

Non CO₂ greenhouse gases: the underrepresented, complex side of the climate challenge

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25 January 2024



Take Home Messages

- 2023 is a special climate year
- Scenarios to limit temperature increase to 1.5°C
 - It is still possible if we act fast
 - But only if we focus on ALL greenhouse gases
- Non-CO2 greenhouse gases:
 - Can be reduced to zero
 - Except for emissions from food production
- What is needed: energy and protein transition

Take Home Messages

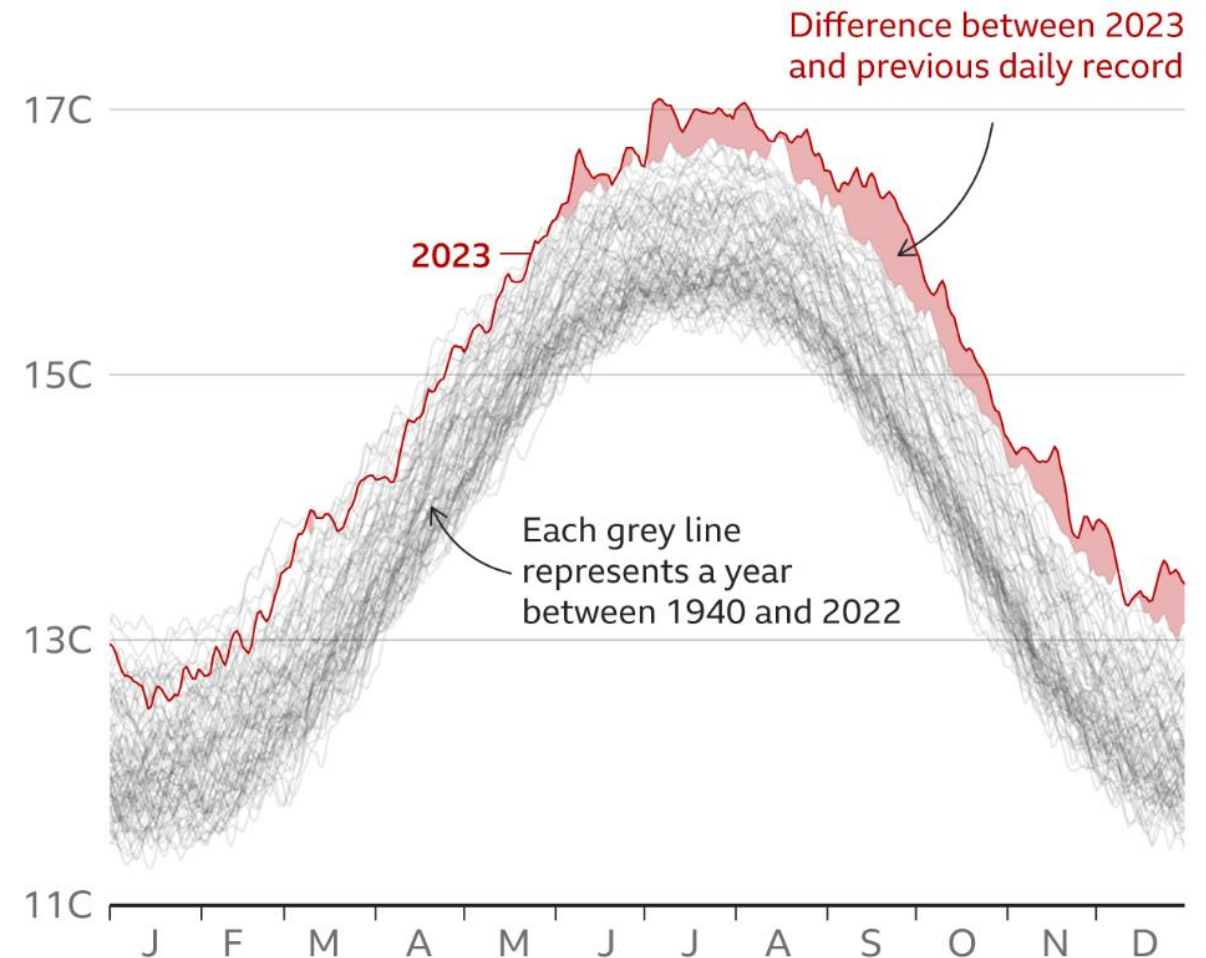
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2023 is a special year

