Sixth Assessment Report

WORKING GROUP III – MITIGATION OF CLIMATE CHANGE

ipcc

INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Climate Change 2022

Mitigation of Climate Change

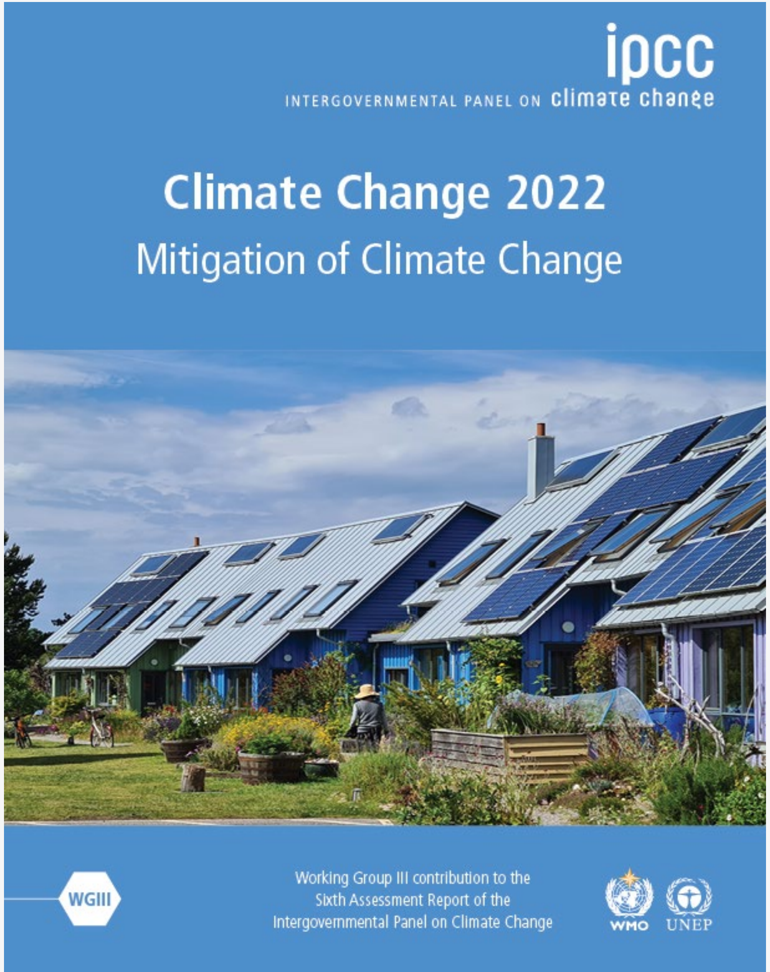
[Matt Bridgestock, Director and Architect at John Gilbert Architects]

3+ *years later …..*

17 Chapters,
c. 2000pp

Technical Summary
142pp

Summary for Policymakers,
63pp



Presentation to REKK, 27 April 22

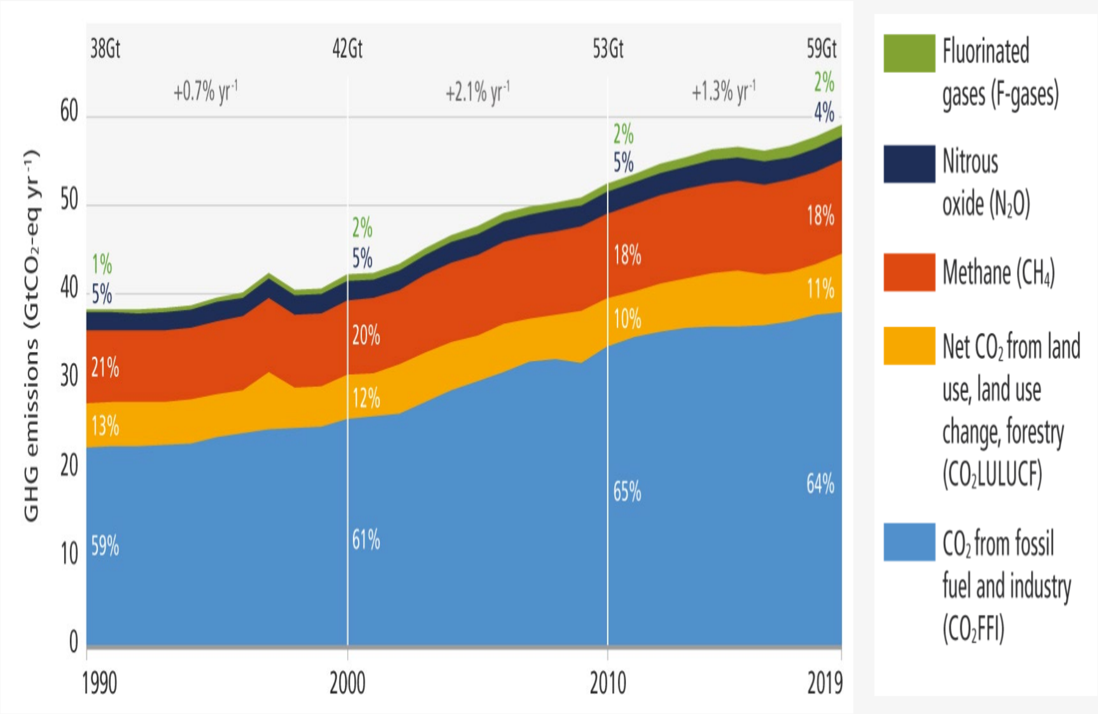
Michael Grubb,
Professor of Energy & Climate Change, UCL

Convening Author Chapter 1

- "Introduction and Frameworks"
- Signs of Progress
- Challenges, Economics and Options

Even the most scientific numbers are not Neutral, even between scientists

We are not on track to limit warming to 1.5 °C.



2010-2019:

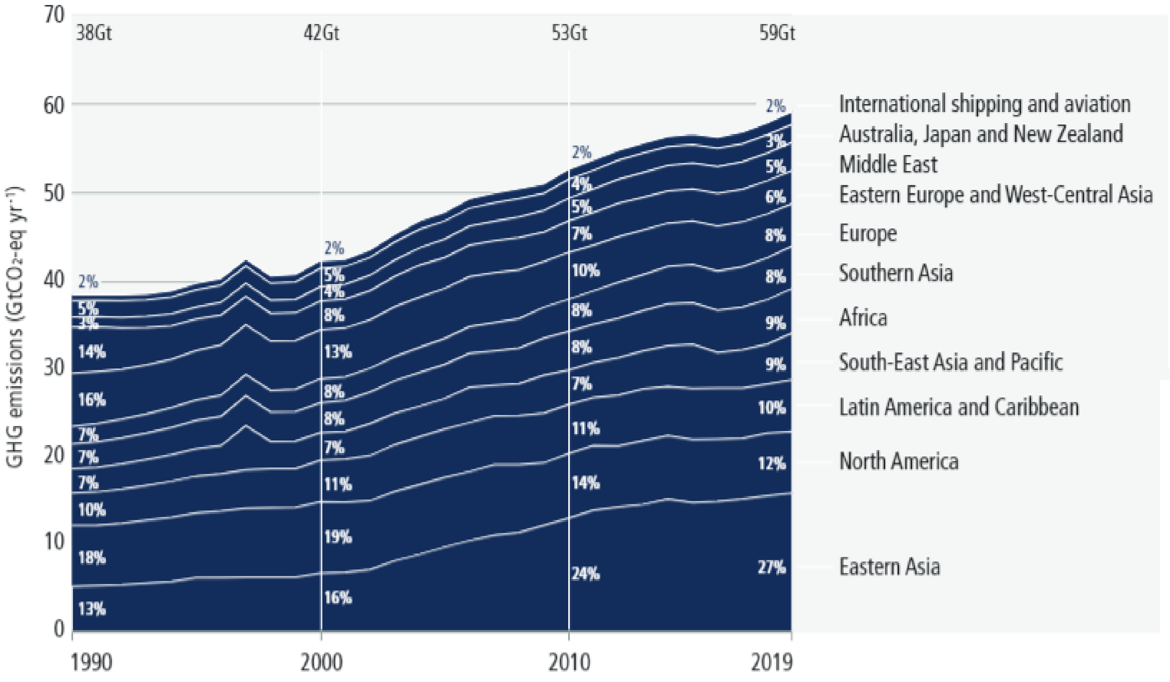
- Average annual greenhouse gas emissions at highest levels in human history
- Increase from previous decade largest ever seen
- Average annual rate of growth during decade, slowed from 2.1%/yr to 1.3%/yr (+sectoral info)
- Average growth since 2014 (for all GHGs) around 0.8%% yr-1*
- Global per-capita emissions since 2014 unchanged

