INTERGOVERNMENTAL PANEL ON Climate change

Climate Change 2022

IPCC's Mitigation Assessment: Conclusions from AR6 and Future Challenges

IPCC Symposium Tokyo, 19 May 2022

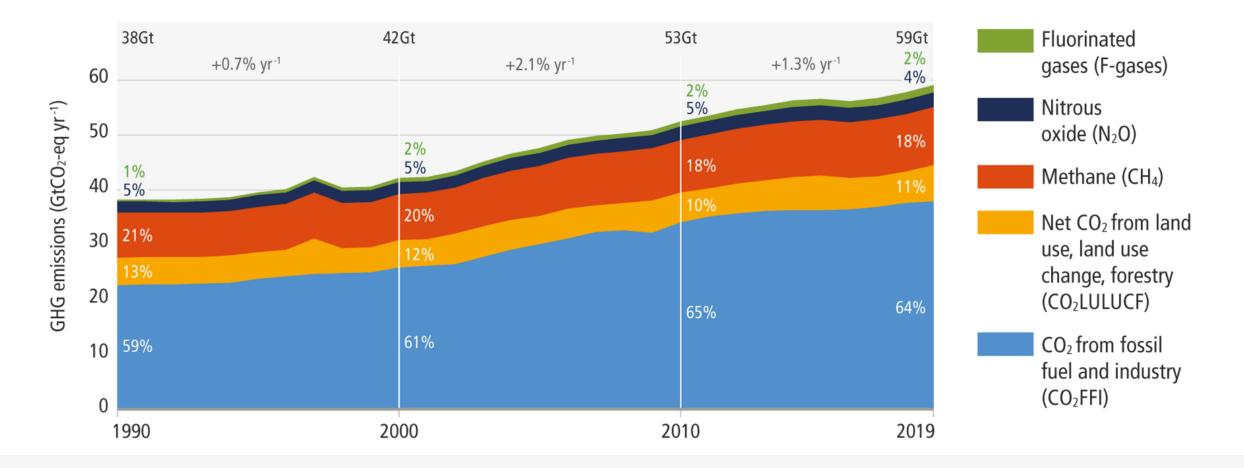
Jim Skea, IPCC WG III Co-Chair

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Matt Bridgestock, Director and Architect at John Gilbert Architects]

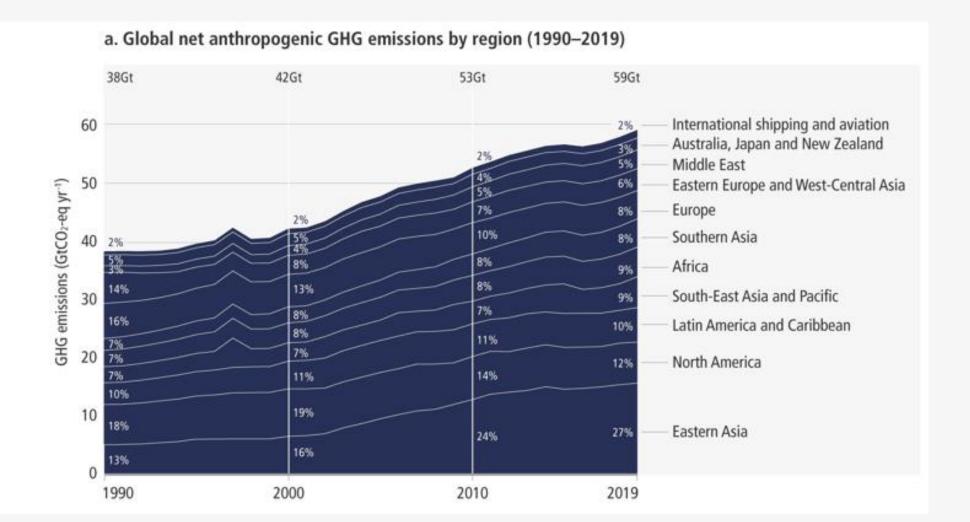


We are not on track to limit warming to 1.5°C Average annual GHG emissions during 2010–19 were the highest in human history..





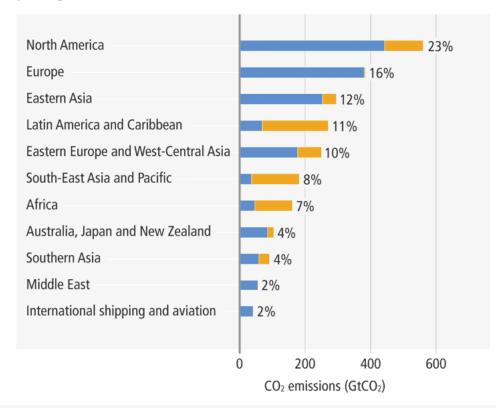
Emissions are growing in most regions



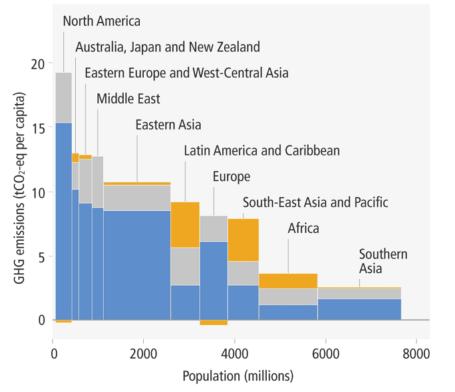


Emissions are distributed unevenly, both in the present day and cumulatively since 1850

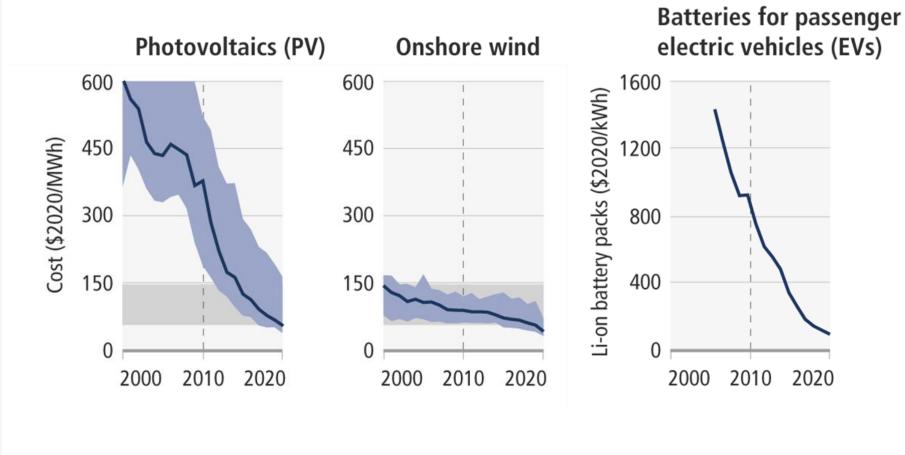
b. Historical cumulative net anthropogenic CO₂ emissions per region (1850–2019)