- Record high temperatures – totally off chart

Global temperatures at record levels in 2023

Daily global average air temperature, 1940-2023



Source: ERA5, C3S/ECMWF

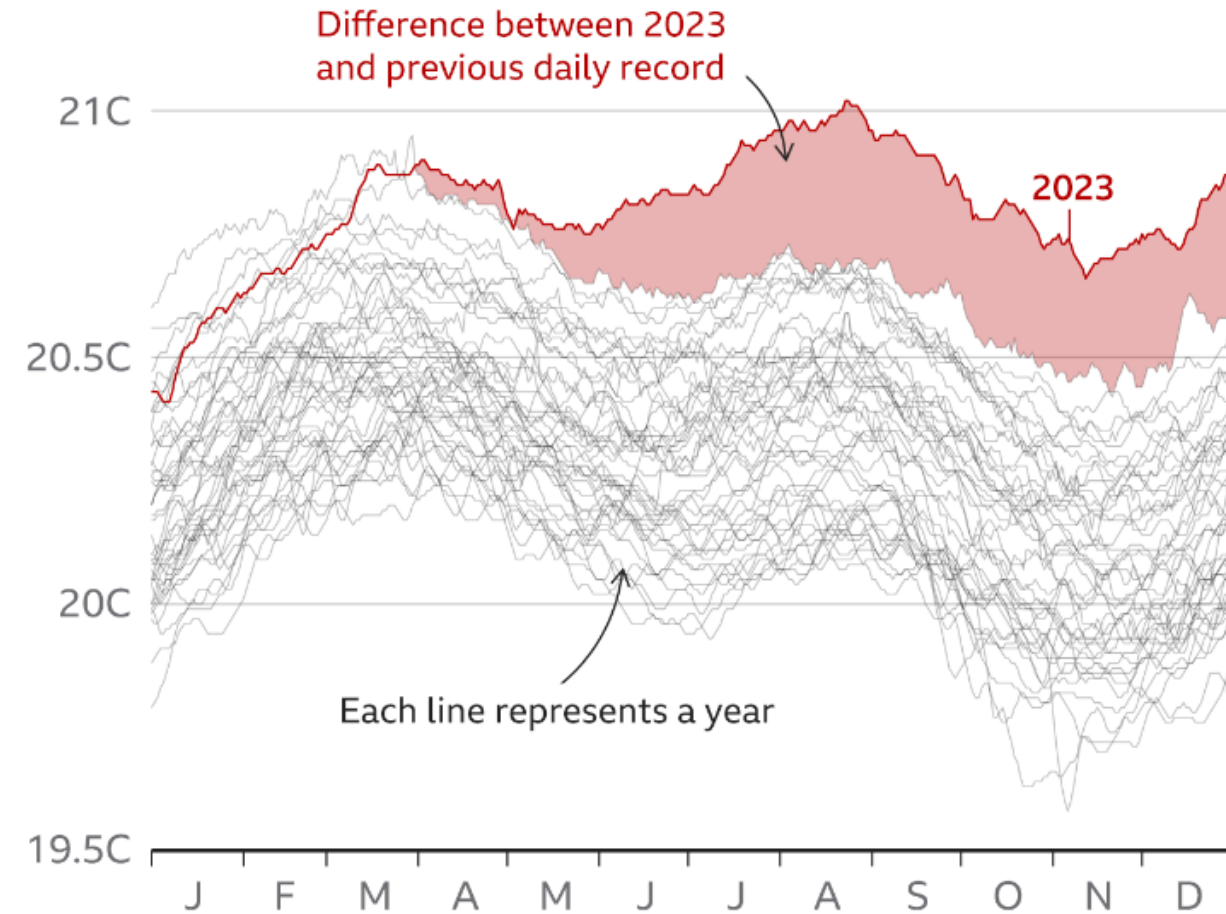


2023 is a special year

- Record high temperatures – totally off chart
- Mindboggling high sea surface temperatures

