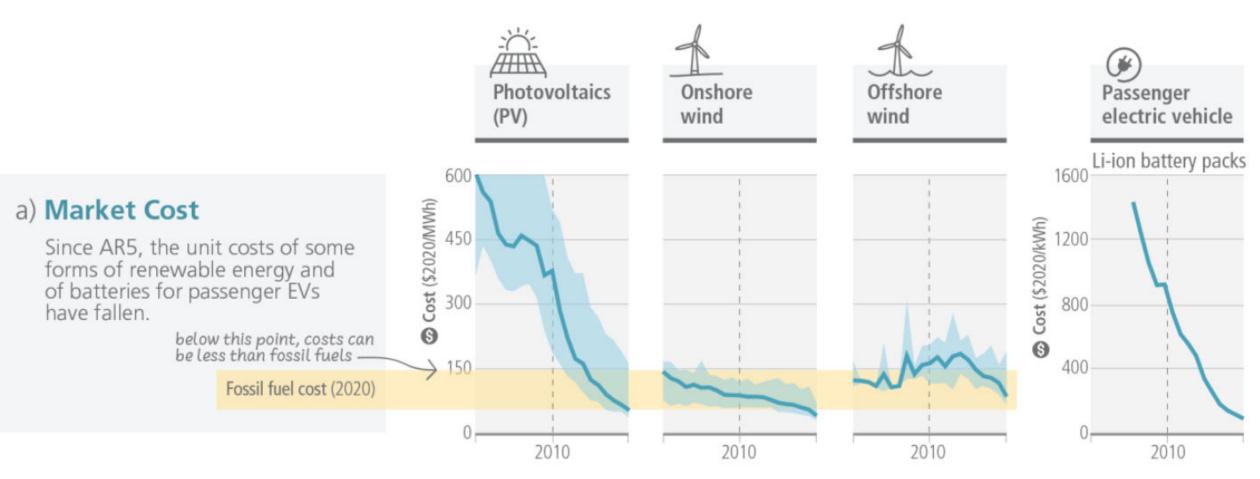


(dot indicates the median)



The role of energy in meeting climate goals Supply and demand

Mitigation is becoming cheaper



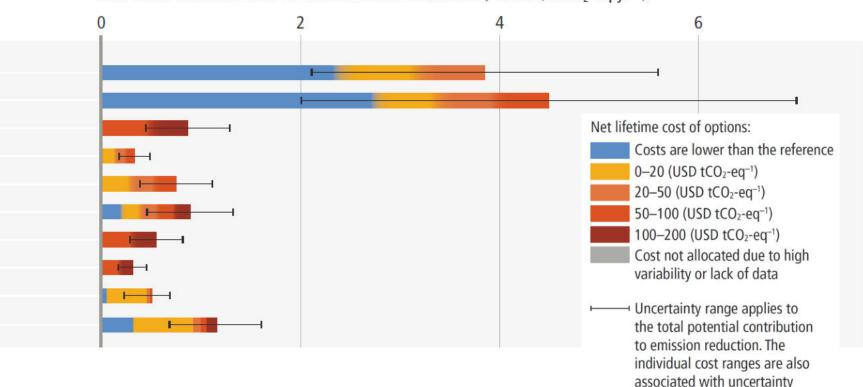
Source: IPCC Working Group III, Synthesis Report (2023)

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The role of energy supply

Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030. Relative potentials and costs will vary across countries and in the longer term compared to 2030.



Potential contribution to net emission reduction, 2030 (GtCO₂-eq yr⁻¹)

Source: IPCC Working Group III, Sixth Assessment Report (2022)

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Solar energy Bioelectricity Hydropower Geothermal energy Nuclear energy Carbon capture and storage (CCS) Bioelectricity with CCS Reduce CH₄ emission from coal mining Reduce CH₄ emission from oil and gas