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



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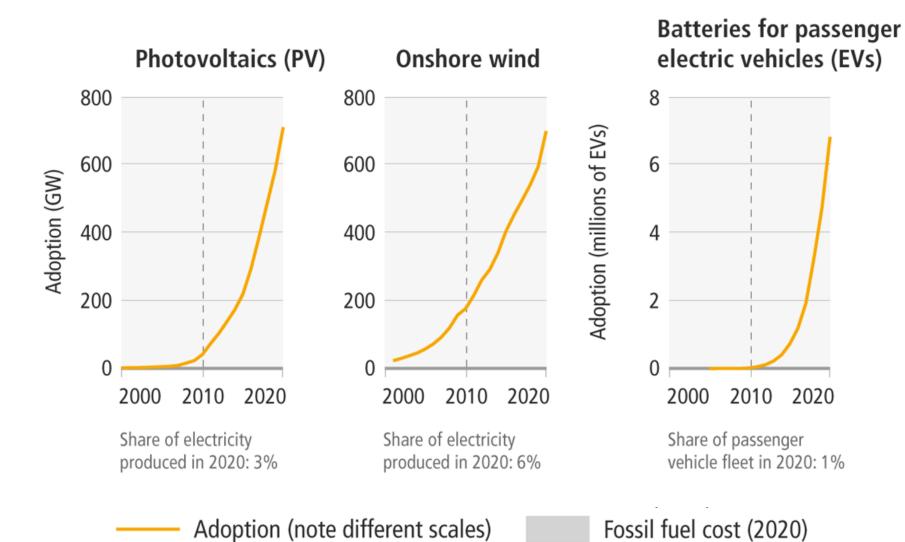
Since 2010, there have been sustained decreases of up to 85% in the costs of solar and wind energy In some cases, costs for renewables have fallen below those of fossil fuels.

---- AR5 (2010)

Market cost

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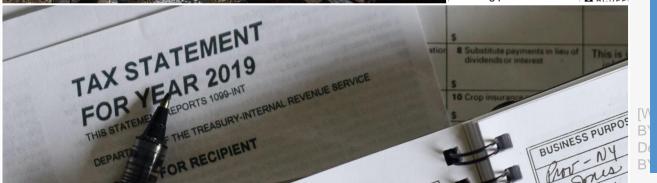
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There have been large increases in capacity installed. Electricity systems in some countries and regions are already predominantly powered by renewables.







Washing Energy machine Manufacturer Model More efficient В G Less efficient Energy consumption 1.75 kWh/cycle (based on standard test results for 60°C Actual energy consumption will depend Washing performance ABODEE

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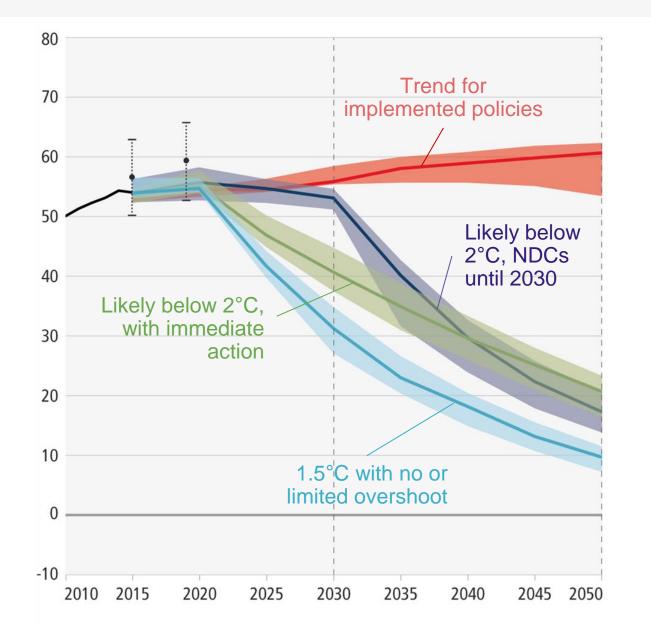
Regulatory and economic instruments have **already proven effective** in reducing emissions;

Climate laws cover **53%** of global emissions;

20% of emissions are covered by carbon taxes or trading systems

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Limiting warming to 1.5 °C

- Global GHG emissions peak before 2025, reduced by 43% by 2030.
- Methane reduced by 34% by 2030

Limiting warming to around 2°C

 Global GHG emissions peak before 2025, reduced by 27% by 2030.

(based on IPCC-assessed scenarios)

SSP1-1.9.

SP

LD

Ren

Neg

SSP1-2.6

GS

SSP2-4.5

Mod-Act

SSP3-7.0

Cur-Pol

SSP5-8.5

limit warming to 1.5°C

... with net-zero GHGs

... without net-zero

return warming to

high overshoot

1.5°C (>50%) after a

limit warming to 2°C

... with action starting

... NDCs until 2030

limit warming to 2°C

limit warming to 2.5°C

limit warming to 3°C

limit warming to 4°C

exceed warming of 4°C

GHGs

(>67%)

in 2020

(>50%)

(>50%)

(>50%)

(>50%)

(>=50%)

(>50%) with no or

limited overshoot

C1 [97]

Cla [50]

C1b [47]

C2 [133]

C3 [311]

C3a [204]

C3b [97]

C4 [159]

C5 [212]

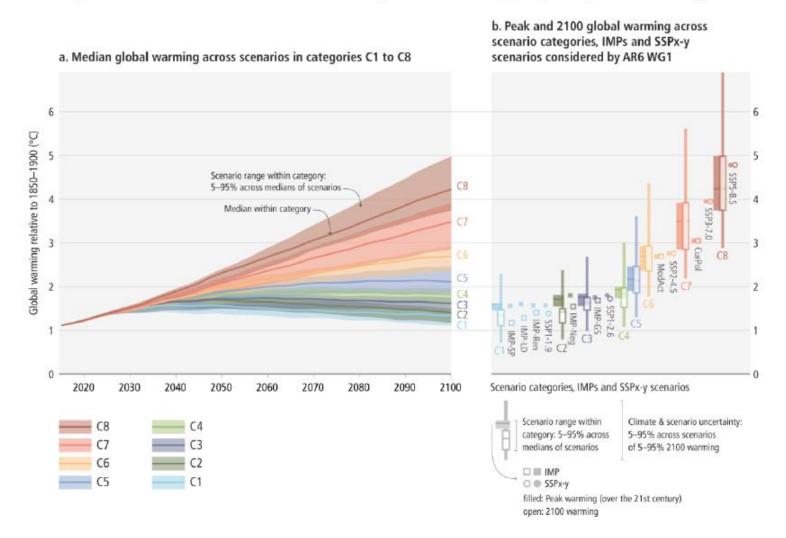
C6 [97]