Gases compared @ 100-year GWP
* Chapter 1, p. line 6-7 & Figure 1.1

To describe contributions by sector is complex,* by region *inevitably* involves 'political' choices

Emissions have grown in most regions but are distributed unevenly, both in the present day and cumulatively since 1850.

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

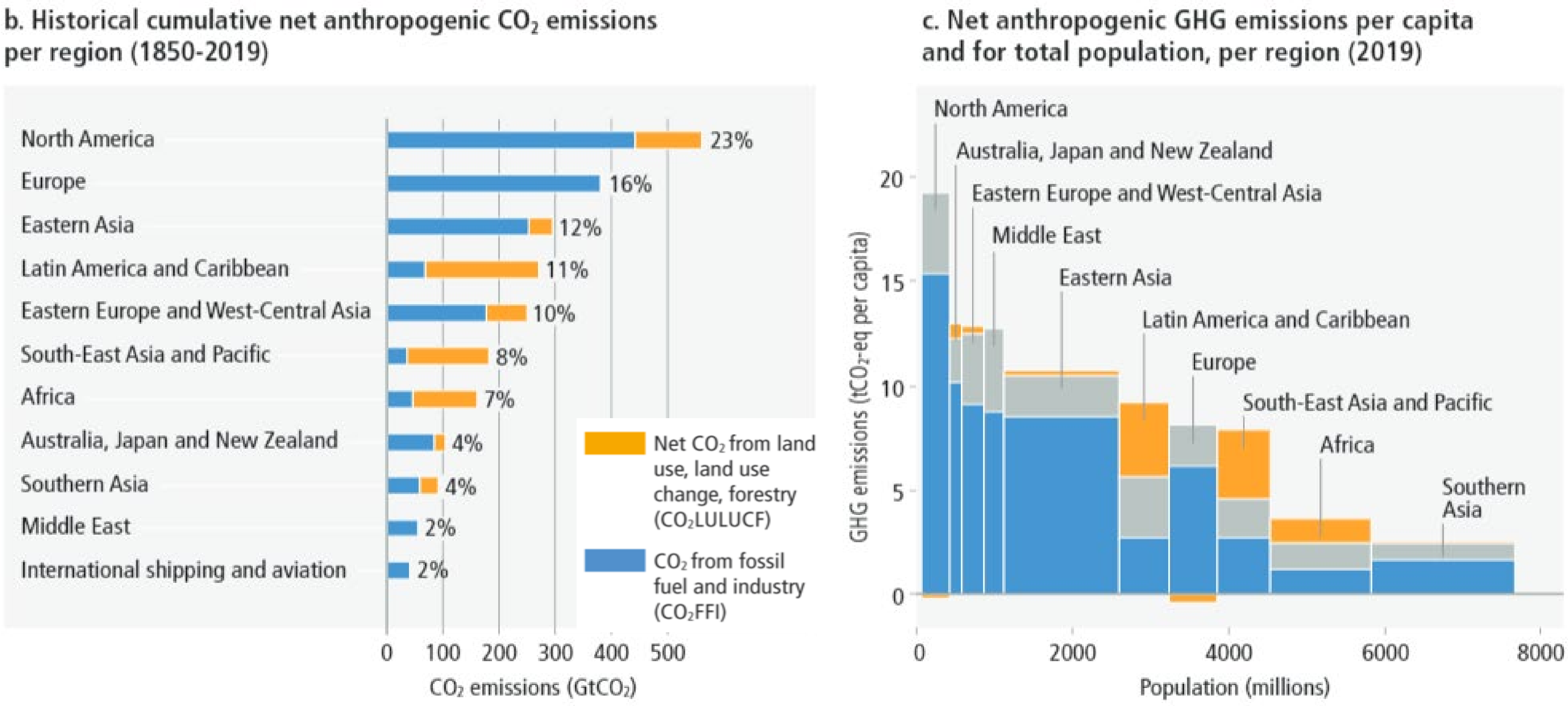


- Sectoral complexity – electricity attribution, LULUCF uncertainties, Urban systems, and more … see SPM sectoral sections, Figure TS.6

Regional emissions:

- % or absolute contributions
- Growth by region?
- Trends & contributions since … when?

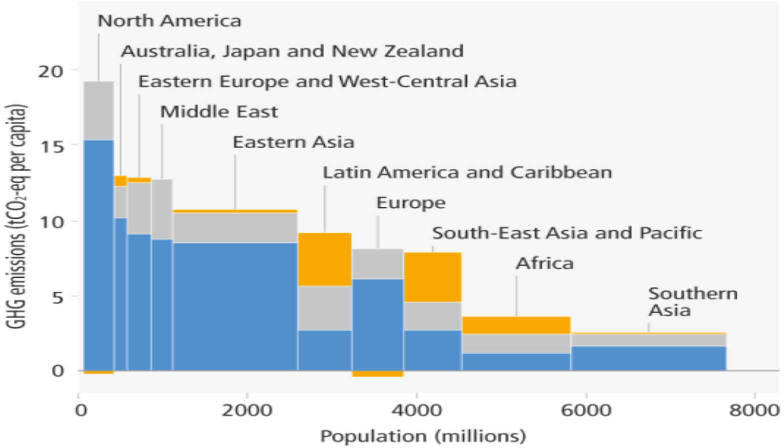
… What about cumulative contributions, data uncertainties, and different indices ..?