Mitigation options

Wind energy

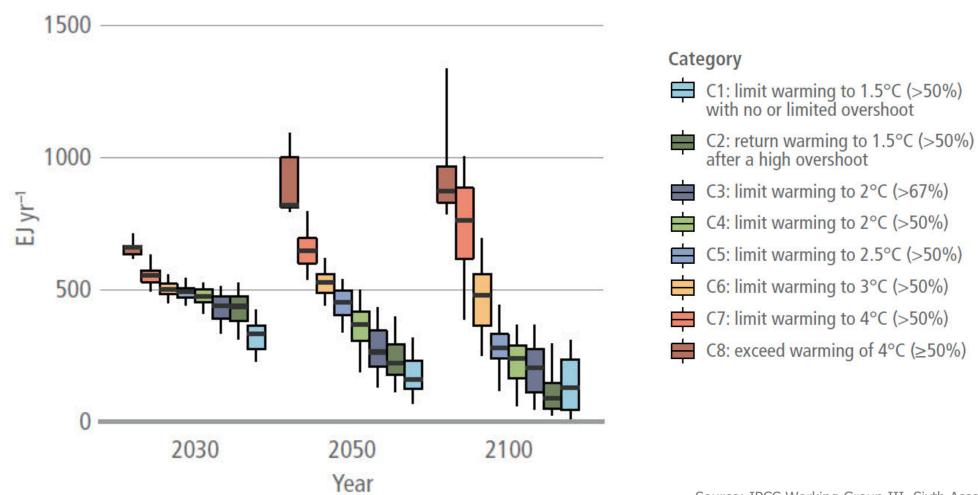


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The role of energy supply: fossils go down fast

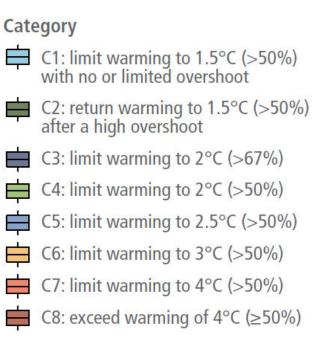
Fossil

(b)

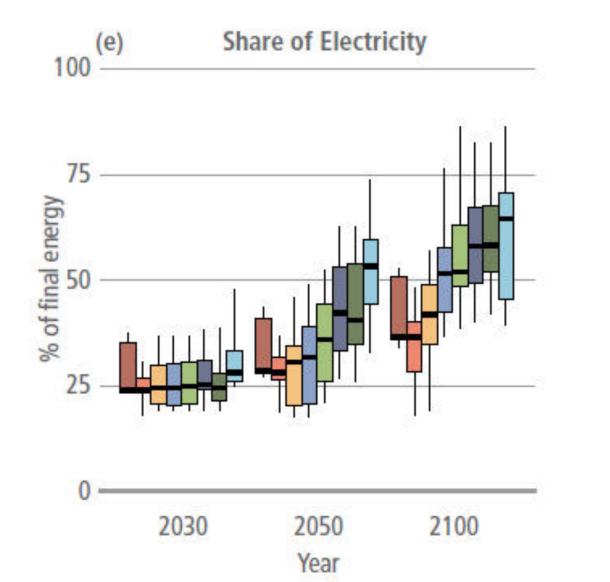


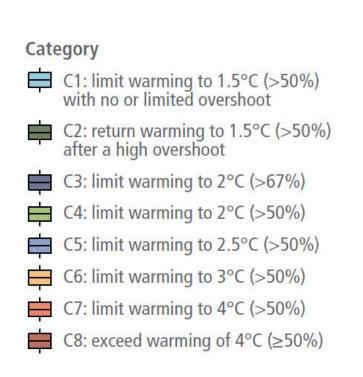
The role of energy supply: coal needs to go

Coal without CCS (c) 800 600 1×400 200 2030 2050 2100 Year



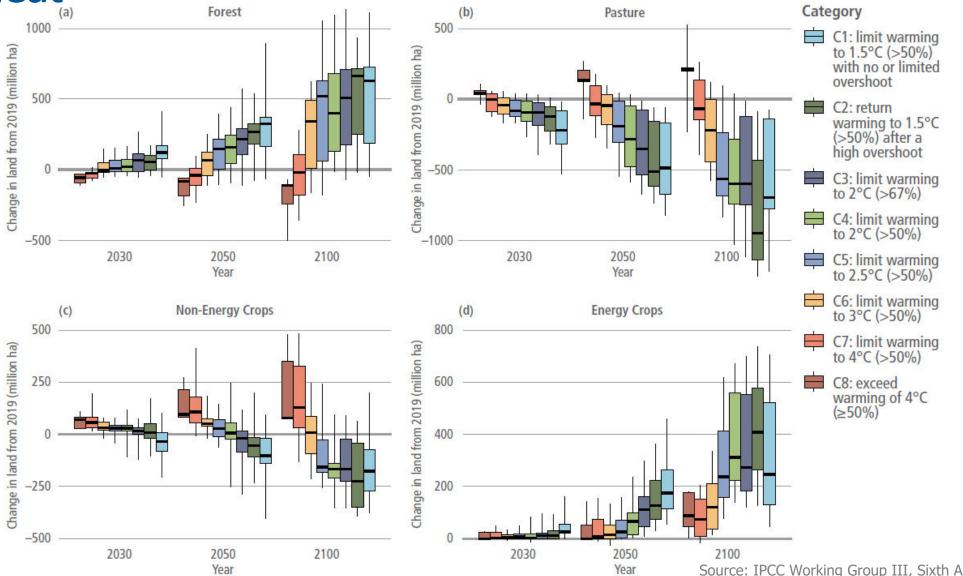
The role of energy supply: electrify everything!



