# Mitigating Climate Change: the IPCC 6th Assessment

*Glass half empty, half full, or half broken?*

**PRESENTATION TO INDIA INTERNATIONAL CENTRE, DELHI**

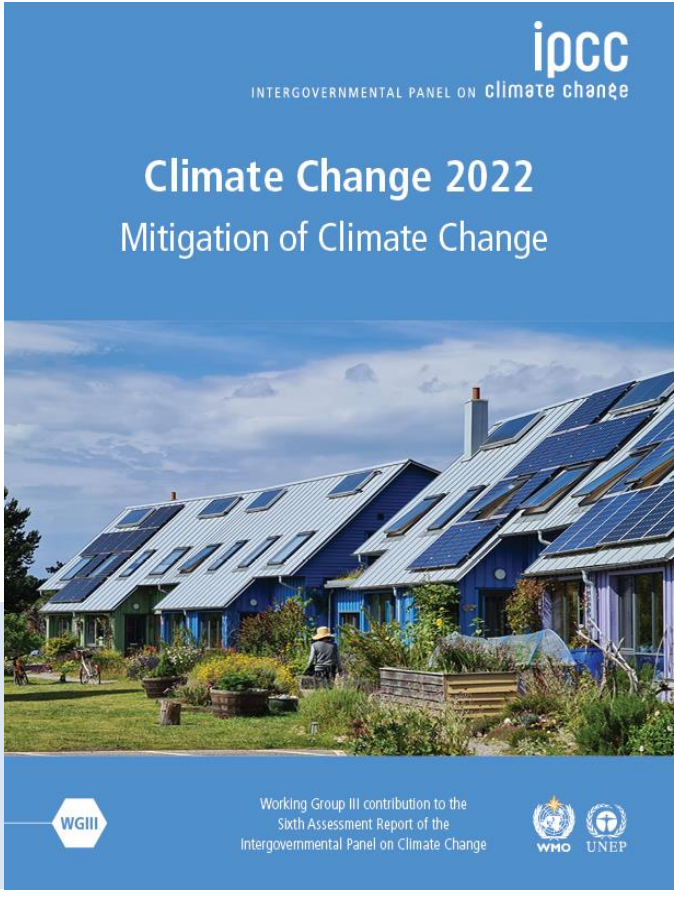
6 December 2022


Michael Grubb, Professor of Energy and Climate Change, UCL

Convening Lead Author, IPCC Sixth Assessment Report – Mitigation

Former Chief Economist, the UK Carbon Trust and

Chair, UK Panel of Technical Experts on Electricity Market Reform

**Sixth Assessment Report**
WORKING GROUP III – MITIGATION OF CLIMATE CHANGE

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INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