* Figure SPM.2. With table of specific indices, including intensity, and consumption-based accounting data

Variations in regional, and national per capita emissions partly reflect different development stages, but also vary widely at similar income levels

- variations are large within the 'developed' countries, and within rest-of-world
- Emissions in Latin / Central America, SE Asia and Africa still dominated by non-fossil fuel GHGs
- Consumption-based ('footprint') accounting underlines inequalities and role of high consumption
- 10% of households with highest per capita emissions contribute 34-45% of global household GHGs



d. Regional indicators (2019) and regional production vs consumption accounting (2018)

	Africa	Australia, Japan, New Zealand	Eastern Asia	Eastern Europe, West-Central Asia	Europe	Latin America and Caribbean	Middle East	North America	South-East Asia and Pacific	Southern Asia
Population (million persons, 2019)	1292	157	1471	291	620	646	252	366	674	1836
GDP per capita ($USD1000_{ppp}2017$ per person)[1]	5.0	43	17	20	43	15	20	61	12	6.2
Net GHG 2019[2] (production basis)										
% GHG contributions	9%	3%	27%	6%	8%	10%	5%	12%	9%	8%
GHG emissions intensity (tCO_2-eq / $USD1000_{ppp}$ 2017)	0.78	0.30	0.62	0.64	0.18	0.61	0.64	0.31	0.65	0.42
GHG per capita (tCO_2-eq per person)	3.9	13	11	13	7.8	9.2	13	19	7.9	2.6
CO_2FFI, 2018, per person										
Production-based emissions (tCO_2FFI per person, based on 2018 data)	1.2	10	8.4	9.2	6.5	2.8	8.7	16	2.6	1.6
Consumption-based emissions (tCO_2FFI per person, based on 2018 data)	0.84	11	6.7	6.2	7.8	2.8	7.6	17	2.5	1.5

Analytic approaches – a broad landscape

Some characterisations

“The biggest market failure in history”
(Nicolas Stern, 2005)

“The perfect moral storm”
(Steve Gardiner, 2011)

A “Super-Wicked” problem
(Lazarus, 2009; Kelly Levin et al, 2012)

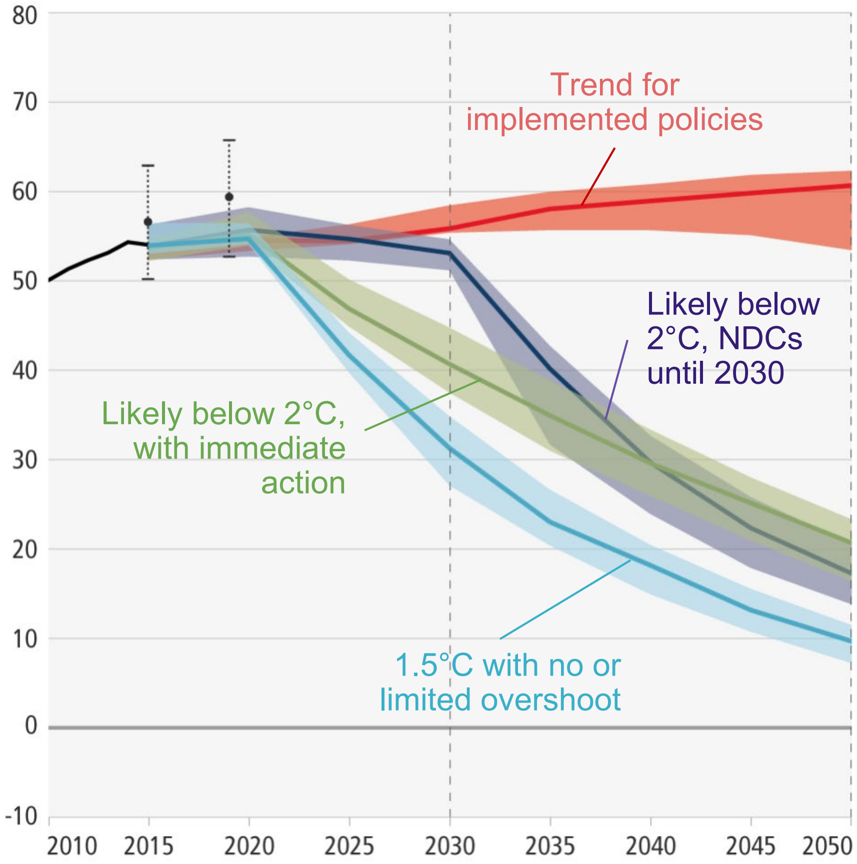
“’Psychological distance’ - our brains are hard wired to ignore climate change”
(Marshall, 2014; also Weber 2018, 2020; Spence et al 2012)

Four Analytic Frameworks

- Aggregate Efficiency
- Ethics and Equity
- Innovation & transition dynamics
- Psychology and politics

Cited and outlined in IPCC Mitigation Report Chapter 1 Section 7, “Four Analytic Frameworks …

"Unless there are immediate and deep emissions reductions across all sectors, 1.5°C is beyond reach.



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)

Close linkages between climate change mitigation, adaptation and development pathways.

The development pathways taken by countries at all stages of economic development impact GHG emissions and hence shape mitigation challenges and opportunities, which vary across countries and regions. Literature explores how development choices and the establishment of enabling conditions for action and support, influence the feasibility and cost of limiting emissions {1, 3, 4, 5, 13, 15, 16}. Literature highlights that climate change mitigation action designed and conducted in the context of sustainable development, equity, and poverty eradication, and rooted in the development aspirations of the societies within which they take place, will be more acceptable, durable and effective {1, 3, 4, 5}. This report covers mitigation from both targeted measures, and from policies and governance with other primary objectives. [SPM, p.3]

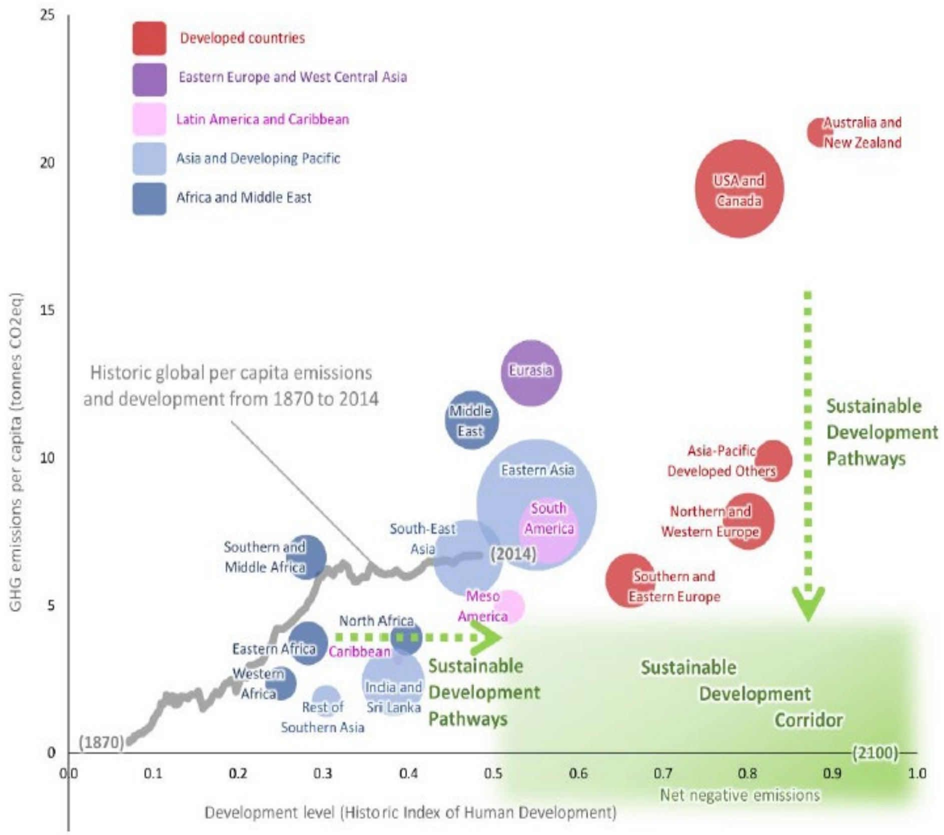


Figure TS.1: Sustainable development pathways towards fulfilling the Sustainable Development Goals