C7 [164]

C8 [29]

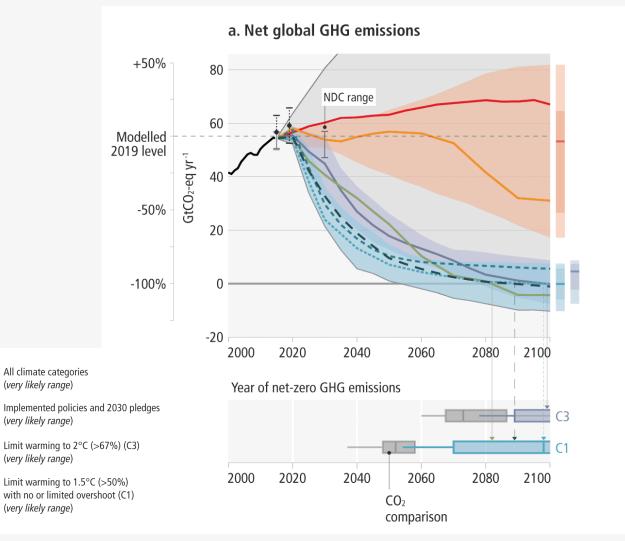
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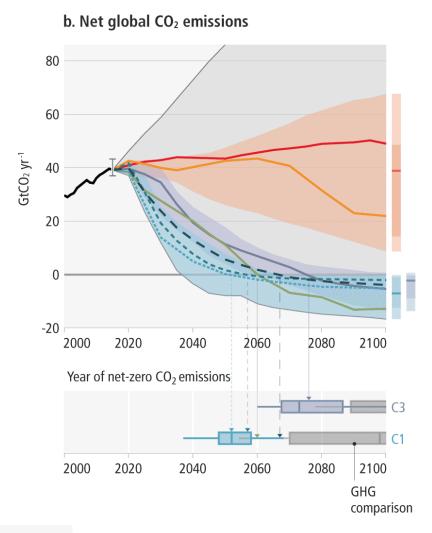
The range of assessed scenarios results in a range of 21st century projected global warming.





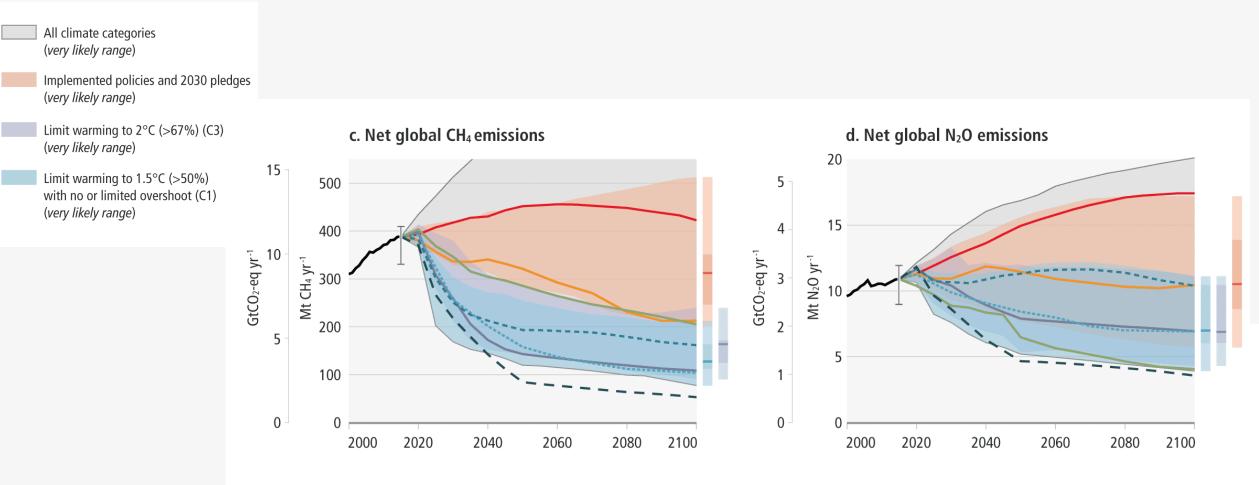
Modelled mitigation pathways that limit warming to 1.5°C, and 2°C, involve deep, rapid and sustained emissions reductions



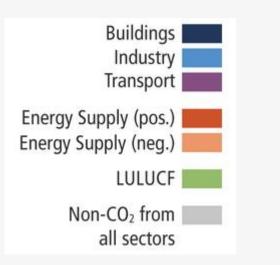


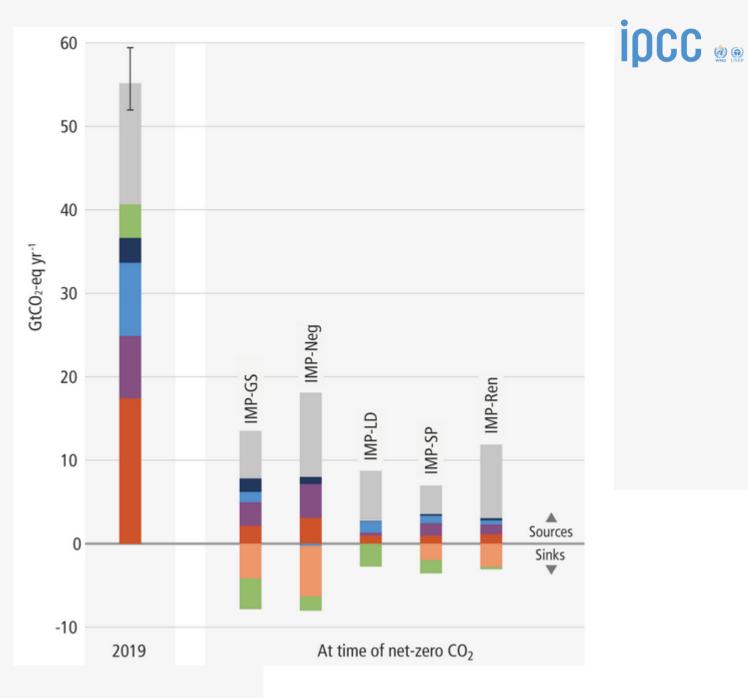


Modelled mitigation pathways that limit warming to 1.5°C, and 2°C, involve deep, rapid and sustained emissions reductions



Net zero CO₂ and net zero GHG emissions are possible through different modelled mitigation pathways