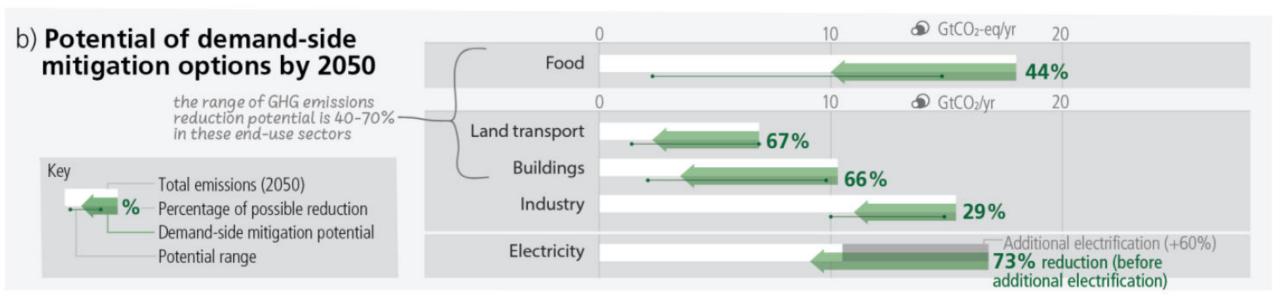


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The fight for land: more forest (for energy), less for meat



The role of energy demand



Three types of energy demand options:

Avoid

Travel less

Shift

• Travel by public transport instead of private car

Improve

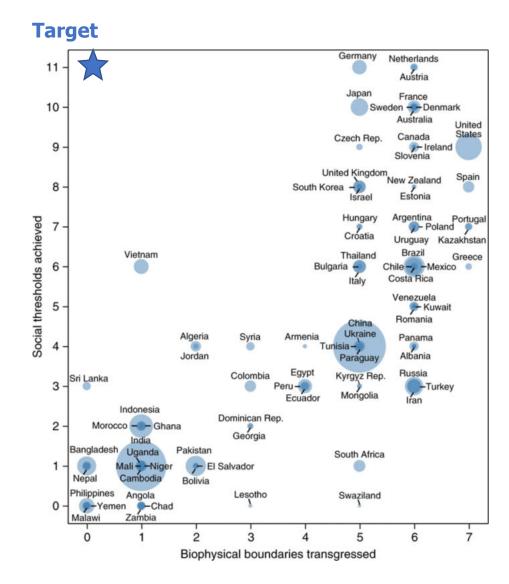
Efficiency of cars



A dual challenge



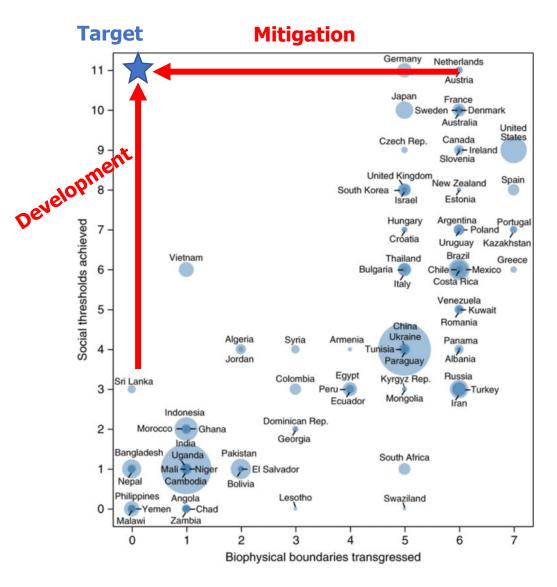
A dual challenge



Source: O'Neill et al. (2018) A good life for all within planetary boundaries



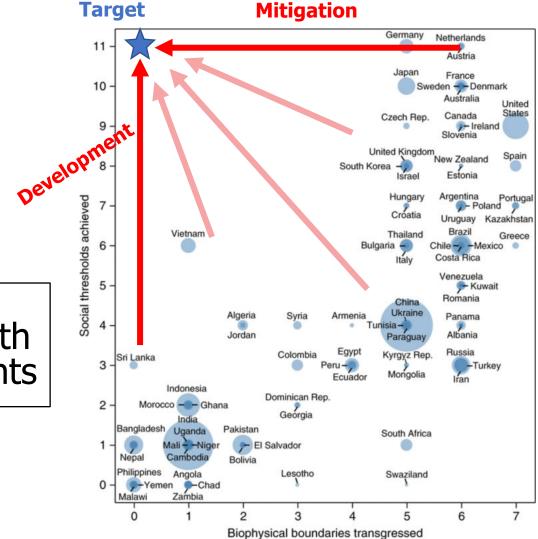
A dual challenge



Source: O'Neill et al. (2018) A good life for all within planetary boundaries



A dual challenge



Pathways combining human development with environmental constraints

> Source: O'Neill et al. (2018) A good life for all within planetary boundaries

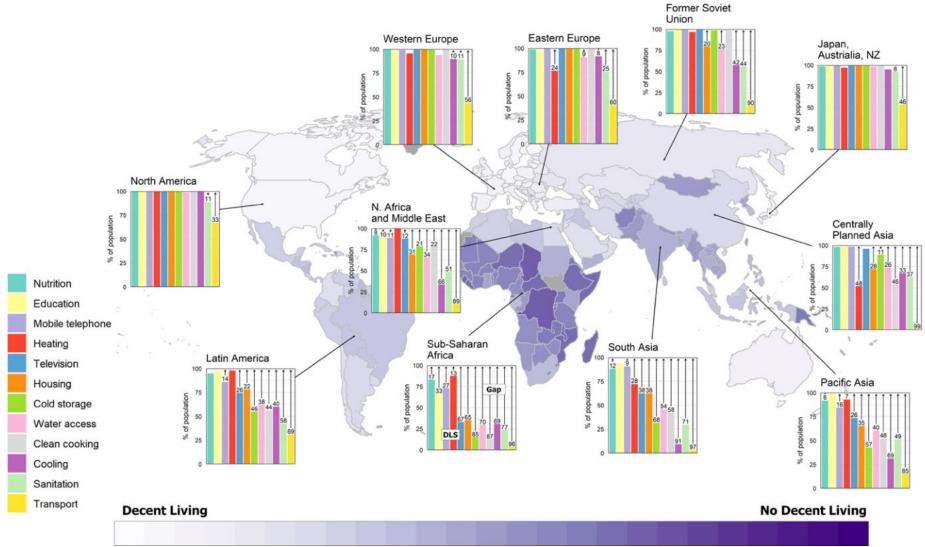


Can we eradicate poverty and meet climate goals?

The idea of "Decent Living Standards" and minimum energy requirements



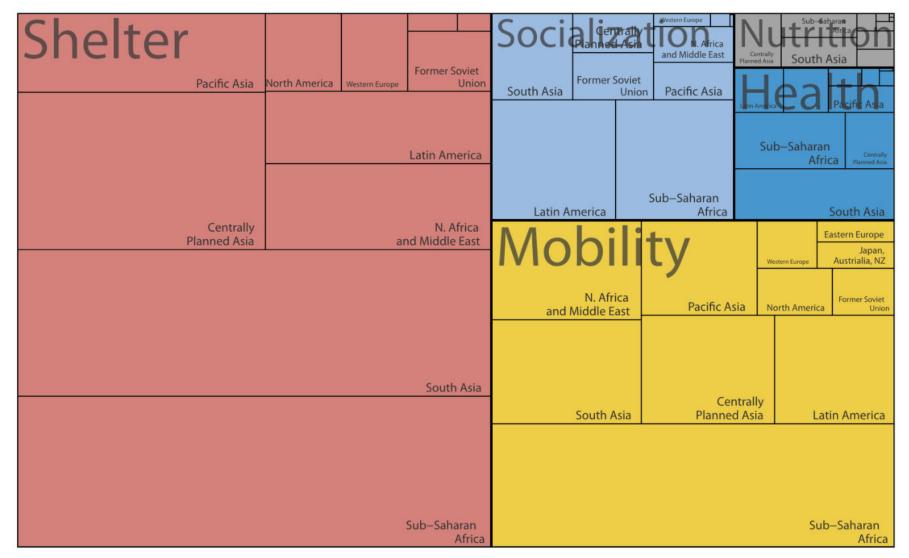
Gaps in services around the world



Source: Kikstra et al. (2021) Decent Living Gaps and Energy Needs around the World

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Closing the gaps: building new infrastructure