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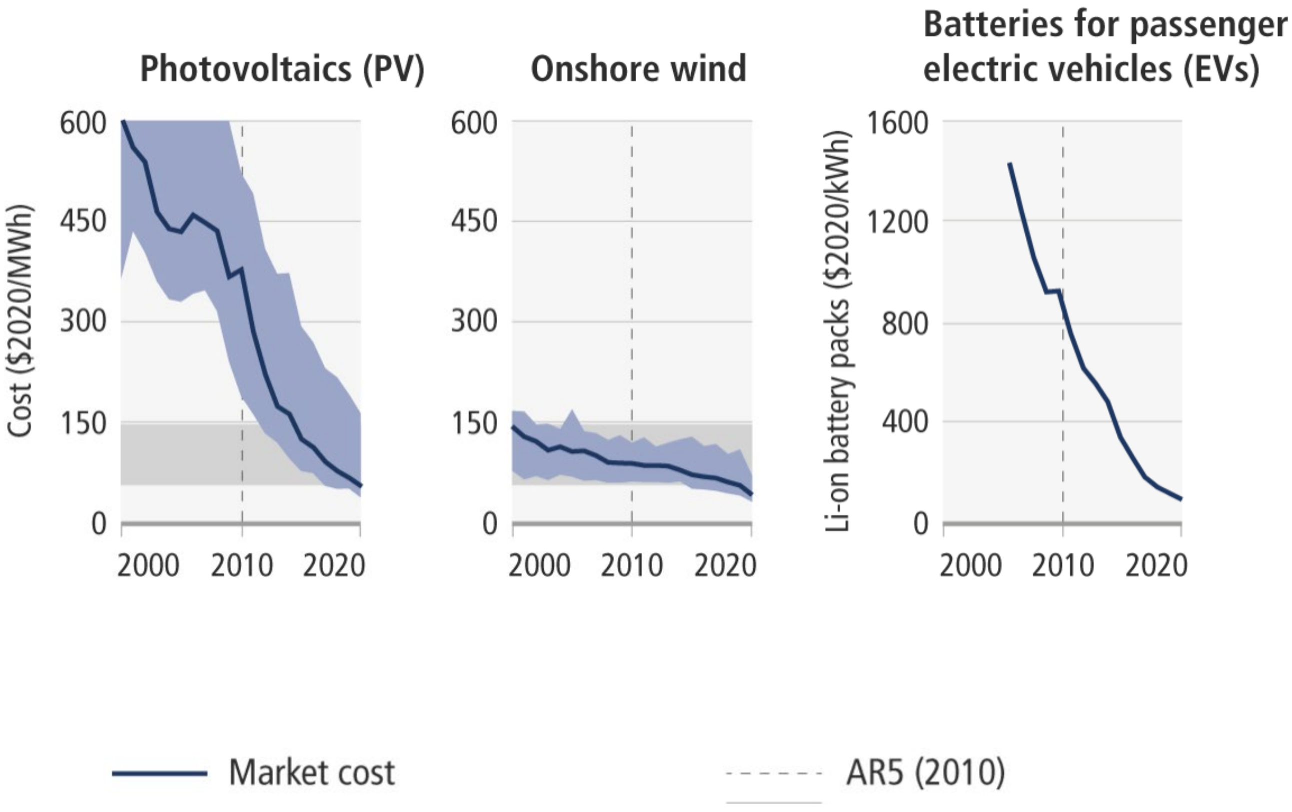
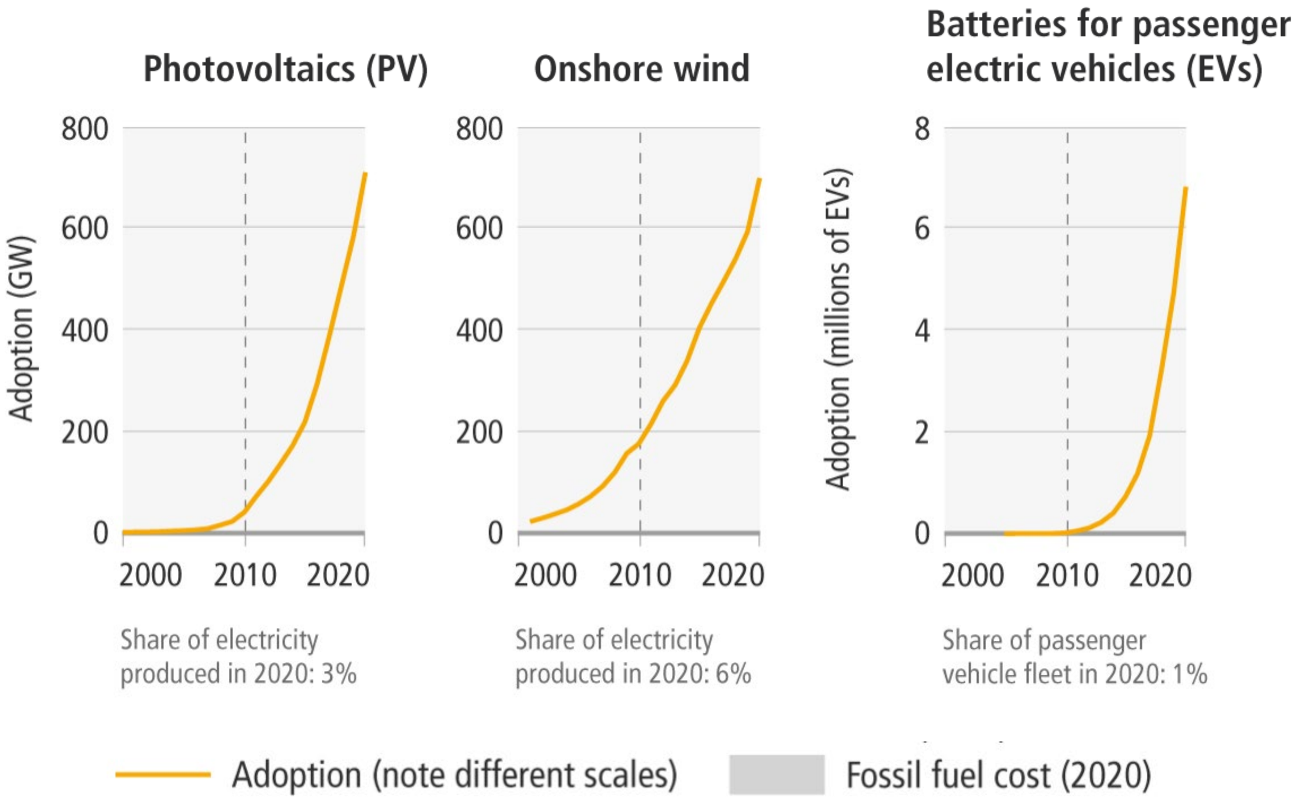
Signs of Progress?

[Charlie Chesvick/IStock.com]



In some cases, costs for renewables have fallen below those of fossil fuels.

Also see Technical Summary, and Chapters 2 and 6



Electricity systems in some countries and regions are already predominantly powered by renewables.

Also see Technical Summary, and Chapters 2 and 6

Policy trends and impacts

SPM B5.2 Policy Trends

- Over 20% of global GHG emissions covered by carbon taxes or emissions trading systems, although coverage and prices insufficient ..
- ‘Direct’ climate laws in 56 countries covering 53% of global
- Remain limited for emissions from agriculture and production of industrial materials and feedstocks
- Annual tracked total financial flows [heavily focused on mitigation] increased by up to 60% 2013/14 to 19/20)
    - are uneven, developed heterogeneously across regions and sectors, and average growth has slowed since 2018.