## Climate Change 2022

# Mitigation of Climate Change

## Report by numbers

278 Authors

65 Countries

41 % Developing countries
59 % Developed countries

354 Contributing authors

29 % Women / 71 % Men

More than 18,000 scientific papers

59,212 Review comments

# 3+ years later …..

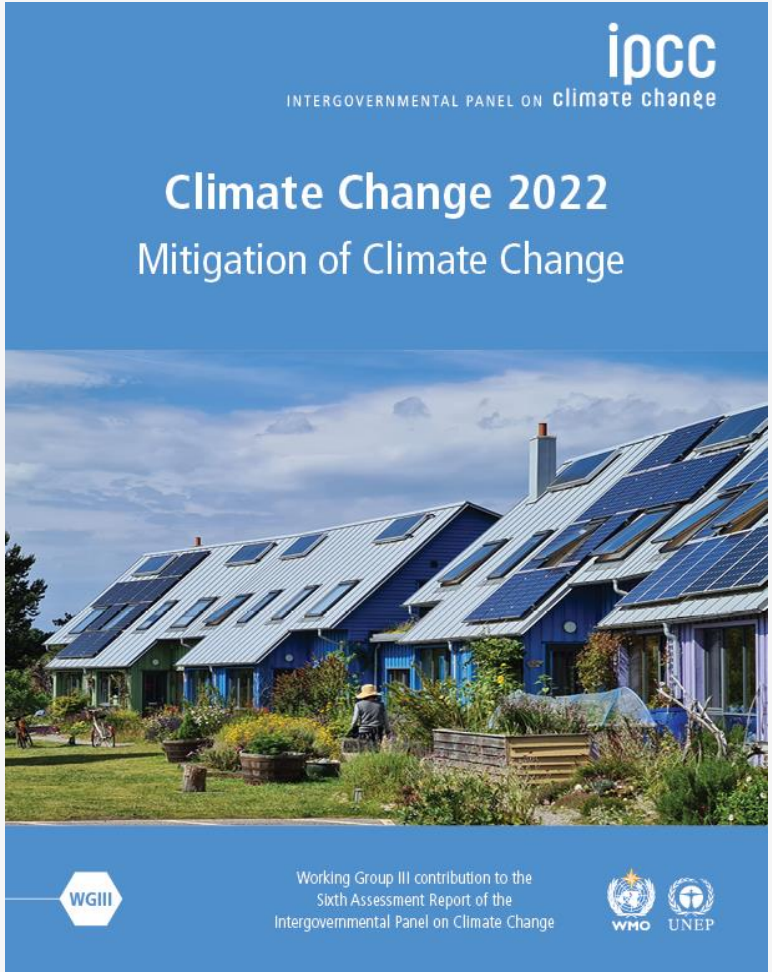
**Global Research**

meets

**Global Review**

with

**National Perspectives**



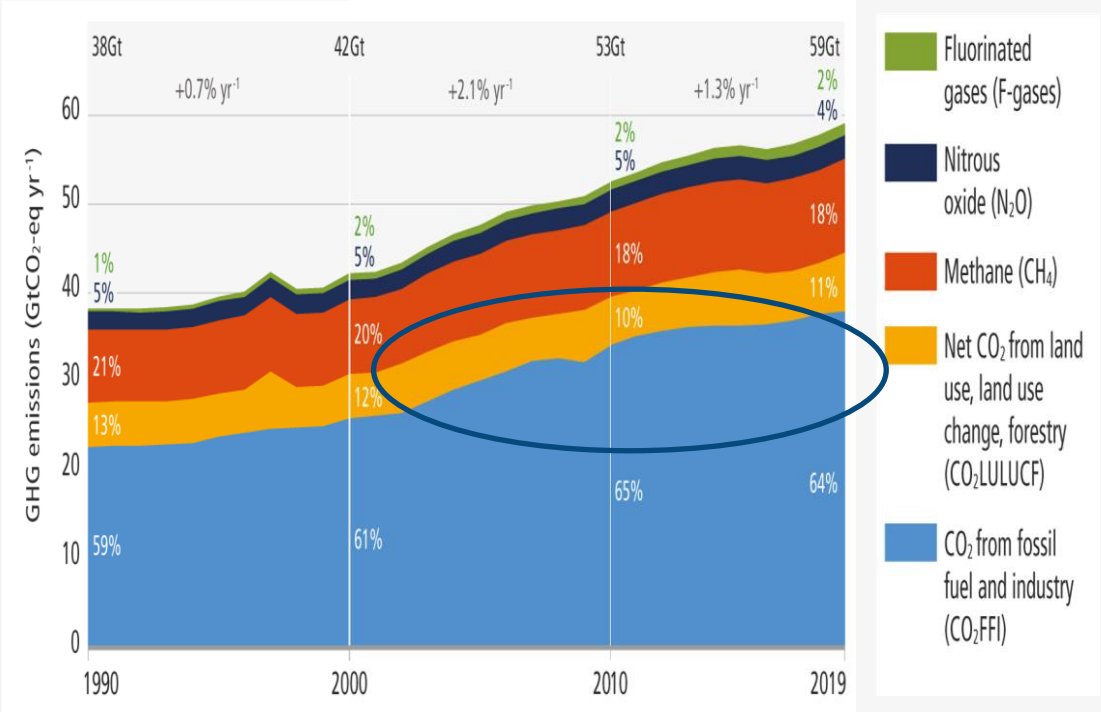

17 Chapters,
c. 3000pp

Technical Summary
142pp

Summary for Policymakers,
45pp

# ‘Mitigation glass more than half empty, but filling?’

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




## 2010-2019:

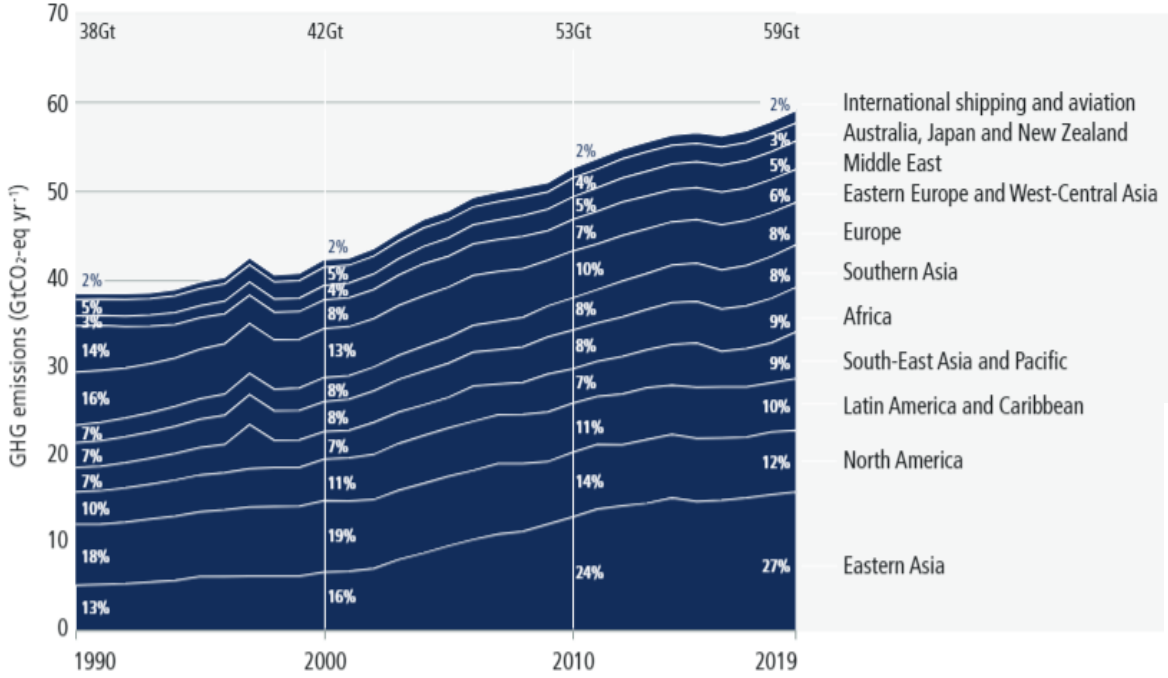
- Average annual greenhouse gas emissions at highest levels in human history
- Increase from previous decade largest ever seen

YET:

- 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*
- Slow-down notably in CO2-FFI ?
- Global per-capita emissions since 2014 unchanged

# 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)

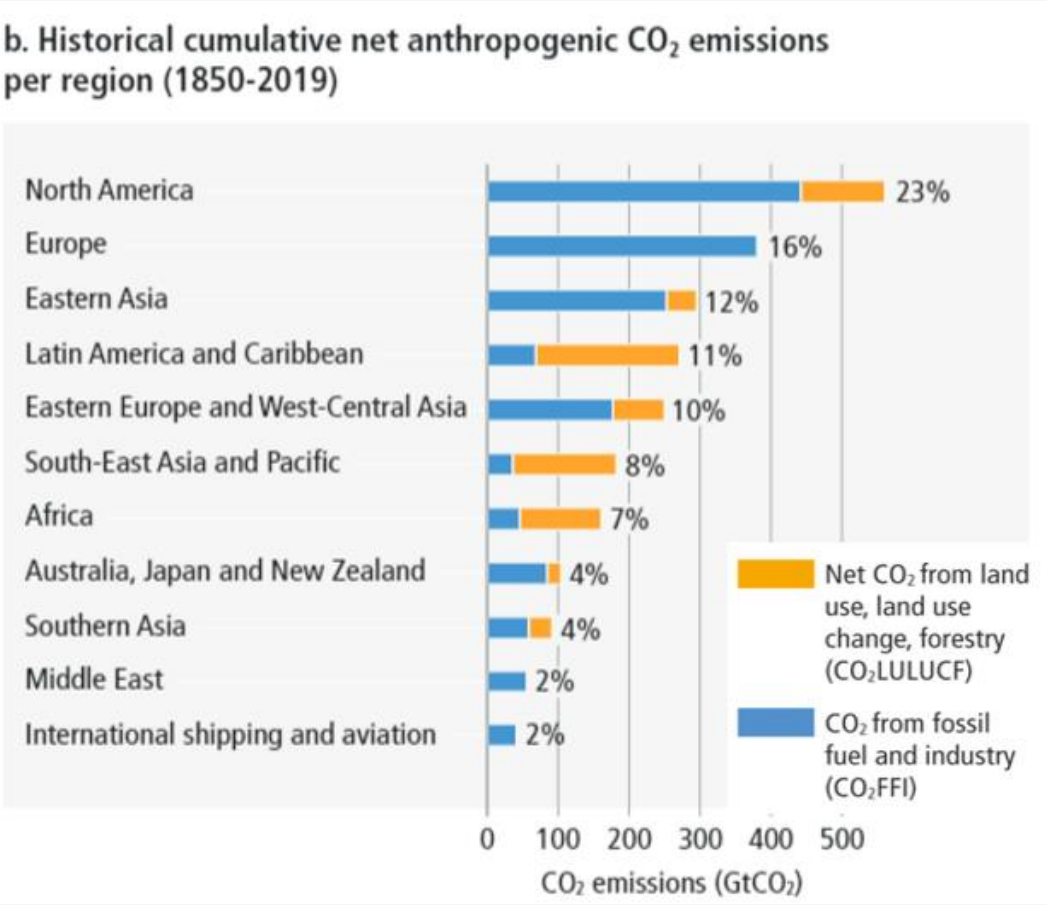



IPCC AR6 Mitigation Report, Figure SPM.2a

- Sectoral complexity – electricity attribution, LULUCF data, Urban systems, and more … see SPM sectoral sections, Figure TS.6
- **To describe contributions by sector is complex**
- **… by region *inevitably* involves choices**

**Regional emissions:**

- % or absolute contributions
- / Growth by region
- Contributions since … when?
- Per capita, per-GDP, consumption/production?