There are options available **now** in every sector that can at least **halve** emissions by 2030



Demand and services













Energy

Land use

Industry

Urban

Buildings

Transport

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Energy

- major transitions are required to limit global warming
- reduction in fossil fuel use and use of carbon capture and storage
- low- or no-carbon energy systems
- widespread electrification and improved energy efficiency
- alternative fuels: e.g. hydrogen and sustainable biofuels

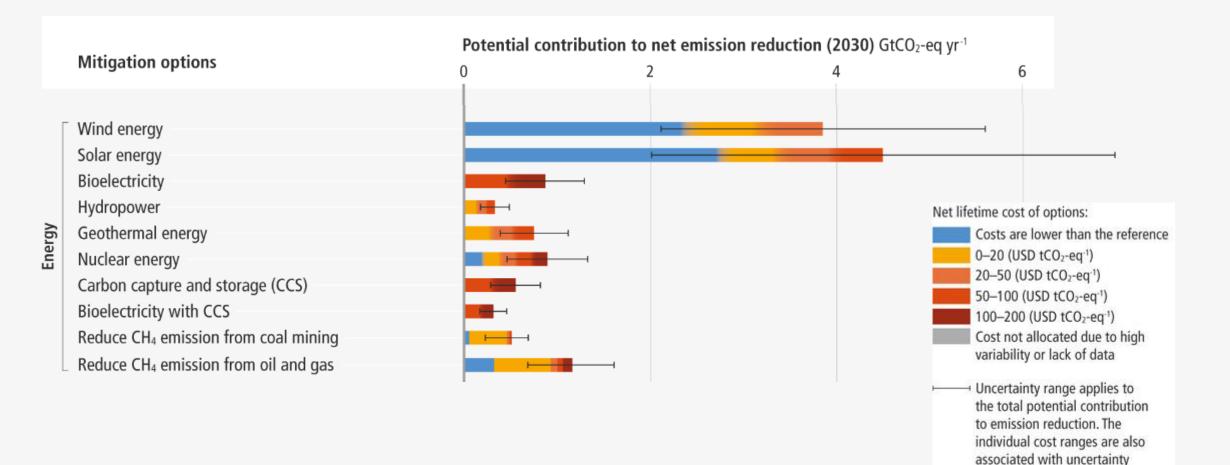




[Portland General Electric CC BY-ND 2.0, Harry Cunningham/Unsplash, Stéphane Bellerose/UNDP in Mauritius and Seychelles CC BY-NC 2.0, IMF Photo/Lisa Marie David, Tamara Merino CC BY-NC-ND 2.0]



Many options available now in all sectors are estimate to offer substantial potential to reduce net emissions by 2030 : Energy





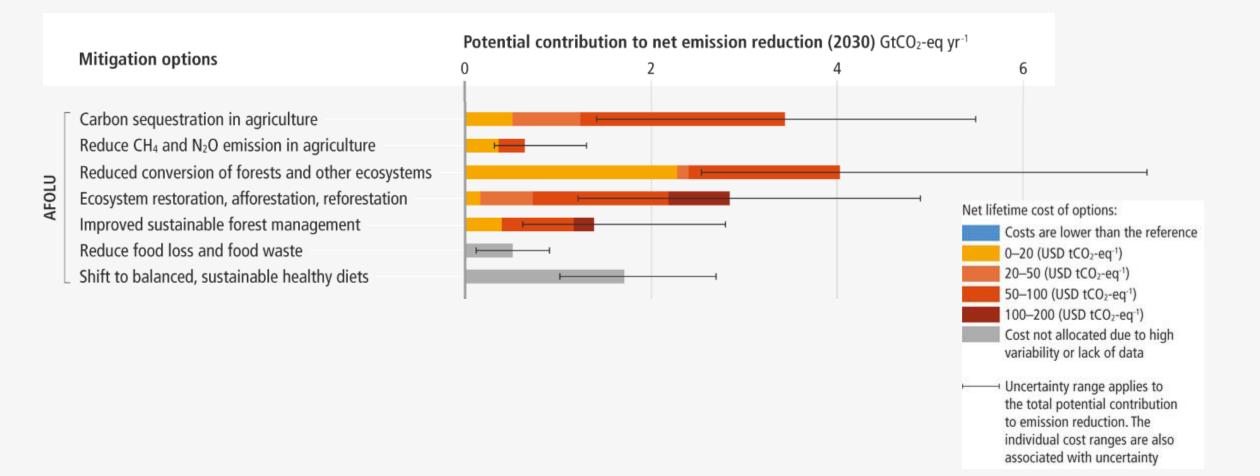
Land use

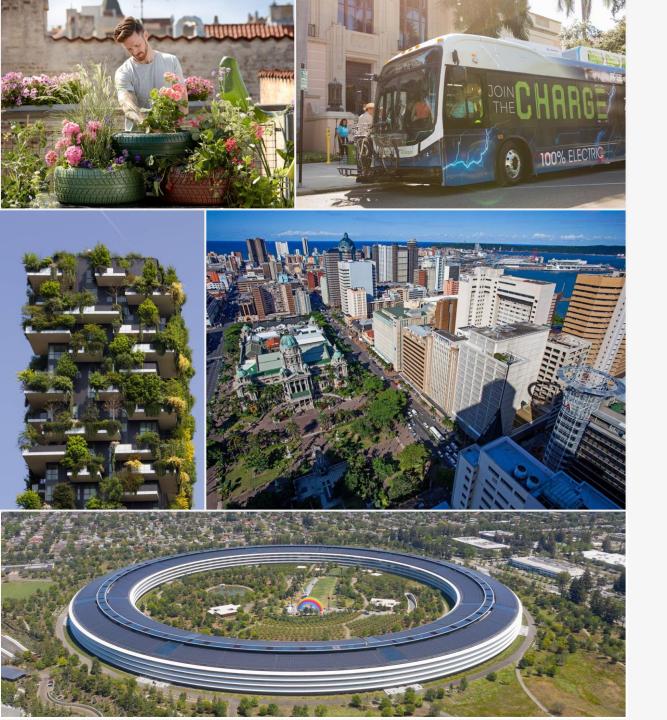
- can provide large-scale emissions reductions **and** remove and store CO₂ at scale
- protecting and restoring **natural ecosystems** to remove carbon: forests, peatlands, coastal wetlands, savannas and grasslands
- competing demands have to be **carefully** managed
- cannot compensate for delayed emission reductions in other sectors





Many options available now in all sectors are estimate to offer substantial potential to reduce net emissions by 2030 : AFOLU





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Cities and urban areas

- better urban planning, as well as:
- sustainable production and consumption of goods and services,
- electrification (low-emission energy),
- enhancing carbon uptake and storage (e.g. green spaces, ponds, trees)