SPM B5.3 Policy Impacts

- In many countries, policies have enhanced energy efficiency, reduced rates of deforestation and accelerated tech deployment
- At least 18 countries have sustained production-based GHG and consumption-based CO2 emission reductions for longer than 10 years [most having Kyoto targets, exc EITs]
- Mitigation policies have led to avoided global emissions of several Gt CO2-eq/yr:
    - At least 1.8 Gt CO2-eq/yr accounted for by aggregating separate estimates for the effects of economic and regulatory instruments.
    - Growing numbers of laws and executive orders, were estimated to result in 5.9 Gt CO2-eq/yr less in 2016 than otherwise would have been.

Increased evidence of climate action

Some countries have achieved a **steady decrease** in emissions **consistent** with limiting warming to **2°C.**

Zero emissions targets have been adopted by at least **826 cities and 103 regions**

Glass half empty or half full?

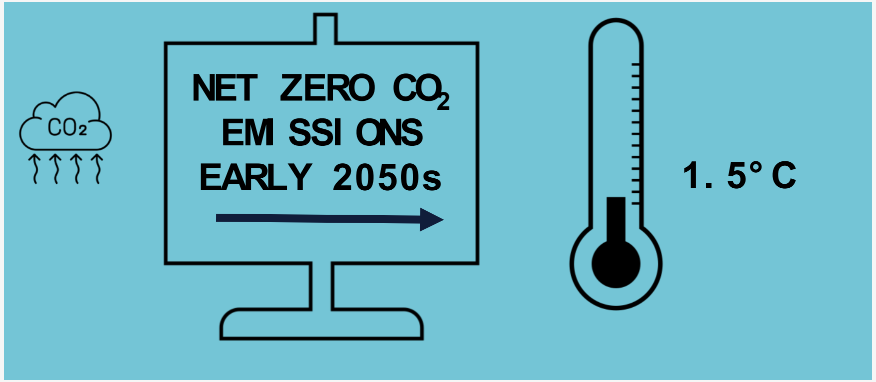
TS.1 Signs of Progress and Continuing Challenges

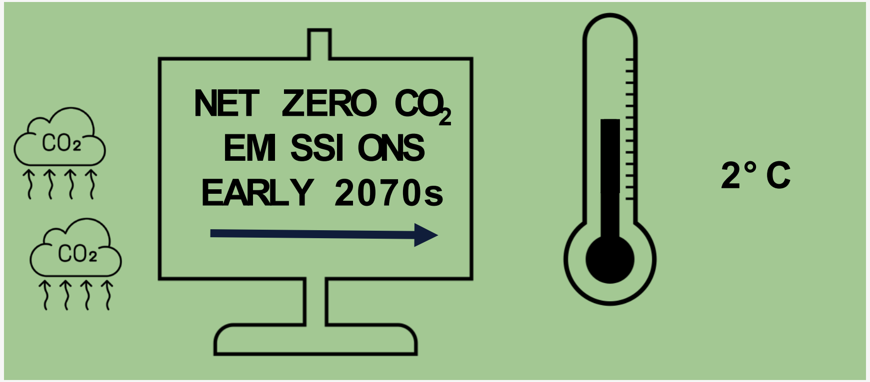
Table TS.1: Signs of Progress and Continuing Challenges

Signs of progress	Continuing challenges
Emissions trends	

- Emission Trends (3)
- Sectors (6)
- Policies and investment (4)

The temperature will stabilise when we reach net zero carbon dioxide emissions





(based on IPCC-assessed scenarios, indicating prompt and deep emission reduction scenarios to be the most cost-effective path towards the Paris temperature range)

'Stranded Assets' and carbon budgets

- **Projected cumulative future CO2 emissions over the lifetime of existing and currently planned fossil fuel infrastructure without additional abatement are approximately equal to total cumulative net CO2 emissions in pathways that limit warming to 2°C (>67%) [and exceed those in pathways for 1.5°C (>50%) with no or limited overshoot. (*high confidence*)**

B7.1 Historical operating patterns of existing infrastructure … without additional abatement

- future CO2, the majority in the power sector, amount to 660 [460–890] $GtCO_2$
- Or 850 [600–1100] $GtCO_2$ when unabated emissions from currently planned infrastructure in power sector included

Compares to 580 [460–890] $GtCO_2$ for 1.5 (>50%), and 890 [640–1160] for 2C(>67%)

B7.3 Most remaining fossil fuel CO2 emissions projected to occur *outside* power sector, mainly in industry and transport

- ***Alignment in power sector:*** Decommissioning and reduced utilisation of existing fossil fuel based power sector infrastructure, retrofitting existing installations with CCS switches to low carbon fuels, and cancellation of new coal installations without CCS are major options

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

See IPCC WGIII Official Launch Presentation for overview of Sector options; SPM also extensive info on modelled / illustrative pathways

Demand and services

Energy

Land use

Industry

Urban

Buildings

Transport

Accelerated climate action – cross-sectoral costs, actions, benefits?

[Duy Pham/Unsplash]

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.

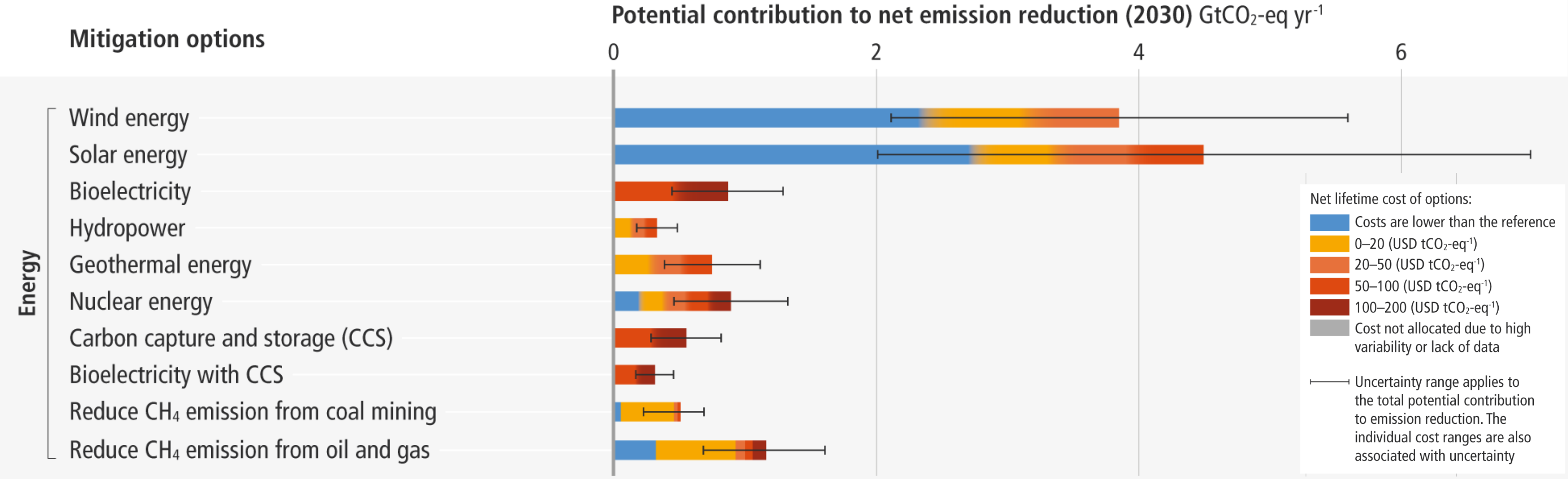


Figure SPM.7 (top panel, Energy)