IPCC AR6 Mitigation Report, Figure SPM.2b

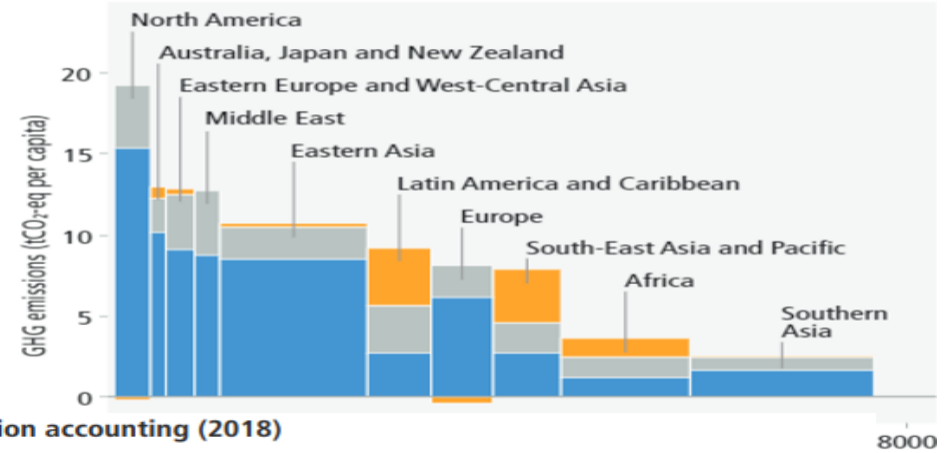
**Regional emissions:**

- % or absolute contributions
- / Growth by region
- **Contributions since … when?**
- **Per capita, per-GDP, consumption/production?**

# Regional and national per capita emissions partly reflect different development stages, also vary widely at similar incomes

- 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

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




**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 |
| **$CO_2$-FFI, 2018, per person** | | | | | | | | | | |
| Production-based emissions ($tCO_2$-FFI 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 ($tCO_2$-FFI per person, based on 2018 data) | 0.84 | 11 | 6.7 | 6.2 | 7.8 | 2.8 | 7.6 | 17 | 2.5 | 1.5 |

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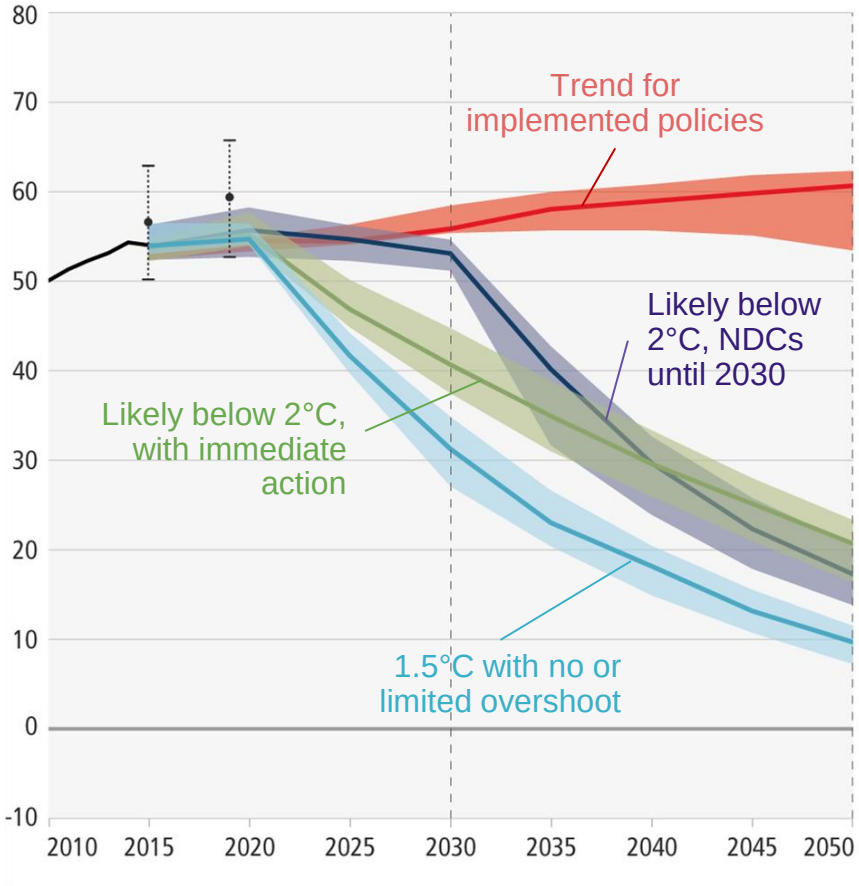
> **Unless there are immediate and deep emissions reductions across all sectors, 1.5°C is beyond reach.**




## Limiting warming to 1.5 °C

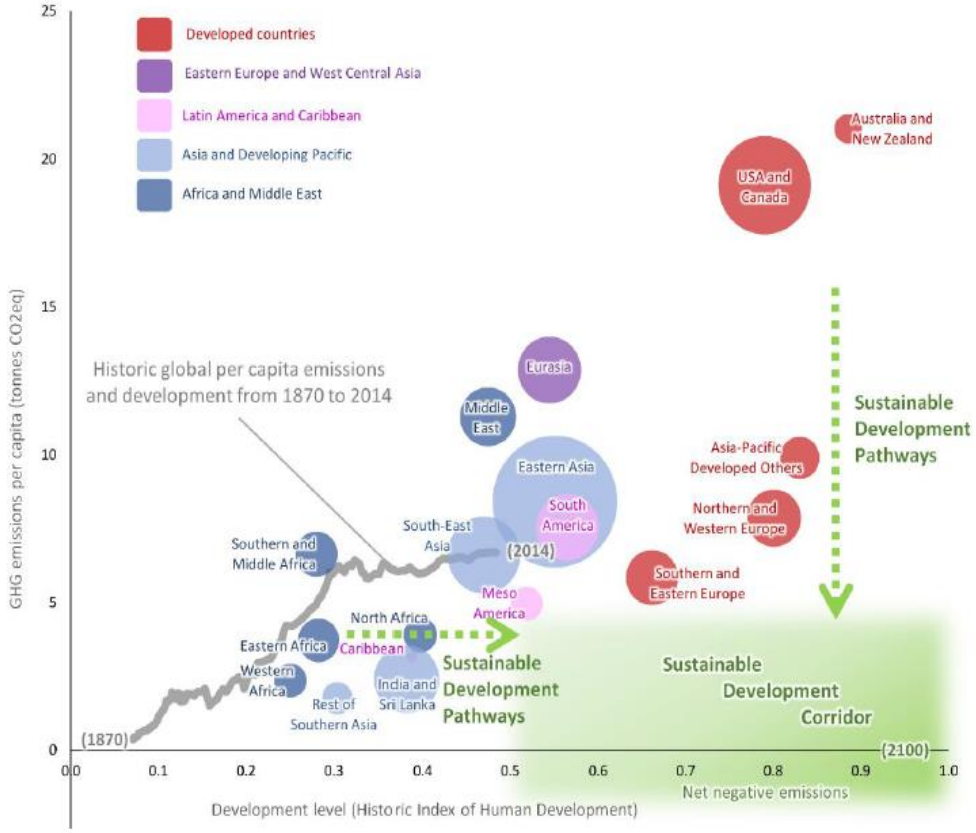
- Global GHG emissions peak before 2025, reduced by 43% by 2030.
- Methane reduced by 34% by 2030

## 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.




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

.. development pathways .. at all stages of economic development impact GHG emissions and hence shape mitigation challenges and opportunities .. 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}.