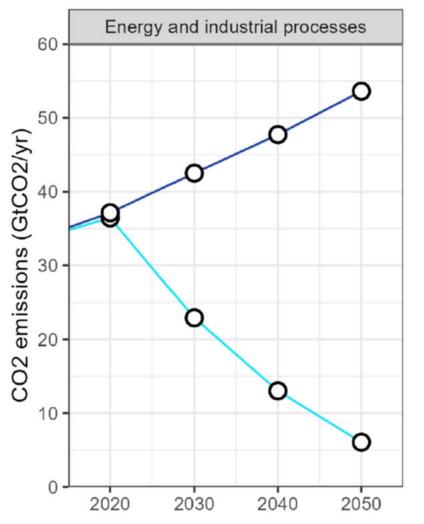


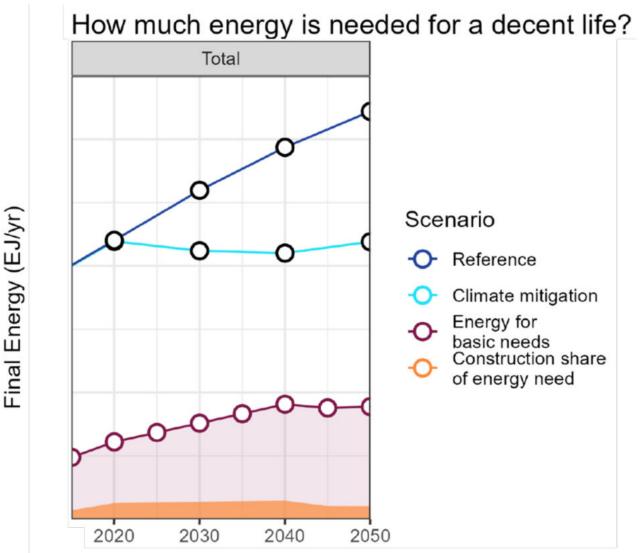
Source: Kikstra et al. (2021) Decent Living Gaps and Energy Needs around the World



Closing the gaps: while meeting climate targets

Required decarbonization.



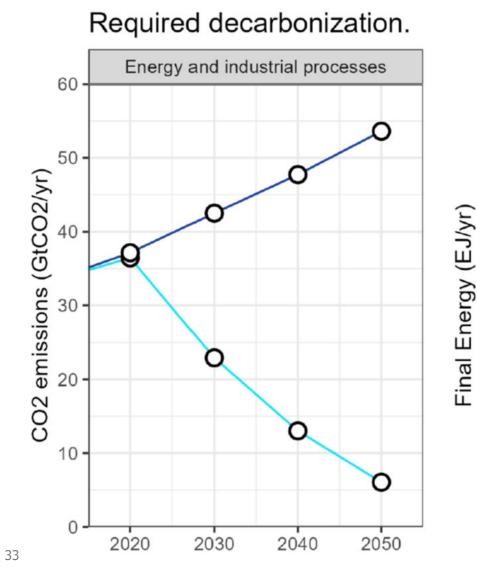


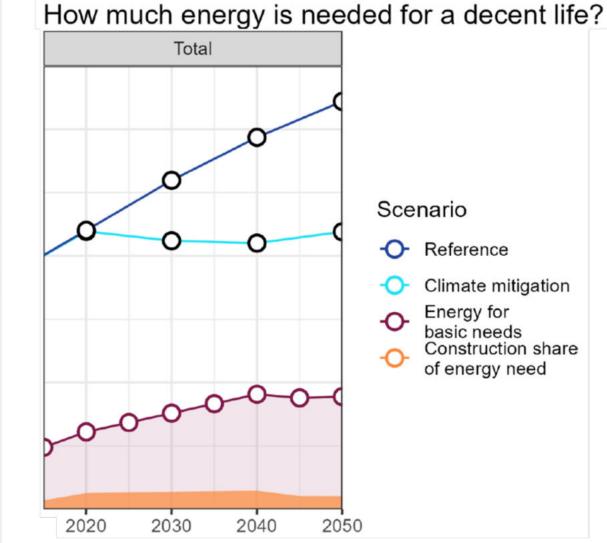
Source: Kikstra et al. (2021) Decent Living Gaps and Energy Needs around the World

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Closing the gaps: some countries need more