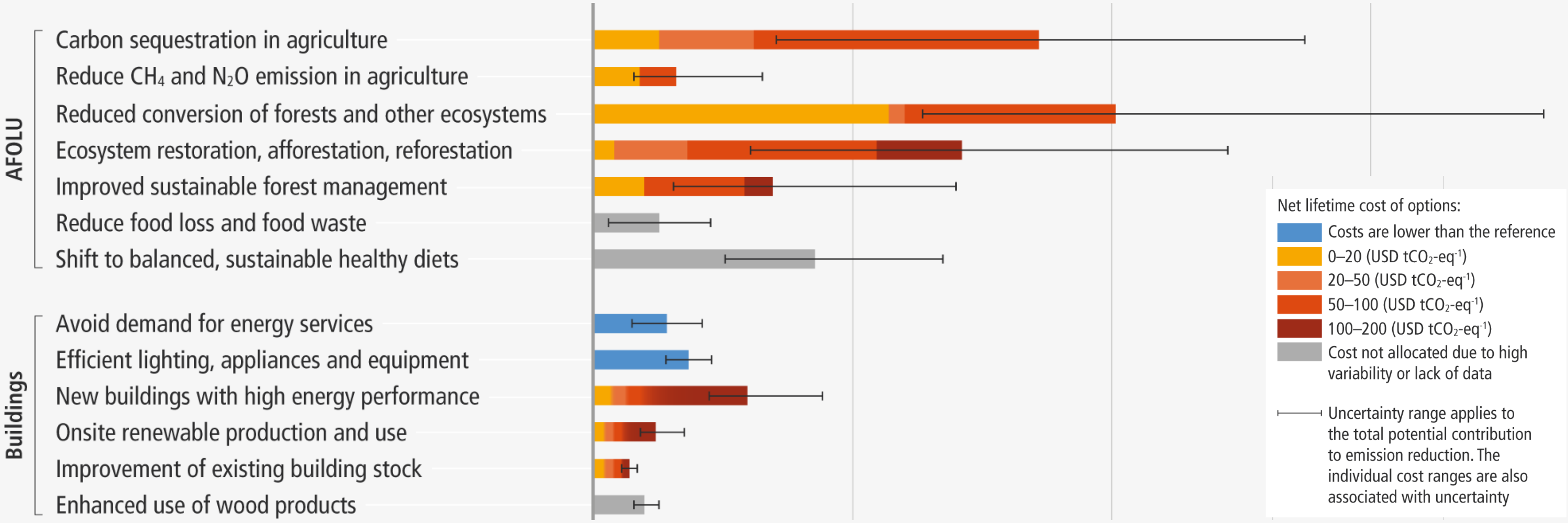


Figure SPM.7 (panels AFOLU, Buildings)

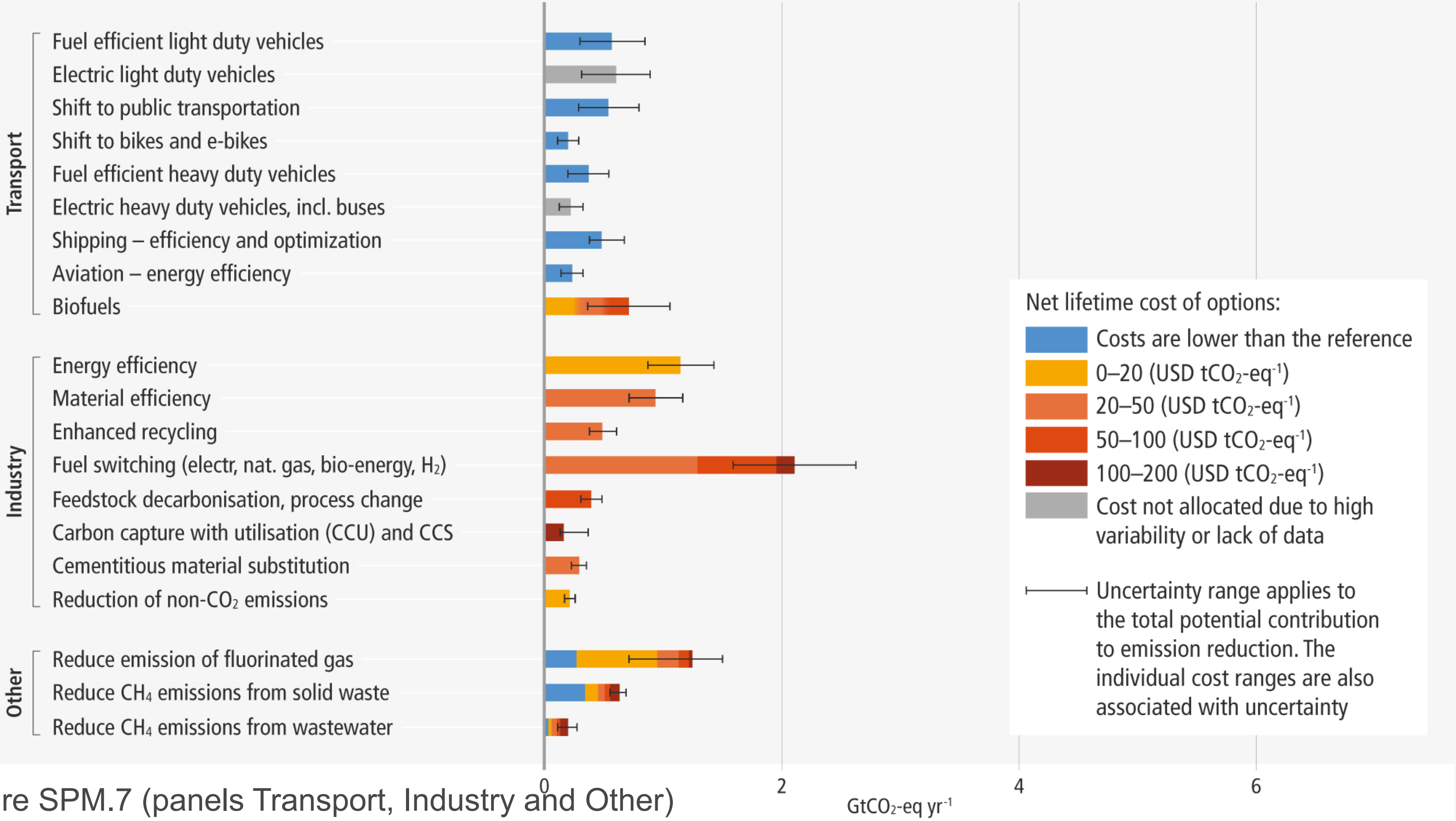


Figure SPM.7 (panels Transport, Industry and Other)