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}…

[SPM, p.3]

# 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

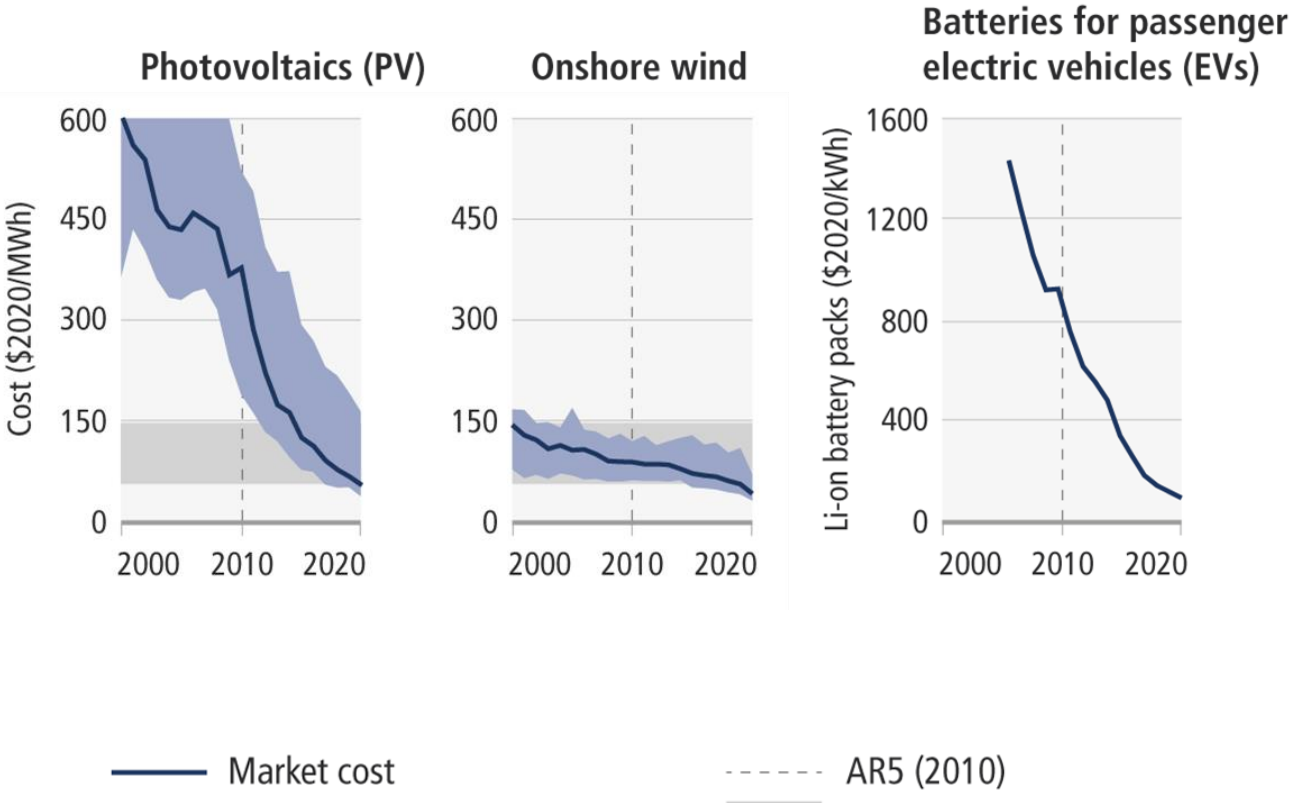
Innovation & transition dynamics

Psychology and politics

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

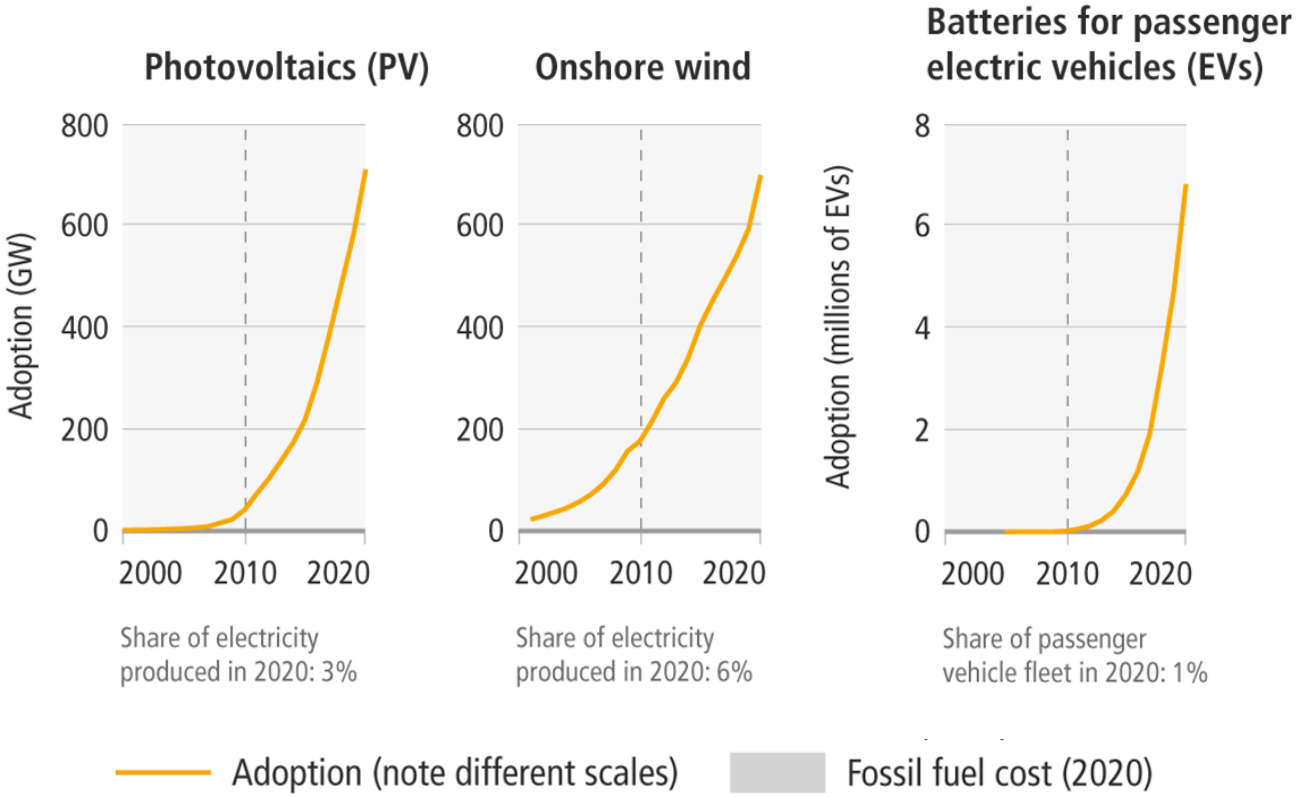
# Signs of Progress?

[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?