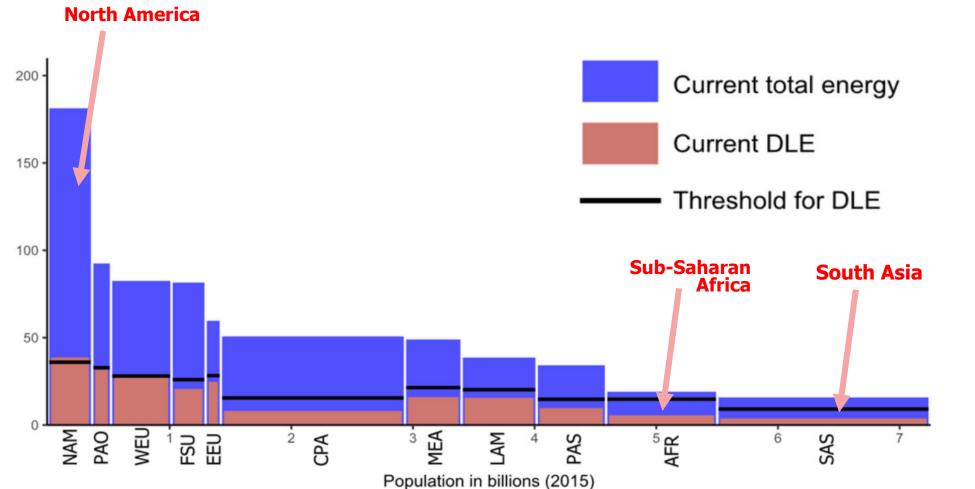




Source: Kikstra et al. (2021) Decent Living Gaps and Energy Needs around the World

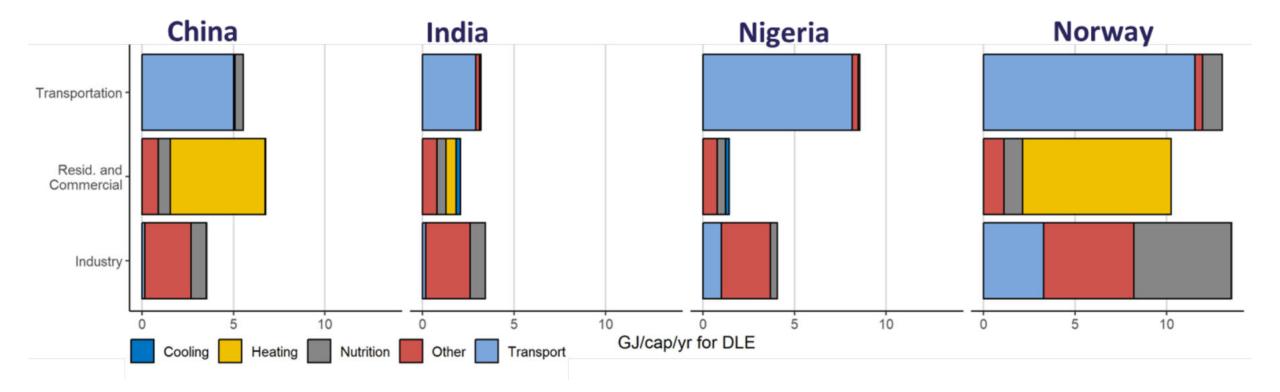


Some countries could use less: large inequality



Source: Kikstra et al. (2021) Decent Living Gaps and Energy Needs around the World

Closing the gaps: energy needs are different, ... even if human needs are the same



Source: author's calculations

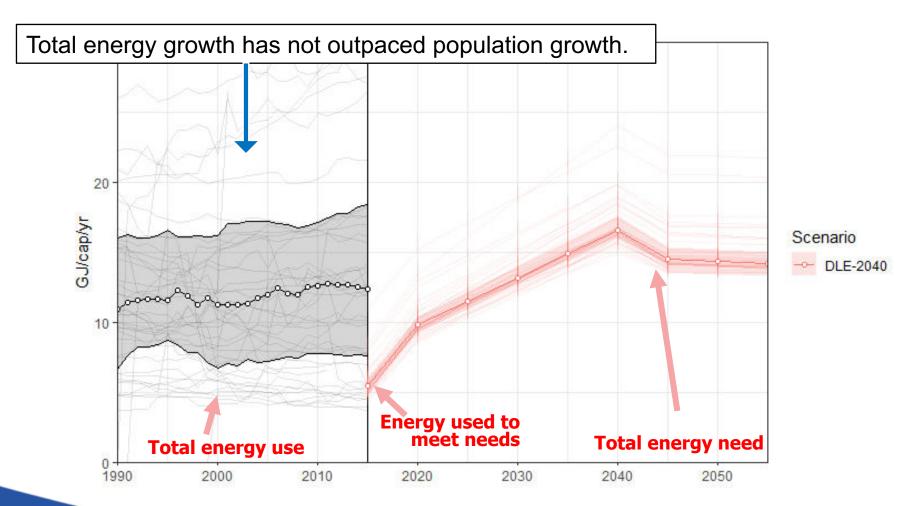
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Closing the gaps: some countries need to grow

Country-level look (Sub-Saharan Africa) reveals size of challenge.