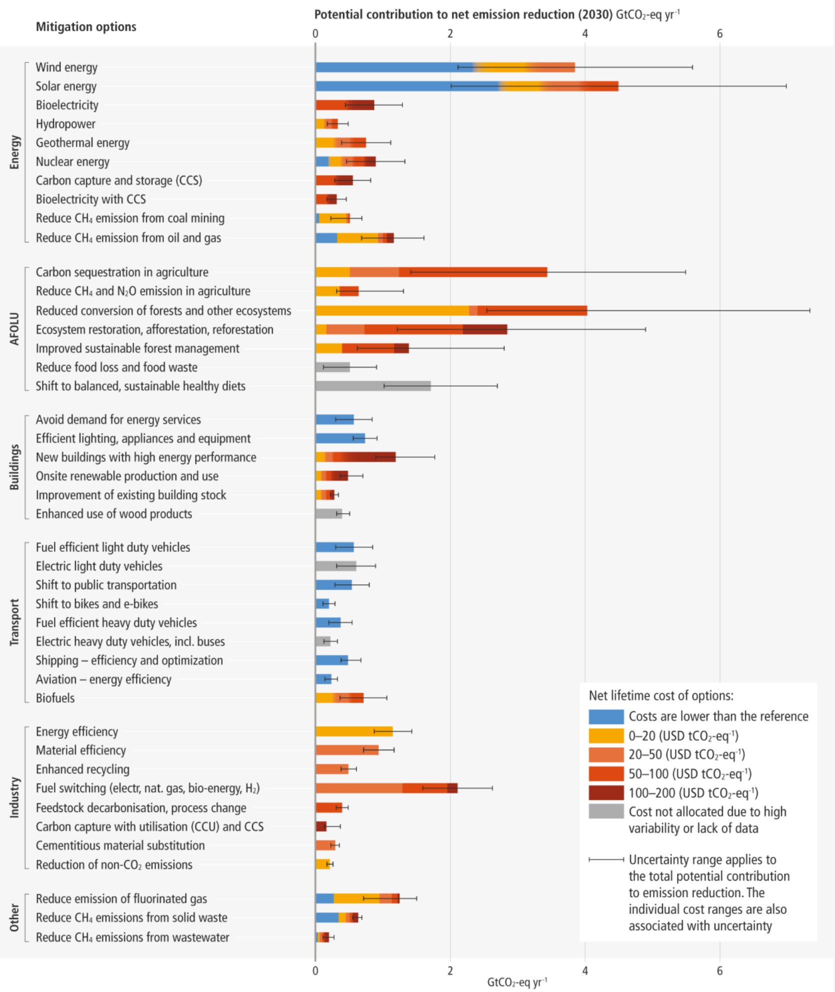
Costs and Potentials - overview

Figure SPM.7: Overview of mitigation options and their estimated ranges of costs ad potentials in 2030.

Mitigation options costing USD100 tCO2-eq-1 or less could reduce global GHG emissions by at least half the 2019 level by 2030

- (options costing less than USD20 tCO2-eq-1 are estimated to make up more than half of this potential)
- For a smaller part of potential, deployment leads to net cost
- Large contributions with costs less than USD20 from solar and wind energy, energy efficiency improvements, reduced conversion of natural ecosystems, and CH4 emissions reductions (coal mining, oil and gas, waste)
- The mitigation potentials and mitigation costs of individual technologies in a specific context or region may differ greatly from the provided estimates.

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.



Macroeconomics of mitigation
- the wider issues

"Philosophical"

Economic growth and human welfare

- 'Developing'/least-developed countries: where poverty, "basic needs" / other SDGs dominate, issue is alignment / synergies
- Rich countries (and individuals): GDP/income vs human welfare, "the good life", overconsumption – *what* exactly is 'further economic development'?

Intergenerational equity and legacy

Planetary risks – the paradox of growth, if growth risks destroying the ecological basis of human welfare and social stability

Anthropocentrism

See AR6, Chapters 1.6, 1.7, 3.6, 5

"Technical"

Discounting principles, rates, forms

- Unresolved debates between 'prescriptive' and 'descriptive' basis (semi-philosophical – the role governments in context of myopic markets/consumers)
- Plenty of econ literature makes case for 'hyperbolic' discounting: declining rates giving more weight to future

Perfect modeling in an imperfect world:

- The "optimal baseline" assumption, vs
- The "optimal policy" assumption

Economics of innovation and transition potentials

- Inevitable costs *vs*
- new growth paradigm: creative destruction. a necessary element to capture value of new innovation-led growth, and 'green recovery' (absent from most models)
- But, potentially big winners and losers

Global mitigation not constrained by macroeconomic costs, but does have structural macroecon consequences

Macroeconomic costs and benefits..

[prize for longest SPM para?]

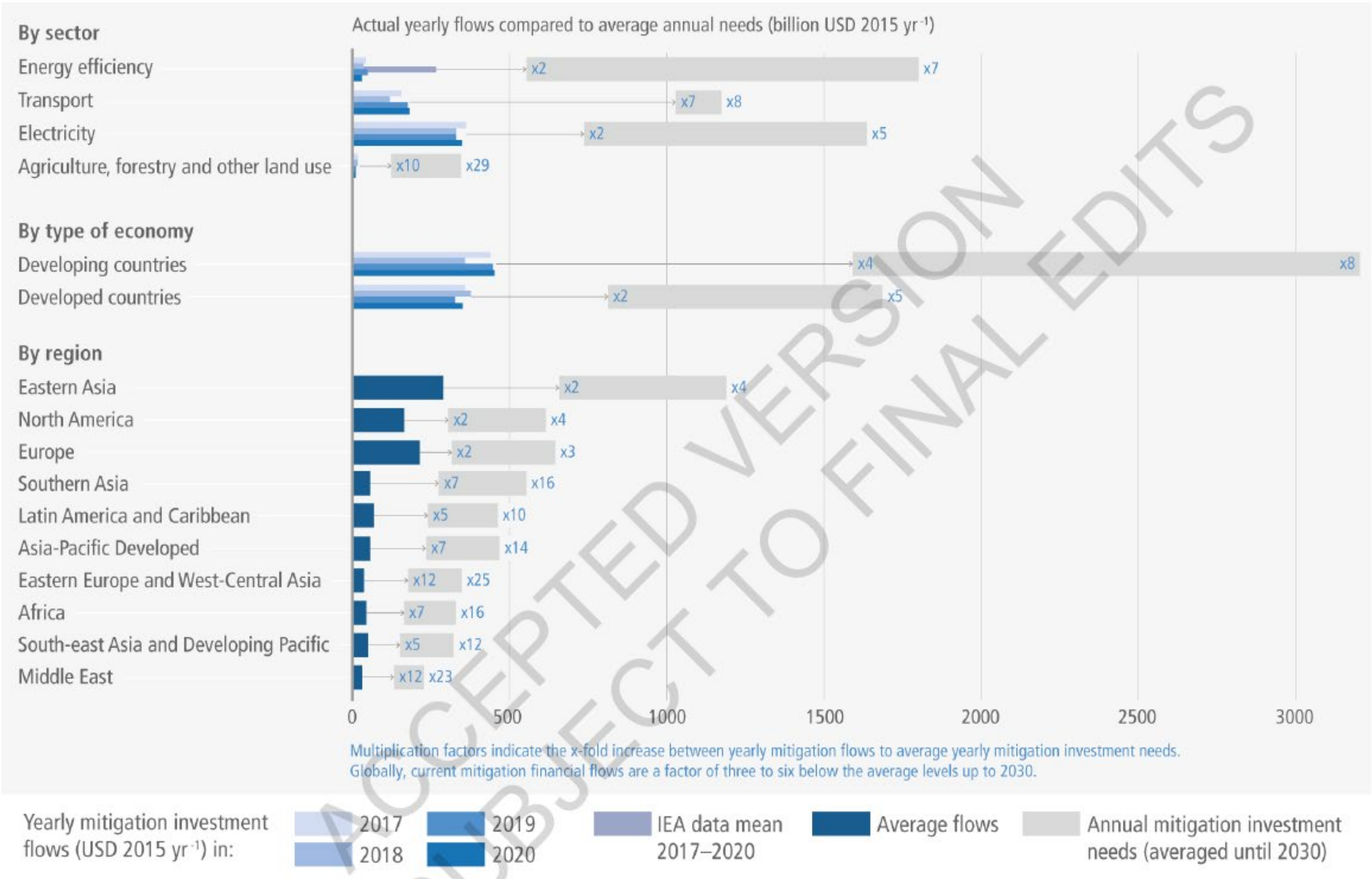
C.12.2 The aggregate effects of [CC] mitigation on global GDP are **small compared to global projected GDP growth in ..** assessed modelled global scenarios that quantify the macroeconomic implications of climate change mitigation, but that do not account for damages from climate change nor adaptation costs (*high confidence*). For example, compared to pathways that assume the continuation of policies implemented by the end of 2020, assessed global GDP reached in 2050 is reduced by 1.3–2.7% in modelled pathways assuming coordinated global action starting between now and 2025 at the latest to limit warming to 2°C (>67%). The corresponding **average reduction in annual global GDP growth over 2020-2050 is 0.04–0.09** percentage points. In assessed modelled pathways, regardless of the level of mitigation action, global GDP is projected to at least double (increase by at least 100%) over 2020-2050 … Country level studies also show large variations in the effect of mitigation on GDP depending notably on the level of mitigation and on the way it is achieved .. Macro- …