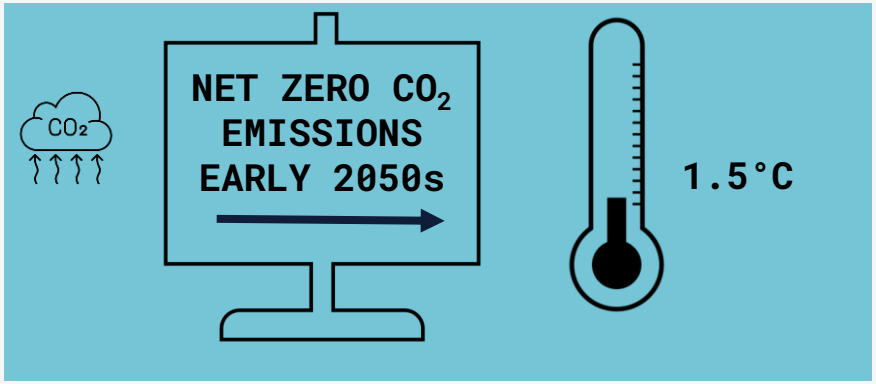
## Technical Summary, Table TS.1 Signs of Progress and Continuing Challenges

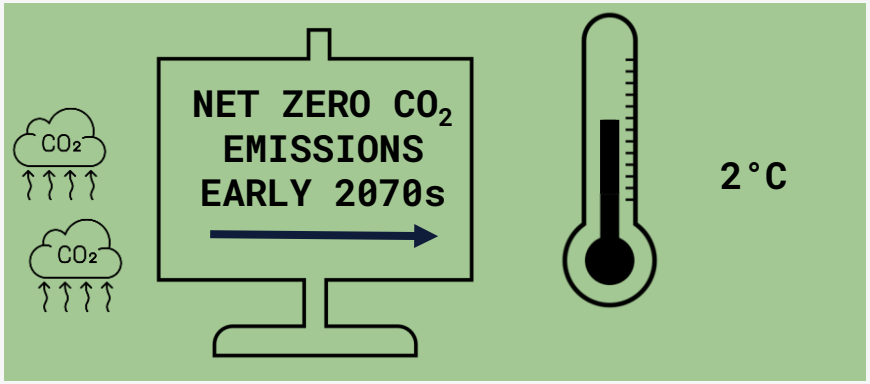
**Table TS.1: Signs of Progress and Continuing Challenges**

| Signs of progress | Continuing challenges |
|---|---|
| *Emissions trends* | |

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

# The longer term: temperature will stabilise when we reach global 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

- ***Given modelled actions 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**

# 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.

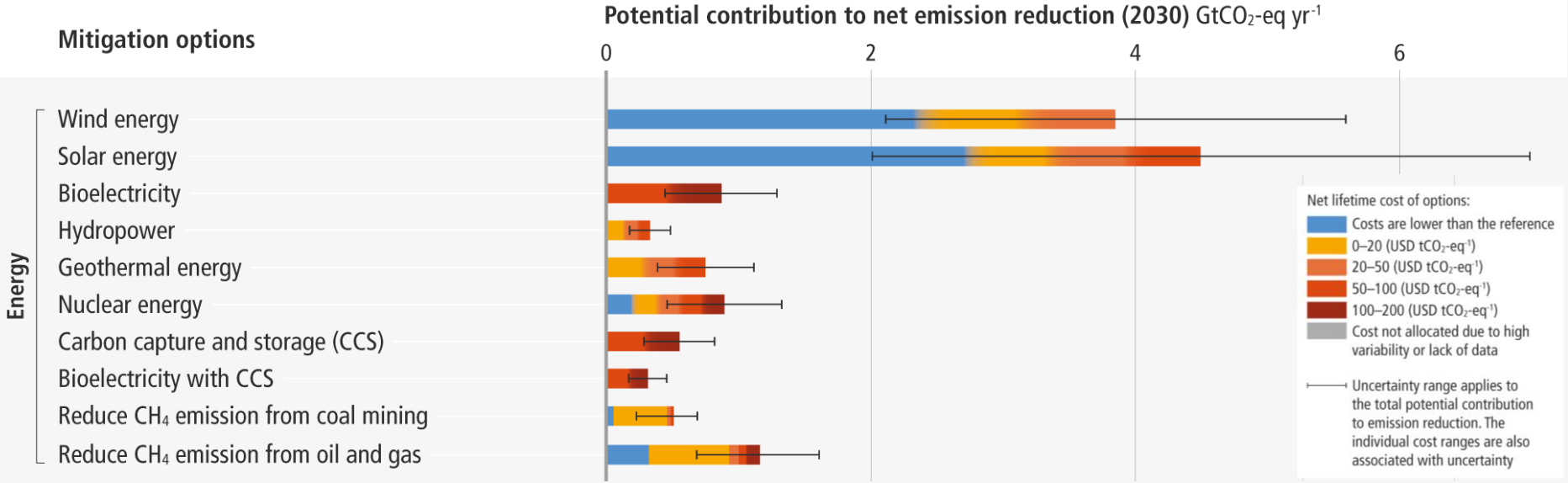


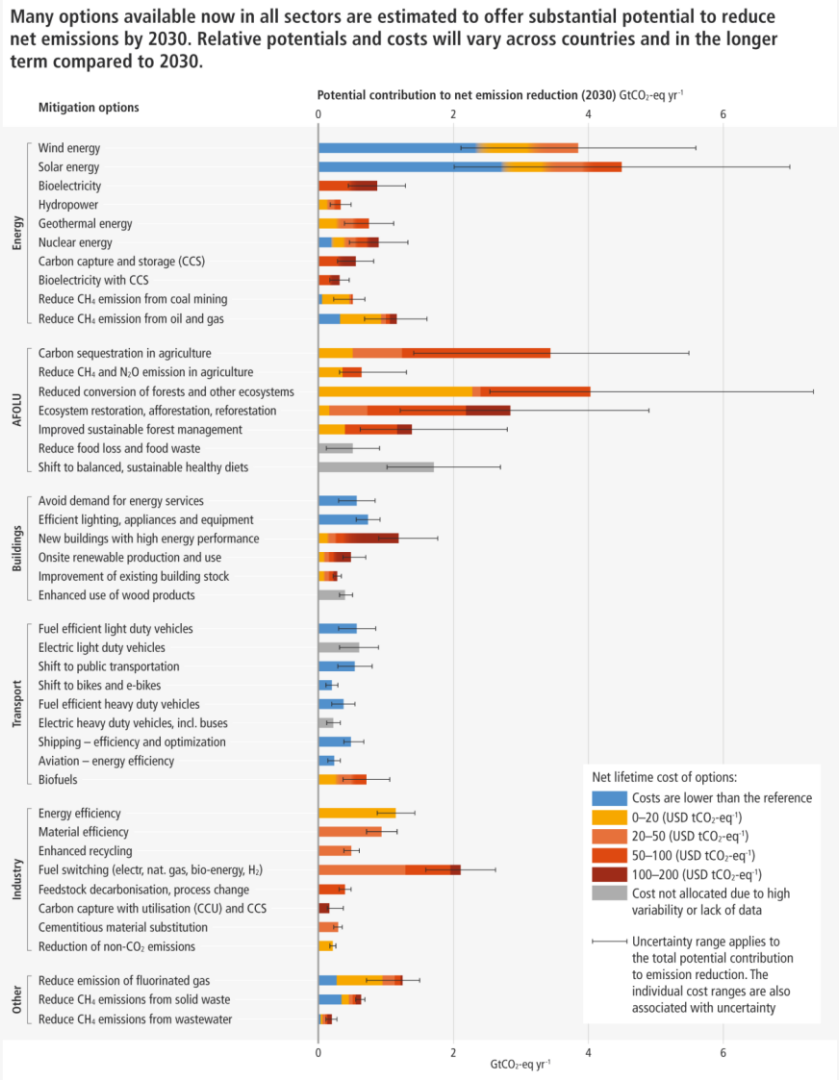

Figure SPM.7 (top panel, Energy)

# Costs and Potentials - overview

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

## Mitigation options costing US$100/tCO$_2$ or less could reduce global GHG emissions by at least half the 2019 level by 2030

- (options costing less than US$20/tCO$_2$ 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 US$20 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.