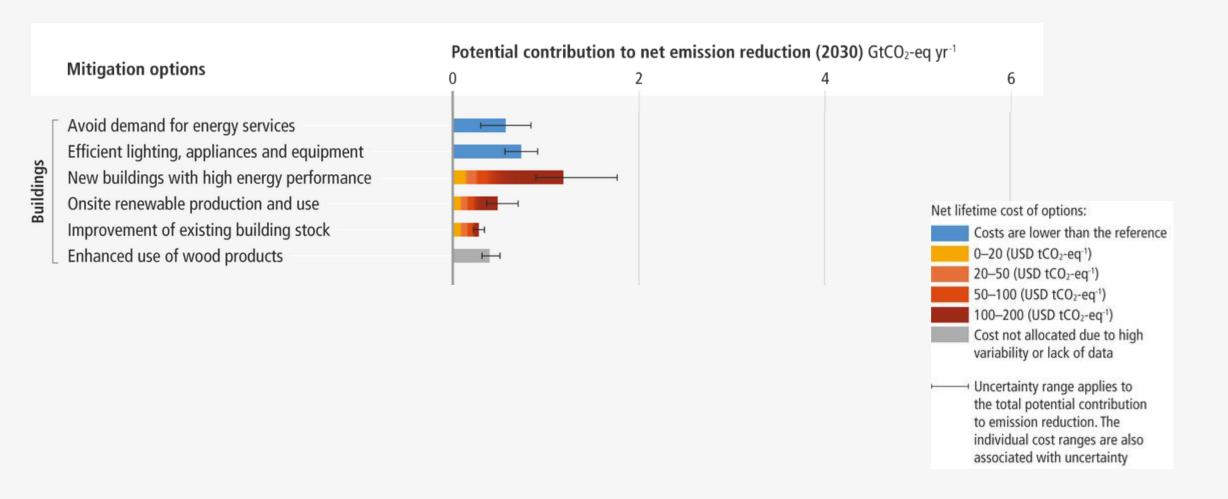
There are options for existing, rapidly growing *and* new cities.

[Pelargoniums for Europe/Unsplash, City of St Pete CC BY-ND 2.0, Victor/Unsplash, EThekwini Municipality, Arne Müseler/arne-mueseler.com, CC BY-SA 3.0 de]





Many options available now in all sectors are estimate to offer substantial potential to reduce net emissions by 2030 : Buildings



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Transport

- reducing demand and low-carbon technologies are key to reducing emissions
- electric vehicles: greatest potential
- battery technology: advances could assist electric rail, trucks
- aviation and shipping: alternative fuels (low-emission hydrogen and biofuels) needed
- Overall, substantial potential but depends on decarbonising the power sector.

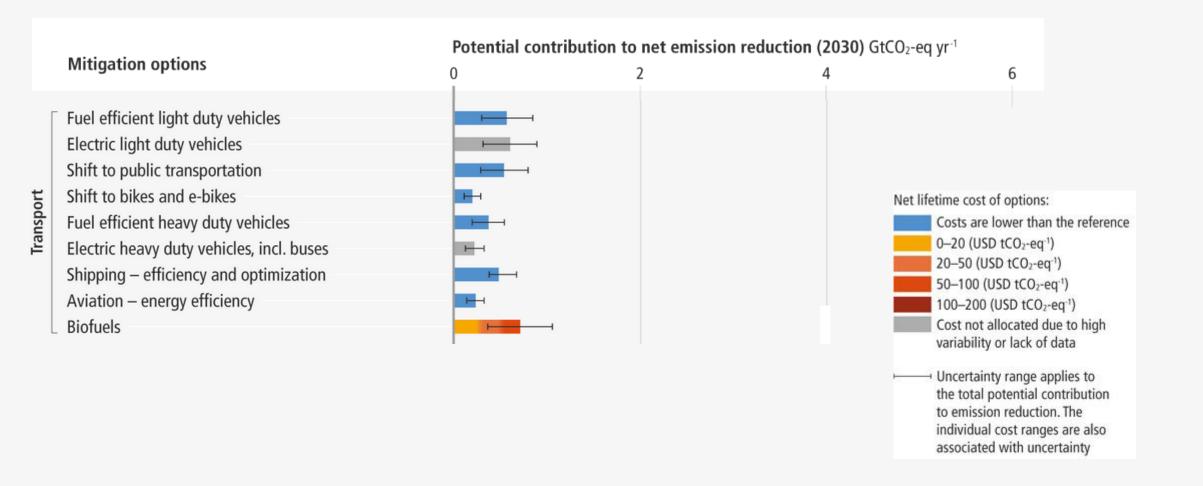


[United Airlines, Jeremy Segrott CC BY 2.0, Andreas160578/Pixabay]



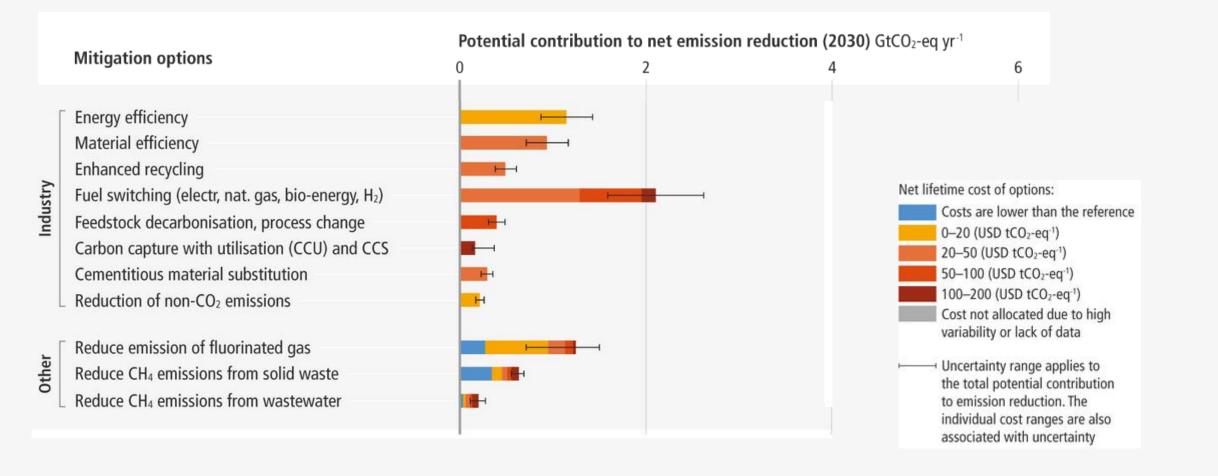


Many options available now in all sectors are estimate to offer substantial potential to reduce net emissions by 2030 : Transport