Estimates of aggregate economic benefits from avoiding damages from climate change, and from reduced adaptation costs, increase with the stringency of mitigation (*high confidence*). Models that incorporate the economic damages from climate change find that **the global cost of limiting warming to 2°C over the 21st century is lower than the global economic benefits of reducing warming, unless:** i) climate damages are towards the low end of the range; or, ii) future damages are discounted at high rates (*medium confidence*) [FOOTNOTE 69]. Modelled pathways with a peak in global emissions between now and 2025 at the latest, compared to modelled pathways with a later peak in global emissions, entail more rapid near-term transitions and higher up-front investments, but bring long-term gains for the economy, as well as earlier benefits of avoided climate change impacts (*high confidence*). The precise magnitude of these gains and benefits is difficult to quantify. {1.7, 3.6, Cross-Working Group Box 1 in Chapter 3 Box TS.7, WGII SPM B.4} ***[Presenters bolding]***

Closing investment gaps

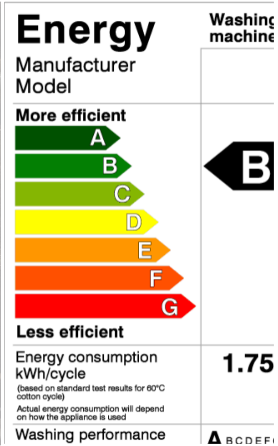
- financial flows: **3-6x lower** than levels needed **by 2030** to limit warming to below 1.5°C or 2°C
- there is **sufficient global capital** and liquidity to close investment gaps
- challenge of closing gaps is widest for developing countries

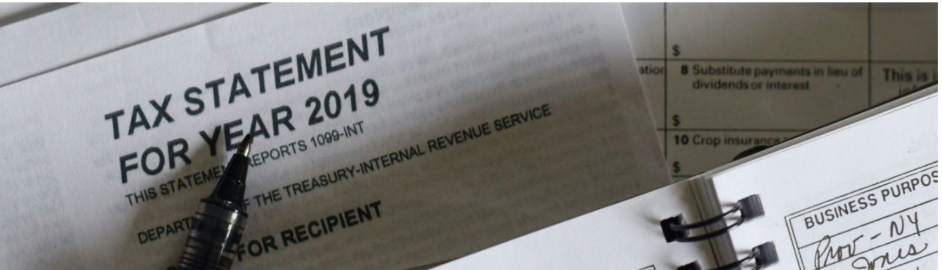
Finance needs to grow x 3-6 by 2030



IPCC AR6 Technical Summary,

Figure TS.25: *Mitigation investment flows fall short of investment needs across all sectors and types of economy, particularly in developing countries*





Policies, regulatory and economic instruments

- regulatory and economic instruments have **already proven effective** in reducing emissions
- **policy packages** and **economy-wide packages** are able to achieve **systemic change**
- ambitious and effective mitigation requires **coordination across government** and society

[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.

Accelerated climate action is critical to sustainable development

[Duy Pham/Unsplash]


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
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 PARTNERSHIPS FOR THE GOALS

Mitigation options in urban areas

Relation with Sustainable Development Goals

	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
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	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Mitigation options in agriculture and forestry

Relation with Sustainable Development Goals

	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17
Carbon sequestration in agriculture[1]	+	+	•			+		+				•	+	+	+	
Reduce CH_4 and N_2O emission in agriculture		•	+			•			•			+	+	+		
Reduced conversion of forests and other ecosystems[2]	•	–	+			+		•			•		+	+	•	•
Ecosystem restoration, reforestation, afforestation	+	•	+			•		–		•	+		+	+		
Improved sustainable forest management	+	•	+			+	•	+	+	•	•		+	+		
Reduce food loss and food waste	+	+	+			+	+			+	+	+	+	+	+	
Shift to balanced, sustainable healthy diets	•	+	+			+	+		•	+	+	+	+	+		
Renewables supply[3]	•	•	•			•	•	+	+				•	•		

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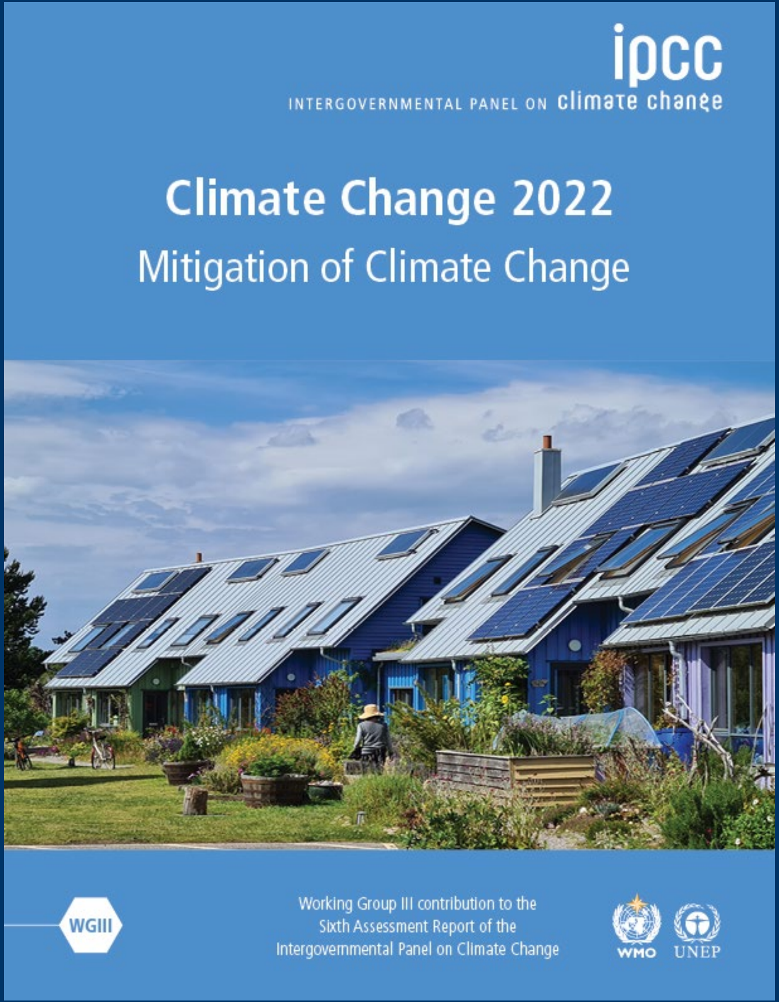
“The evidence is clear: The time for action is now



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