[Tobias/Unsplash, Rwanda Green Fund /CC BY-SA 2.0]

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

[Duy Pham/Unsplash]

# 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- **…**

**C.12.3** 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}

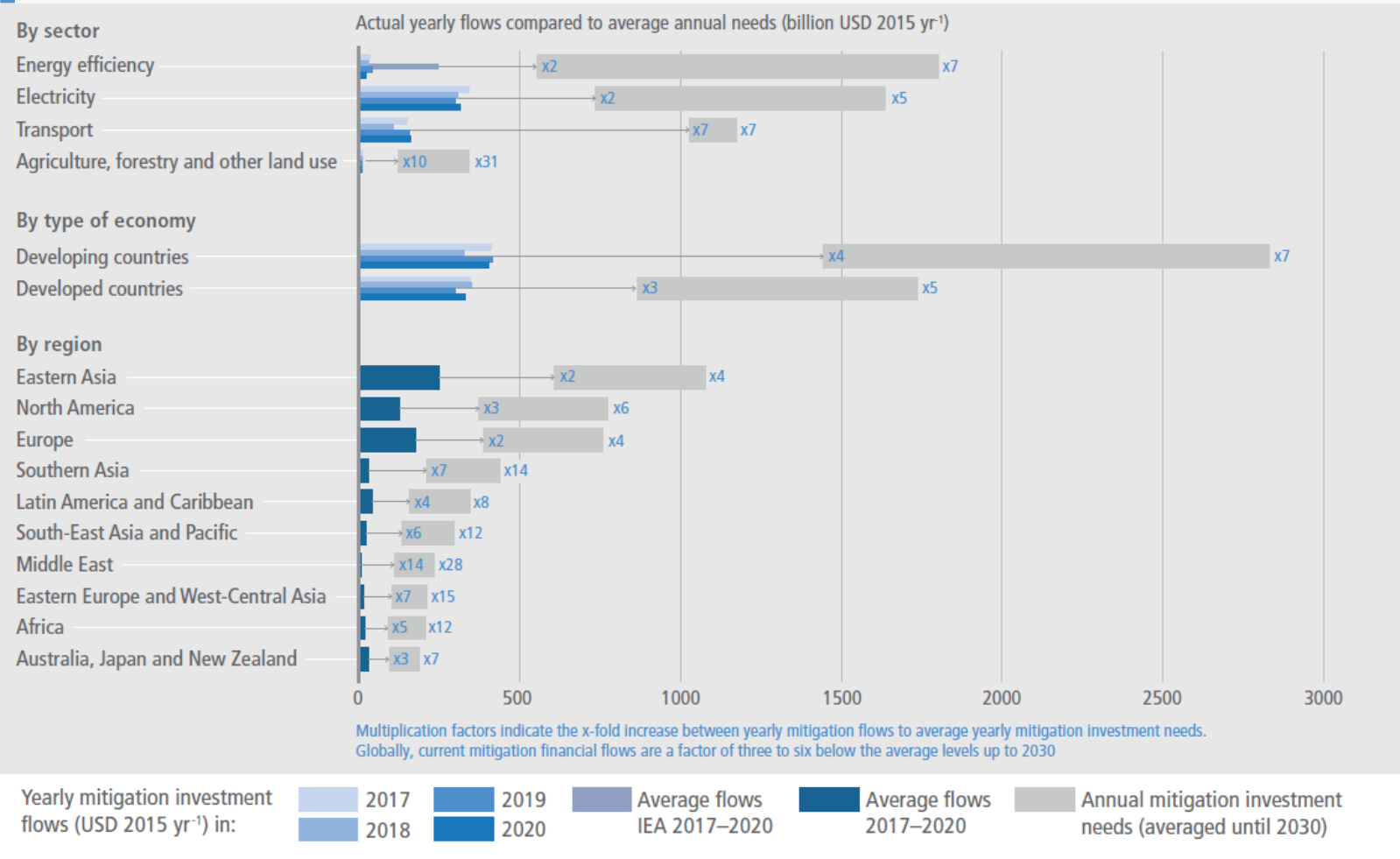
***[Presenter's bolding]***

# 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

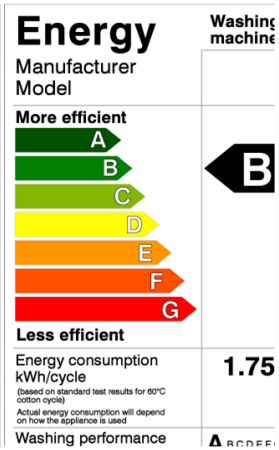
[Tobias/Unsplash, Rwanda Green Fund /CC BY-SA 2.0]

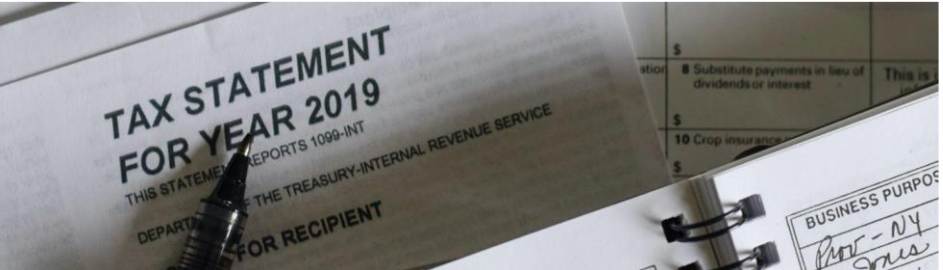
# Finance needs to grow x 3-6 by 2030




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

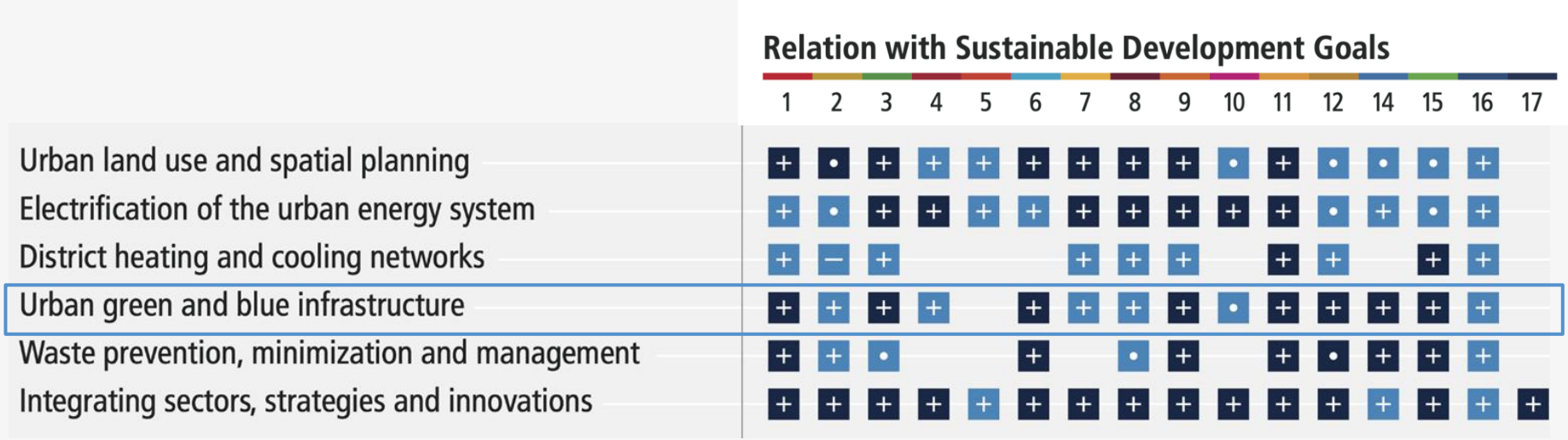
**Adoption of low-emission technologies is slower in most developing countries, particularly the least developed ones.**