Ocean temperatures highest on record

Daily average sea surface temperature, 1979-2023



Note: Temperatures between latitudes 60° North and 60° South

Source: ERA5, C3S/ECMWF (data until 30 Dec 2023)

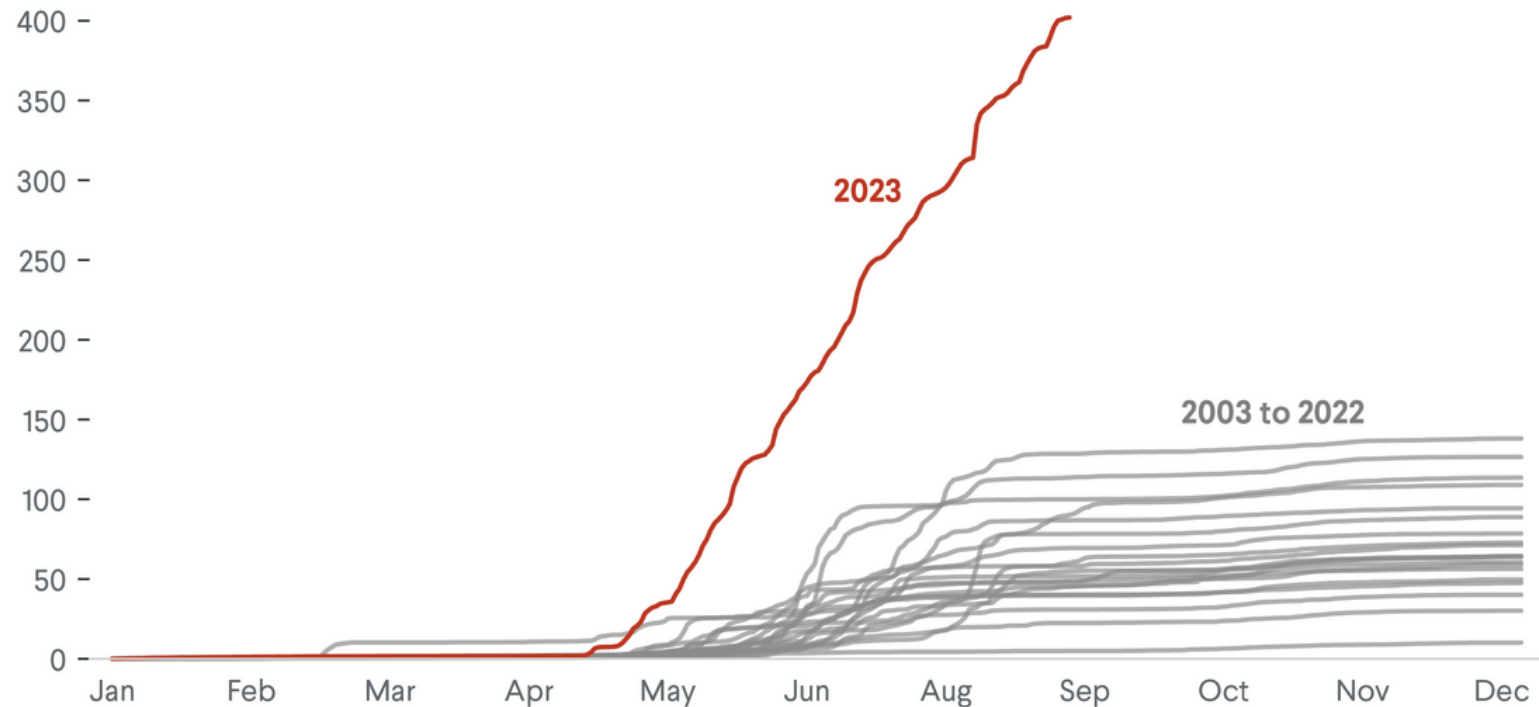


2023 is a special year

- Record high temperatures totally off chart
- Mindboggling high sea surface temperatures
- Incredible heat, fires, droughts and extreme weather events all around the world