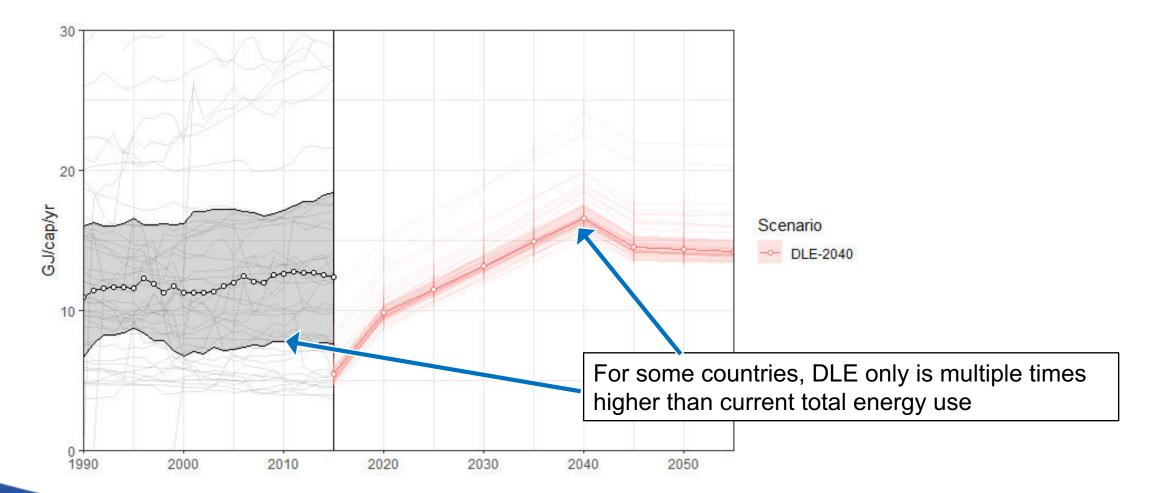
Source: Kikstra et al. (2021) Decent Living Gaps and Energy Needs around the World

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Closing the gaps: some countries need to grow

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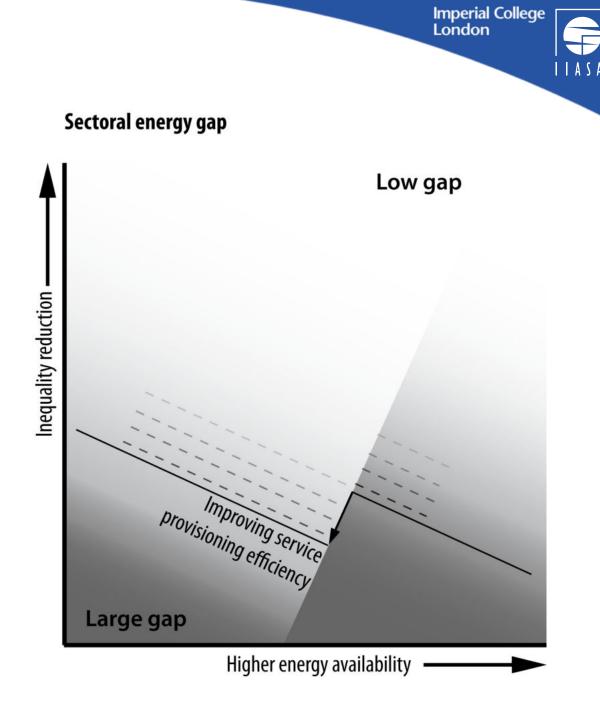
What types of sustainable development pathways exist?

... and what role does energy play in the whole?

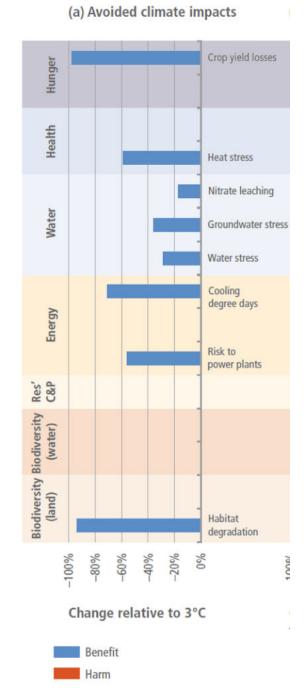
Illustrating the options

Options to reduce poverty ...:

- More growth where needed
- More equality
- Better service provisioning systems



The need for holistic climate policies



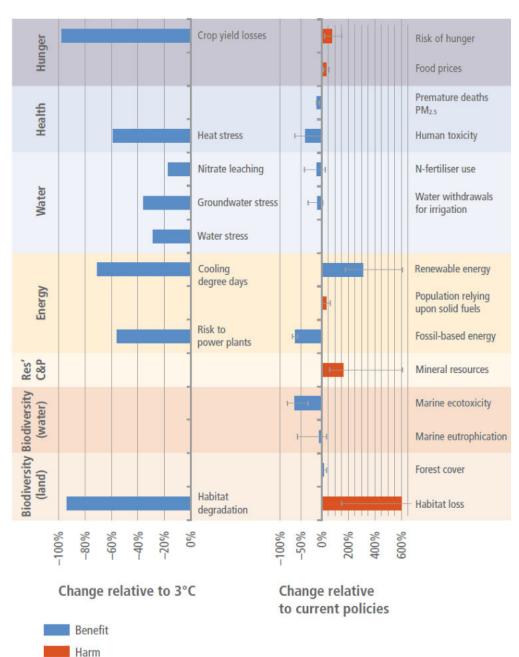
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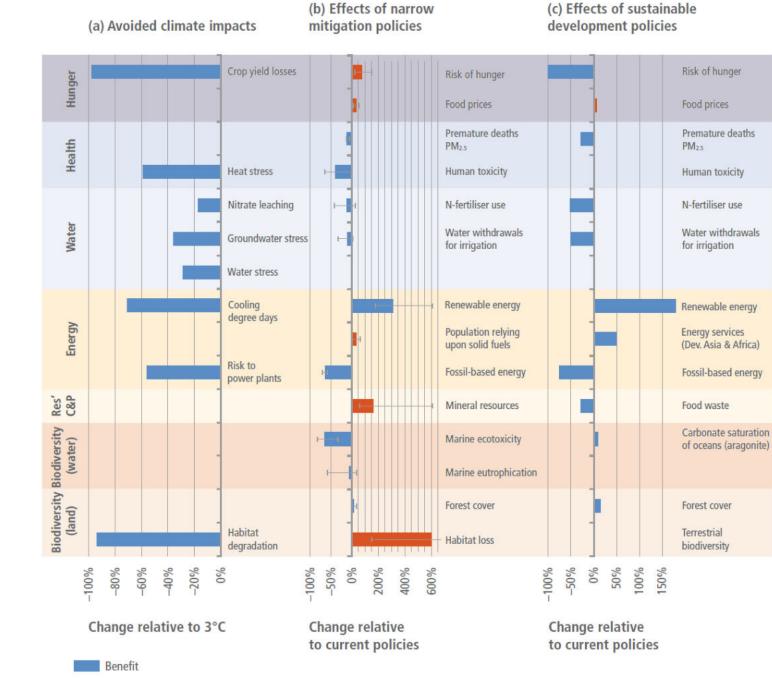
(a) Avoided climate impacts

(b) Effects of narrow mitigation policies

The need for holistic climate policies



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The need for holistic climate policies

Harm

Source: IPCC Working Group III, Sixth Assessment Report (2022)

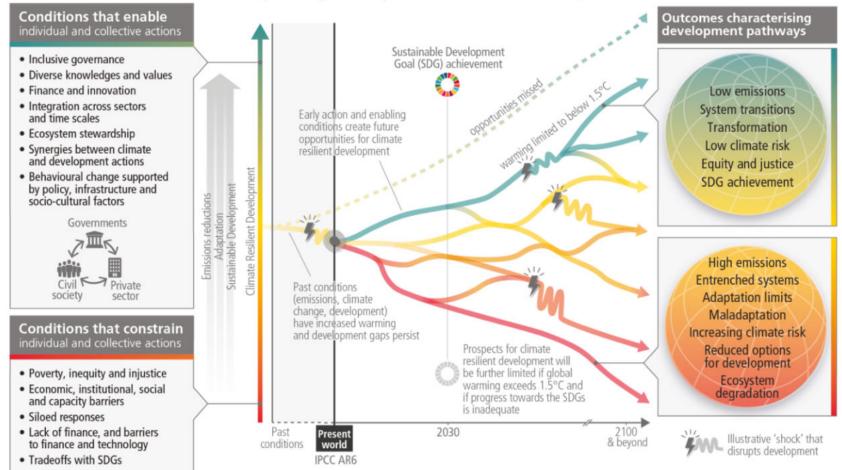
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Climate resilient development

There is a rapidly narrowing window of opportunity to enable climate resilient development

Multiple interacting choices and actions can shift development pathways towards sustainability



Source: IPCC Working Group III, Synthesis Report (2023)

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Thank you so much for your attention!

Questions?

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