# Accelerated climate action is critical to sustainable development

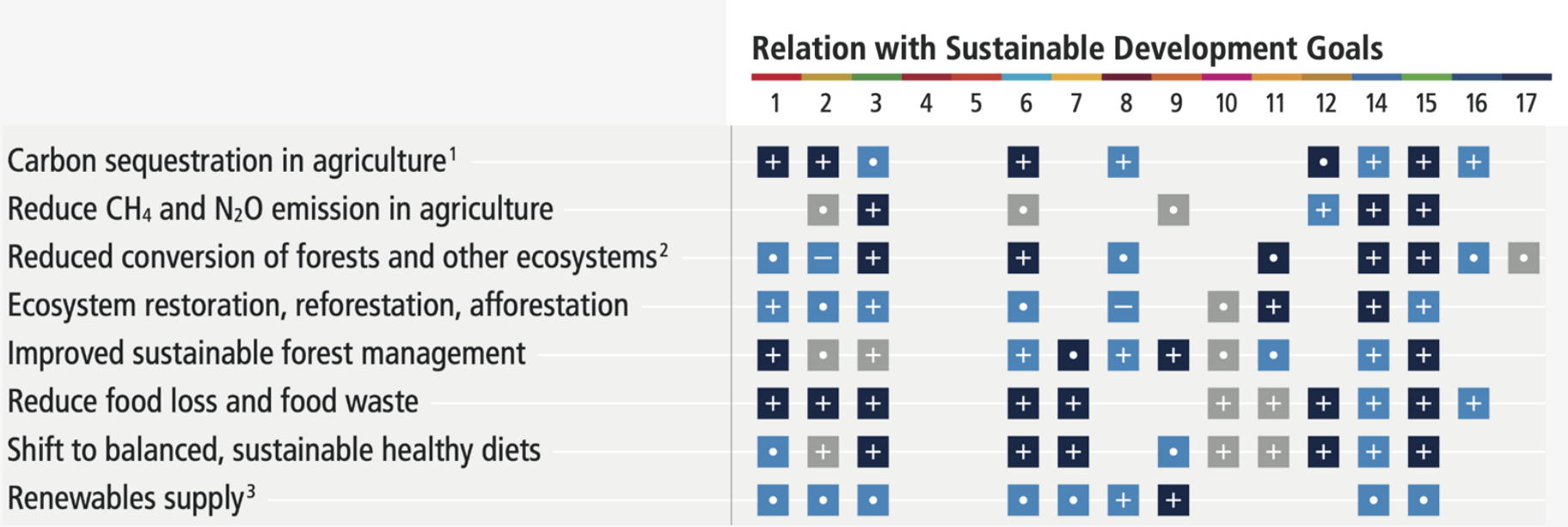
[Duy Pham/Unsplash]


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



# Mitigation options in agriculture and forestry



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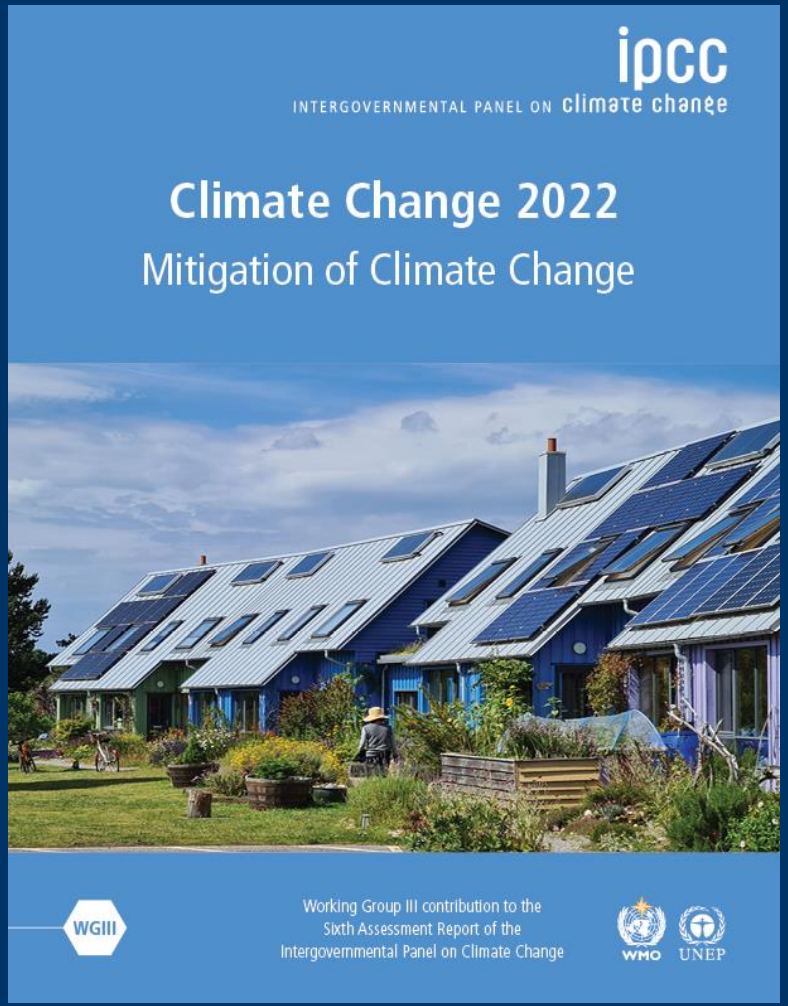
Convening Lead Author, Chapter 1




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

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**PRESENTATION TO INDIA INTERNATIONAL CENTRE, DELHI**

6 December 2022

Some personal reflections


Michael Grubb, Professor of Energy and Climate Change, UCL

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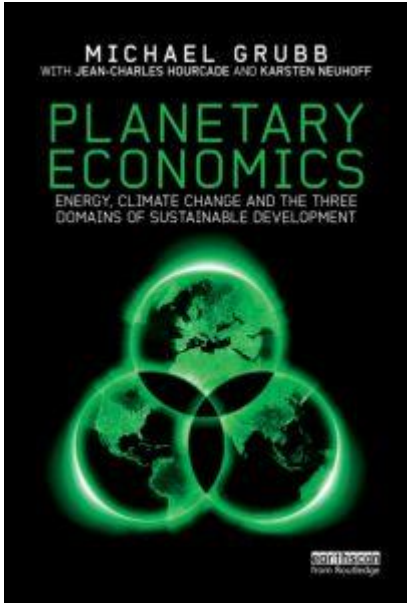