Canada Has Seen Record Wildfire Emissions in 2023

Cumulative annual carbon emissions (megatons)



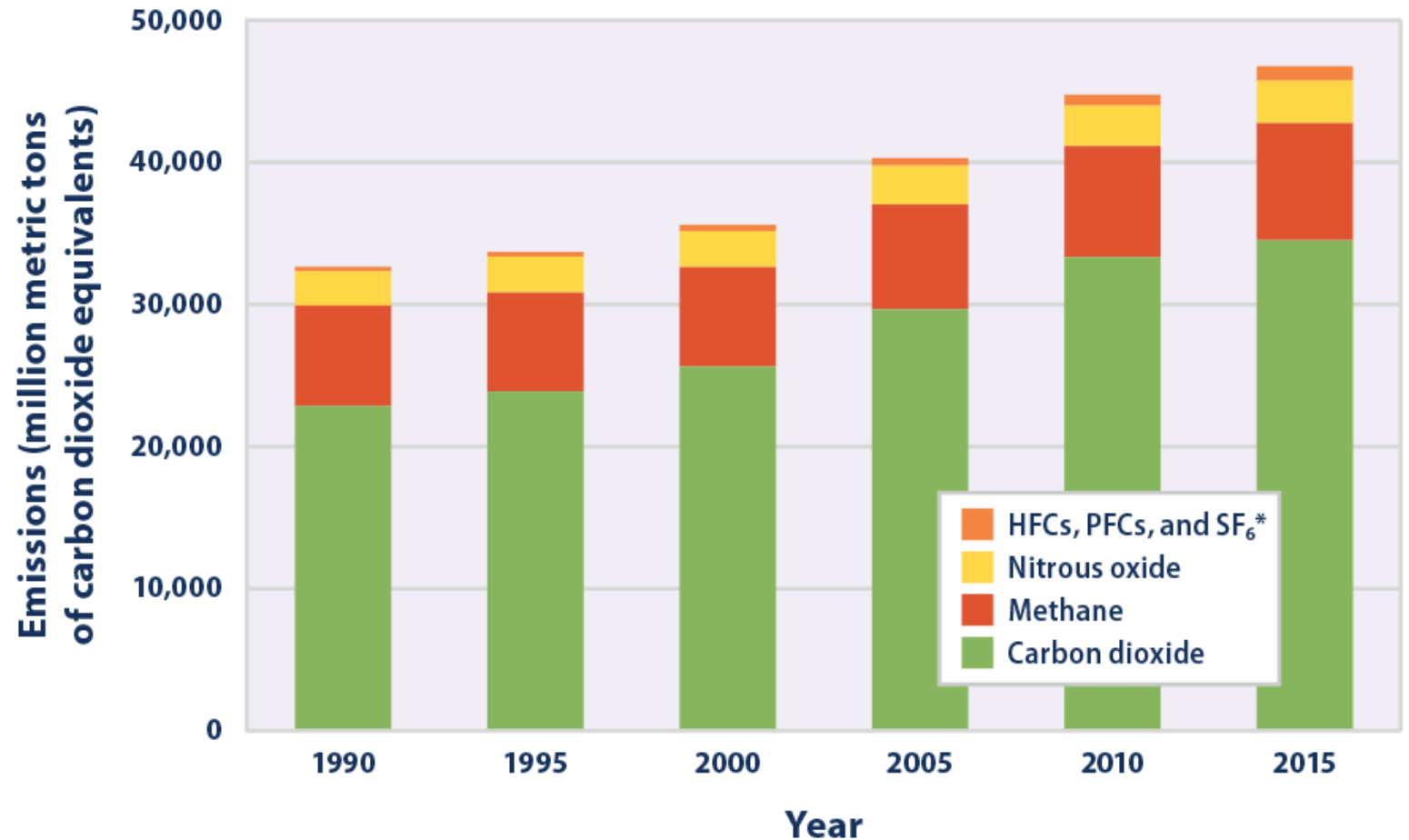
Sources: Copernicus Atmosphere Monitoring Service; European Center for Medium-Range Weather Forecasts.