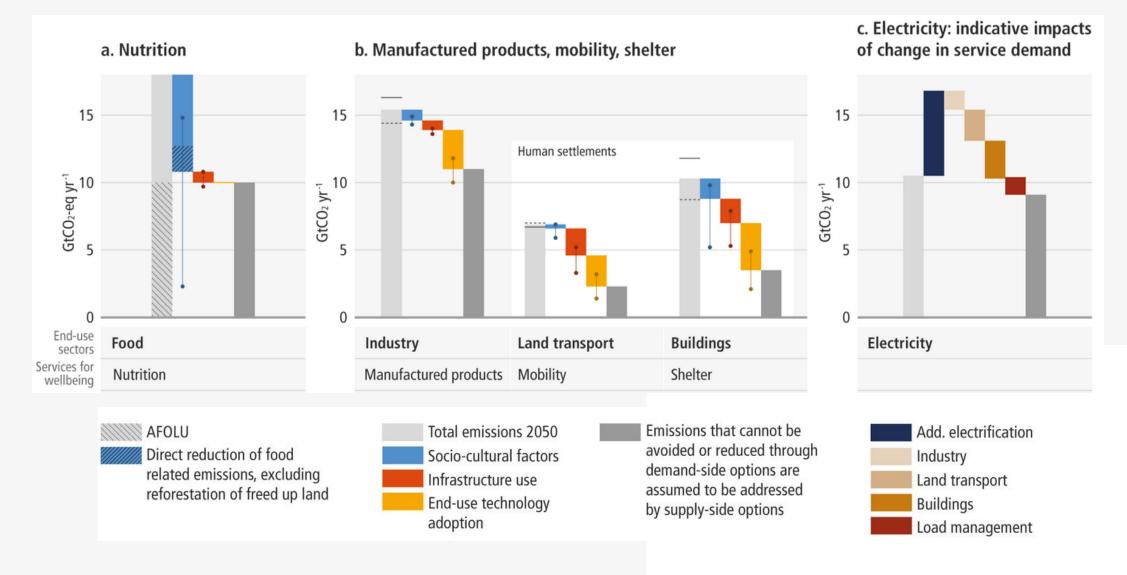


Many options available now in all sectors are estimate to offer substantial potential to reduce net emissions by 2030 : Industry





Demand side mitigation can be achieved by changes in socio-cultural factors, infrastructure design and use, and end use technology adoption by 2050





Carbon Dioxide Removal

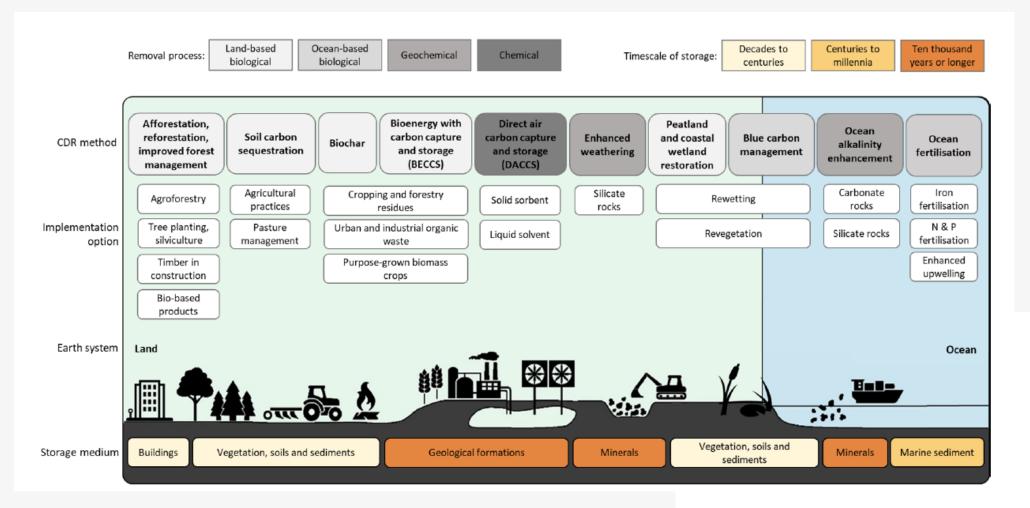
- required to counterbalance hard-to-eliminate emissions
- through **biological** methods: reforestation, and soil carbon sequestration
- new technologies require more research, up-front investment, and proof of concept at larger scales
- essential to achieve net zero
- agreed methods for measuring, reporting and verification required

[Forest Service Northern Region CC BY 2.0, Fiston Wasanga/CIFOR CC BY-NC-ND 2.0, Climeworks]





Carbon Dioxide Removal (CDR): Taxonomy of Methods



Mitigation options have many synergies with the Sustainable Development Goals, but some options can also have tradeoffs.

The synergies and trade-offs vary dependent on context and scale

	Sectoral and system mitigation options	1	2	3	4	5	ain. 6	7	8	9	10	11	12	-	15	.16	17
÷,	Wind energy							-	-						-		
	Solar energy		ä					-		100		2	-	-	i		
tem	Bioenergy			i			-	ā				ñ			_		
sks	Hydropower	-	ā						-	-		-	-	_	i		
rgy	Geothermal energy	10	-				_							-	-		
Energy systems	Nuclear power	-		ī					-	ī		-		-			
	Carbon capture and storage (CCS)			•				-	•	•				-	1		
5	Carbon sequestration in agriculture ¹	+	٠				٠		٠						+	•	É.
5	Reduce CH ₄ and N ₂ O emission in agriculture		12	+						13			+	+	+		
B	Reduced conversion of forests and other ecosystems?	•	E	+			٠		•			٠		+	+		
Use	Ecosystem restoration, reforestation, afforestation		•	٠							12	+					
Other Land Use (AFOLU)	Improved sustainable forest management	+						٠	•	٠		•			+		
rte	Reduce food loss and food waste	+	+	+			+	+			12	12	+	-	+		
othe	Shift to balanced, sustainable healthy diets		13	+			+	+			12	11	+	+	+		
	. Renewables supply ¹	٠	Ŀ	•			•	•	٠	٠				•	•		
2	Urban land use and spatial planning	+		٠		٠	•	+	+	٠		+	•			٠	
Urban systems	Electrification of the urban energy system	+	•	+	+	+	٠	+	+	+	٠	+	٠	+	٠	+	
sys	District heating and cooling networks	+		+				+	+	+		+	+		+	+	l –
Dan	Urban green and blue infrastructure	+	٠	٠	٠		٠	•	٠	+	٠	+	+	+	+	٠	
5	Waste prevention, minimization and management Integrating sectors, strategies and innovations	-		•	H		•		•	•		+	•		•	-	
	Demand-side management				-		_	_	_				5				
	Highly energy efficient building envelope		-	ï	-		2				7		-			-	
	Efficient heating, ventilation and air conditioning (HVAC)		-		-		2			-	-		-			-	
Buildings	Efficient appliances		-	ā	-	-	2						-		-		
	Building design and performance		-		-	-	2			E			-		-	-	
B	On-site and nearby production and use of renewables		ā		-	-	÷.				-		a		-		
	Change in construction methods and circular economy		-	ā	-	-	-	-	ā	-	-		-		-	-	
	Change in construction materials						-		_	_					=		•
1	Fuel efficiency – light duty vehicle	+						-									
	Electric light duty vehicles	-		•				•	-			+					
	Shift to public transport	+		٠	H	+		+				-	+				
t	Shift to bikes, ebikes and non motorized transport	+									100				13		
Ispo	Fuel efficiency – heavy duty vehicle			•	-	-		ā	_	-	-	-	-		-		
Transport	Fuel shift (including electricity) – heavy duty vehicle							_	-						-		
51	Shipping efficiency, logistics optimization, new fuels			-				-	-	-			-				
	Aviation – energy efficiency, new fuels							a	ĩ	100							
	Biofuels			•				_	ī	1.000		•			•		
12	Energy efficiency																
2	Material efficiency and demand reduction						13	_	-	_							
Industry	Circular material flows			•						-		•			13		
Ind	Electrification	+				+	-		H			-	-	1		-	
	CCS and carbon capture and utilisation (CCU)		-			_	-		_	-		+			_		