*Energy, Climate Change and the Three Domains of Sustainable Development*

# Some personal reflections: glass half empty?

*[or worse]*

- Global emission trends
  - Vs remaining carbon budget
- Inequality, need for growth
  - Most obviously, basic infrastructure in poorer countries
- Lock-ins
  - Accumulation of will-be stranded assets
- Exceptional levels of waste and profligacy
  - In some of the richest countries and consumer groups
- Continued inadequacy of international finance
  - And lack of any significant initiative on new finance sources

# Some personal reflections: glass half full?

*[.. And filling]*

- The low carbon technology revolution
  - Beyond wind and solar, to batteries, EVs, grid technologies and more
- Countries with sustained emission reductions
  - 24 and counting .. [see Annex slide]
- Global spread of mitigation policies
  - As well documented in IPCC
- Wide recognition of co-benefits, dimensions of ‘just transition’
  - And potential for *shifting development pathways towards sustainability*
- Adequacy of private finance availability in capital markets
  - With extensive business commitment and growing social commitment

# Some personal reflections: glass half broken?

- The annual pre-COP ‘gap reports” (e.g. emissions vs PA, production, finance…)
  - Apparent lack of purchase on actual action
- International regime: from deep but narrow (Kyoto) to broad but shallow (Paris Agreement)
  - A system in which countries simply offer contributions, non-binding, without even a Common Accounting Framework is not adequate
- Insufficient intellectual / cross-disciplinary integration
  - Across the “Four Analytic Frameworks” – even within the IPCC assessment
- Crucial unresolved debates
  - e.g. Role of carbon pricing, relevance of historical emissions, treatment of production vs consumption & ‘embodied’ traded emissions
- Reluctance to countenance new & innovate financial sources / approaches
  - When its clear that ‘western Treasuries’ can never fill the gap
- Historical inconsistency and instability of US engagement
  - Reflects a wider lack of global ethic / awareness

# India lectures on climate change, 5-6th December

**Annual Jeremy Grantham Lecture on Climate Change organised by Divecha Centre at IISc, Bangalore***

Topic: "*Planetary Economics and the challenge of climate change*"

Venue: Divecha Centre for Climate Change at the IISc campus, Bangalore, 2.30pm, 5th December

**National Institute of Advanced Studies (NIAS), Indian Institute of Science, Bangalore**

Topic: "*The Economics of Energy Innovation and Transition: lessons and principles for policymaking*"

Venue: NIAS, IISc campus, Bangalore, 4.15pm, 5th December

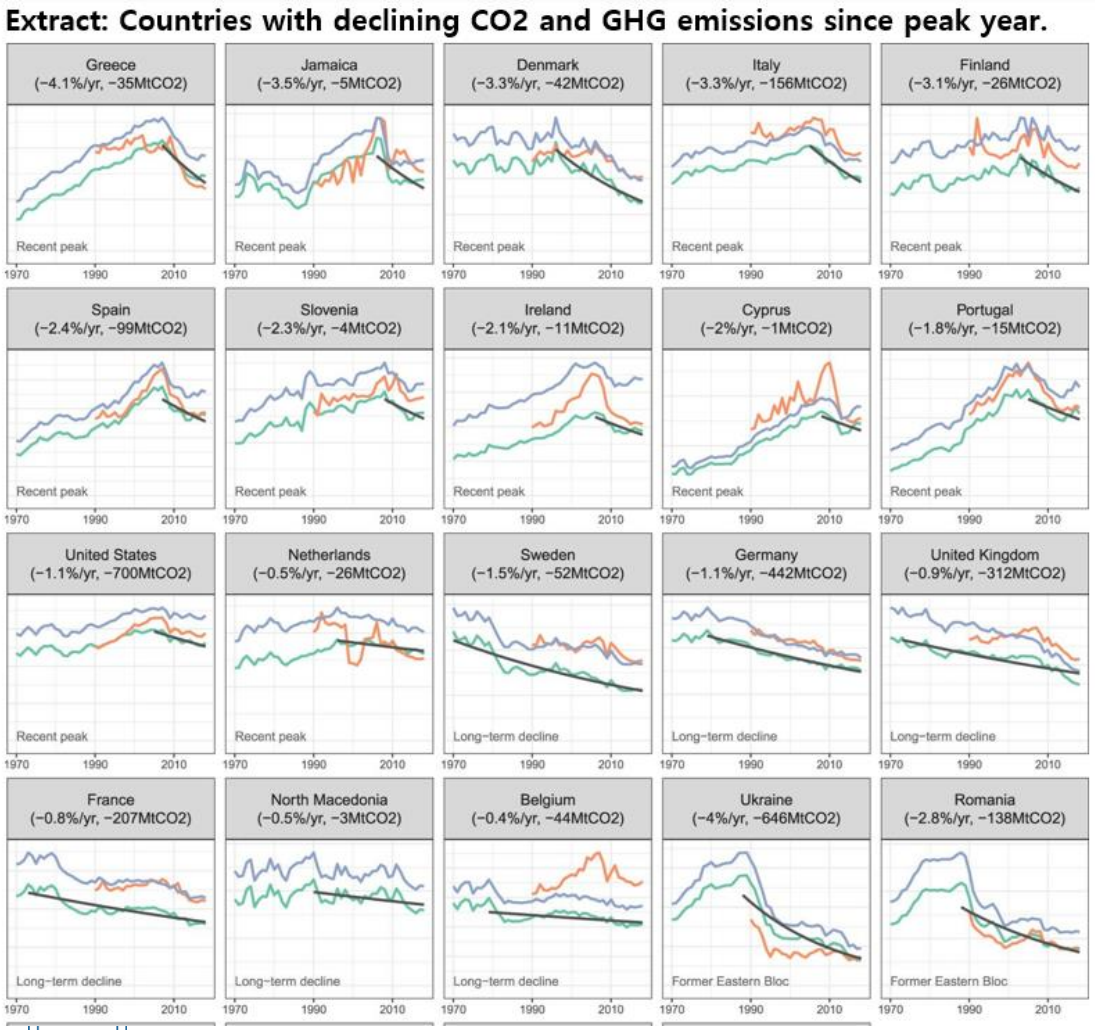
**India International Centre (IIC), Delhi***

Topic: *"The IPCC report on Climate Change Mitigation and remarks on COP27: glass half empty, half full, or half broken?"*

Venue: IIC Conference Room I, IIC Main Building), 6.30pm 6th December


Livestreamed at:
https://iicdelhi.in/programmes/ipcc-report-climate-change-mitigation-and-remarks-cop27-glass-half-empty-half-full-or

*Available through www.profmichaelgrubb.com (beta version)




# Signs of Hope (1):

The accumulating evidence is not just about climate impacts

**c.24 *countries with sustained emission reductions, of CO2 and all GHGs, including consumption-basis***

Almost all employed ‘3 pillar’ policies, sustained since early-mid 2000s (in some cases, since early 1990s)

*Lamb W.F., Diluiso F, Grubb M., Minx J.C. (2021), Countries with sustained greenhouse gas emissions reductions: an analysis of trends and progress by sector, Climate Policy, https://www.tandfonline.com/doi/full/10.1080/14693062.2021.1990831*