Mitigation options and the SDGs: Energy

Sectoral and system mitigation options

Wind energy
Solar energy
Bioenergy
Hydropower
Geothermal energy
Nuclear power
Carlson and standard (CCC)

Relation with Sustainable Development Goals



- Carbon capture and storage (CCS)
 - Type of relations:
 - + Synergies
 - Trade-offs

Both synergies and trade-offs⁴ Blanks represent no assessment⁵

- Confidence level:
- High confidence
- Medium confidence
- Low confidence

Related Sustainable Development Goals:

- 1 No poverty
- 2 Zero hunger
- 3 Good health and wellbeing
- 4 Quality education
- 5 Gender equality
- 6 Clean water and sanitation
- 7 Affordable and clean energy
- 8 Decent work and economic growth
- O Induction continue and infraction of

- 10 Reduced inequalities
- 11 Sustainable cities and communities
- 12 Responsible consumption and production
- 13 Climate action
- 14 Life below water
- 15 Life on land
- 16 Peace, justice and strong institutions
- 17 Partnership for the goals



Mitigation options and the SDGs: AFOLU

Sectoral and system mitigation options

Agriculture, Forestry and Other Land Use (AFOLU) Carbon sequestration in agriculture¹ Reduce CH₄ and N₂O emission in agriculture Reduced conversion of forests and other ecosystems² Ecosystem restoration, reforestation, afforestation Improved sustainable forest management Reduce food loss and food waste Shift to balanced, sustainable healthy diets Renewables supply³



Type of relations:

- + Synergies
- Trade-offs

Both synergies and trade-offs⁴
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Mitigation options and the SDGs: Urban Systems

Sectoral and system mitigation options

Urban land use and spatial planning Electrification of the urban energy system District heating and cooling networks Urban green and blue infrastructure Waste prevention, minimization and management Integrating sectors, strategies and innovations

Relation with Sustainable Development Goals 15 16 17 12 14 +

- Type of relations:
- + Synergies
- Trade-offs
- Both synergies and trade-offs⁴ Blanks represent no assessment⁵
- Confidence level:
- High confidence
- Medium confidence
- Low confidence

- **Related Sustainable Development Goals:**
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Urban systems

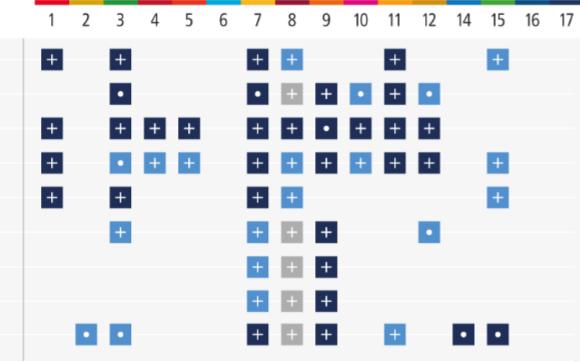


Mitigation options and the SDGs: Transport

Sectoral and system mitigation options

- Fuel efficiency light duty vehicle
- Electric light duty vehicles
- Shift to public transport
- Shift to bikes, ebikes and non motorized transport Fuel efficiency – heavy duty vehicle
- Fuel shift (including electricity) heavy duty vehicle Shipping efficiency, logistics optimization, new fuels Aviation – energy efficiency, new fuels Biofuels

Relation with Sustainable Development Goals



- Type of relations:
- + Synergies
- Trade-offs
- Both synergies and trade-offs⁴
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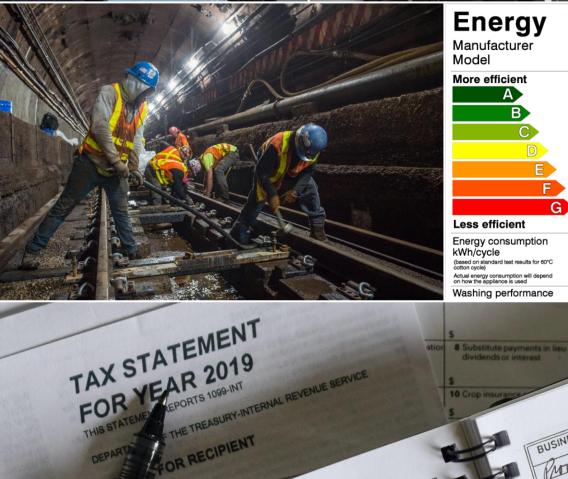
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Transport



We have the policy tools





Washing machine Policy packages and economy-wide packages are able to achieve systemic change

1.75

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Policies, regulatory and

ambitious and effective mitigation requires **coordination across government** and society

An increasing range of policies and laws have enhanced energy efficiency, reduced rates of deforestation and accelerated the deployment of renewable energy.

[World Bank/Simone D. McCourtie, Dominic Chavez CC BY-NC-ND 2.0, Trent Reeves/MTA Construction & Development CC BY 2.0, IMF Photo/Tamara Merino CC BY-NC-ND 2.0, Olga Delawrence/Unsplash.]

Technology and Innovation

- investment and policies push forward low emissions technological innovation
- effective decision making requires assessing potential benefits, barriers and risks
- some options are technically viable, rapidly becoming cost-effective, and have relatively high public support. Other options face barriers

Adoption of low-emission technologies is slower in most developing countries, particularly the least developed ones.



Closing investment gaps

- financial flows: 3-6x lower than levels needed by 2030 to limit warming to below 1.5°C or 2°C
- there is sufficient global capital and liquidity to close investment gaps
- challenge of closing gaps is widest for developing countries

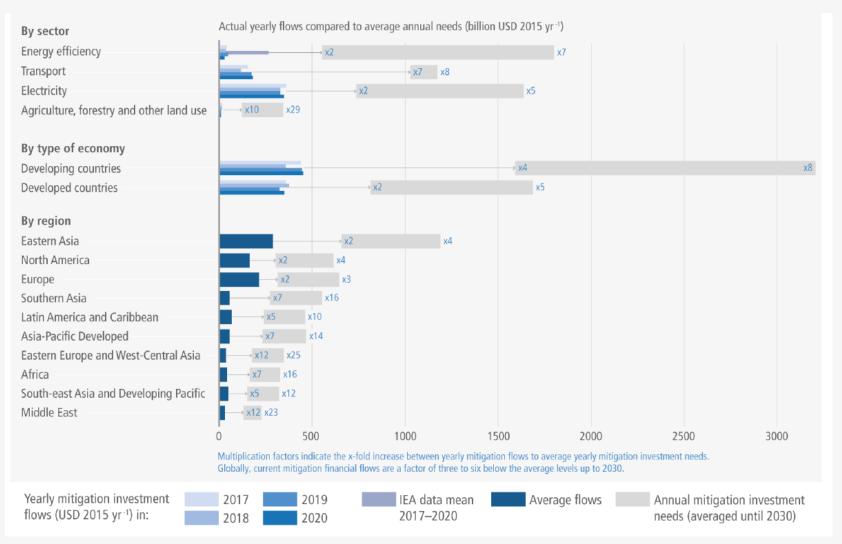








Mitigation investment flows fall short of investment needs across all sectors and types of economy, particularly in developing countries

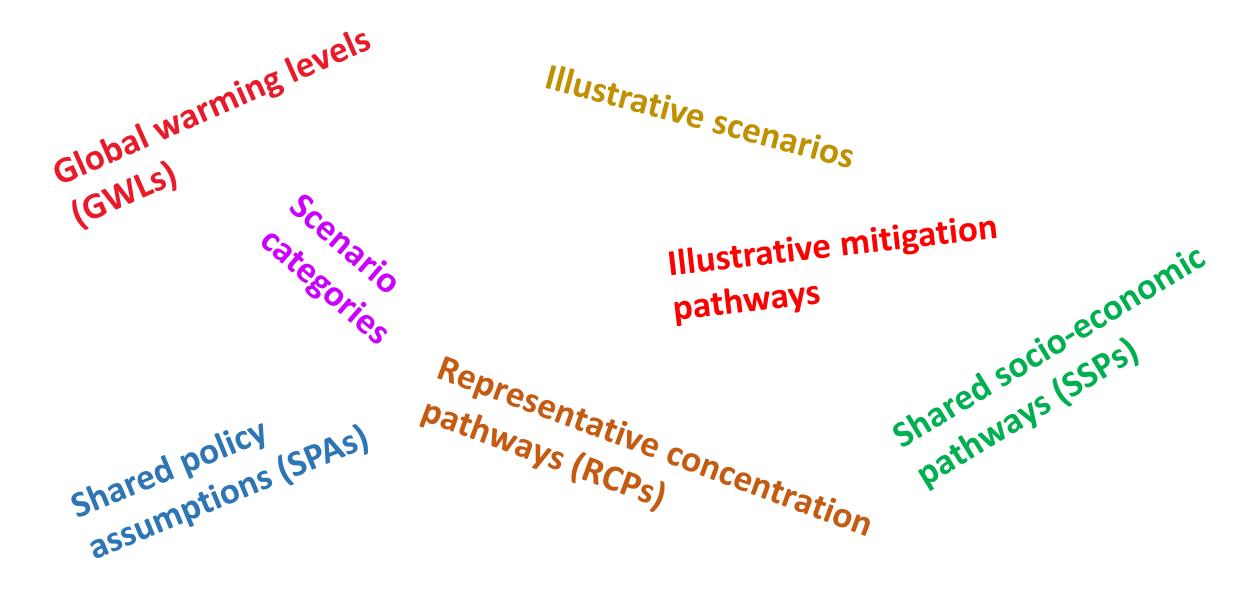


Note: from Technical Summary

New Scientific Challenges

- Scenarios
- Inventories, sources and sinks, and mitigation
- Adaptation and mitigation
- The impacts of the implementation of response measures
- Engaging with social science
- Coherent science and assessment

Scenarios (or is it pathways?)



Scenarios (2)

- Lack of attention to pathways that are off the "middle of the road" (97% of <u>new</u> scenarios in the AR6 database are based on SSP2)
- Lack of valuation of co-benefits in models
- More policy-relevant transparency about key assumptions
- More explicit attention to "who pays" to complement "what actions are taken where"
- Do Integrated Assessment Models have all the answers?

AR6 Scenario Explorer: secondary research opportunities

https://data.ene.iiasa.ac.at/ar6/

Inventories, sources and sinks, mitigation

- Not just three WGs Task Force on National Greenhouse Gas Emission Inventories (TFI)
- 5.5 Gigatonne gap between CO₂-LULUCF in UNFCCC inventories and dynamic global vegetation models (DVGMs)
- Uncertainty ranges
 - CO₂-LULUCF +/- 70%
 - CH₄ +/- 30%
 - N₂O +/- 60%
- TFI Expert Meeting on use of atmospheric observation data in emission inventories (September 2022)

Adaptation and mitigation

• Areas where there are no adaptation and mitigation responses, only responses with adaptation and mitigation (and other) outcomes:

• Settlements

• Land use

The impacts of the implementation of response measures

• The work of the UNFCCC Katowice Committee of Experts

• Just Transition and Climate Justice

IPCC and the social sciences

- IPCC wants social science more than social scientists like IPCC
- Lack of alignment between IPCC activities and career structures

Mechanisms for coherent science and assessment

- Common glossaries (Note UNEP-led Ad-Hoc Global Assessment Dialogue process)
- Cross-Working Group Boxes and other activities
- Cross-chapter (cross-WG activities)
- Changed IPCC structure?

The evidence is clear:

The time for action is now

INTERGOVERNMENTAL PANEL ON CLIMATE CHARGE

Climate Change 2022 Mitigation of Climate Change





Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change



[Matt Bridgestock, Director and Architect at John Gilbert Architects]