COUNCIL *on*
FOREIGN
RELATIONS

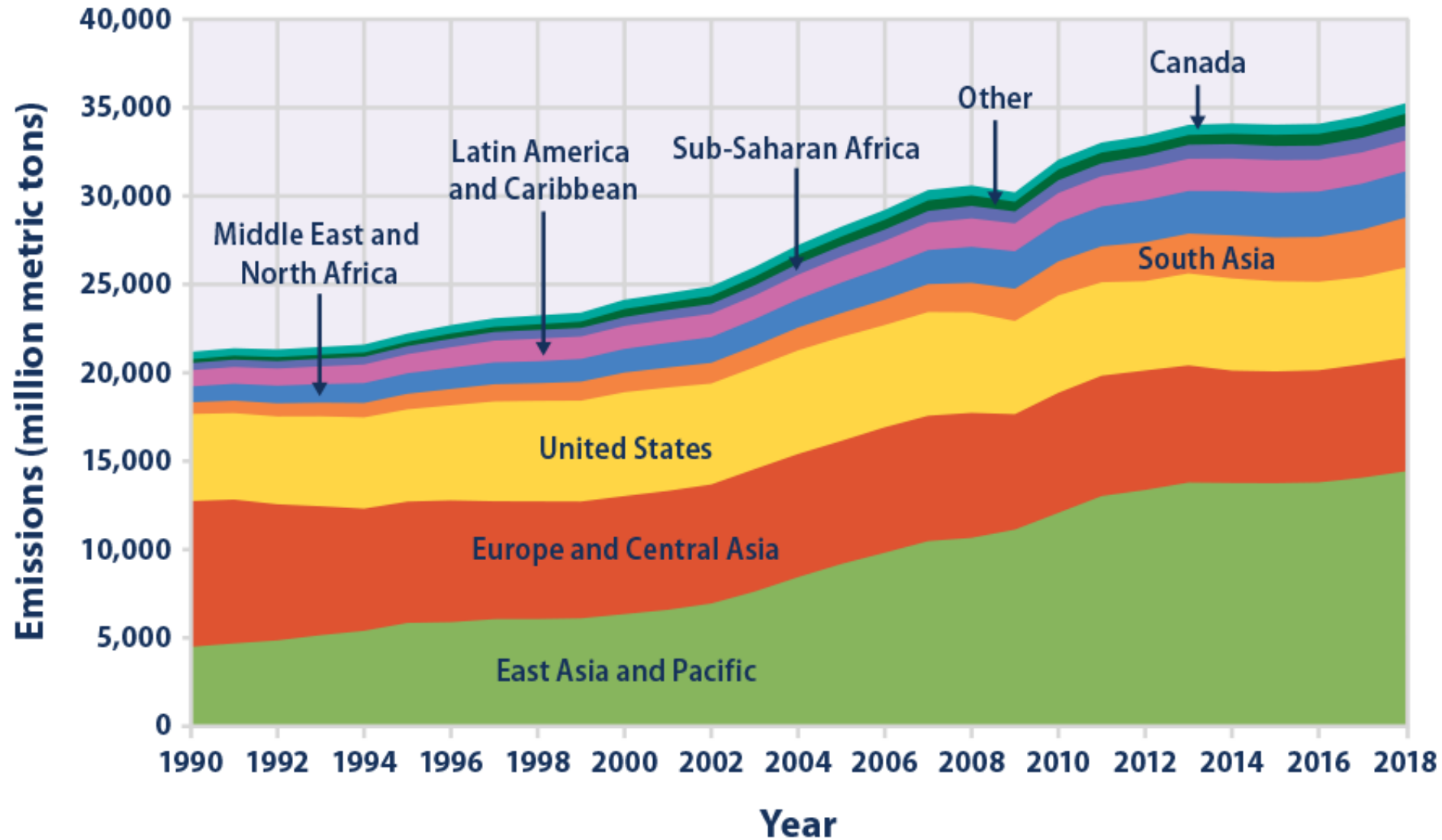
Most important greenhouse gases?

Sources:

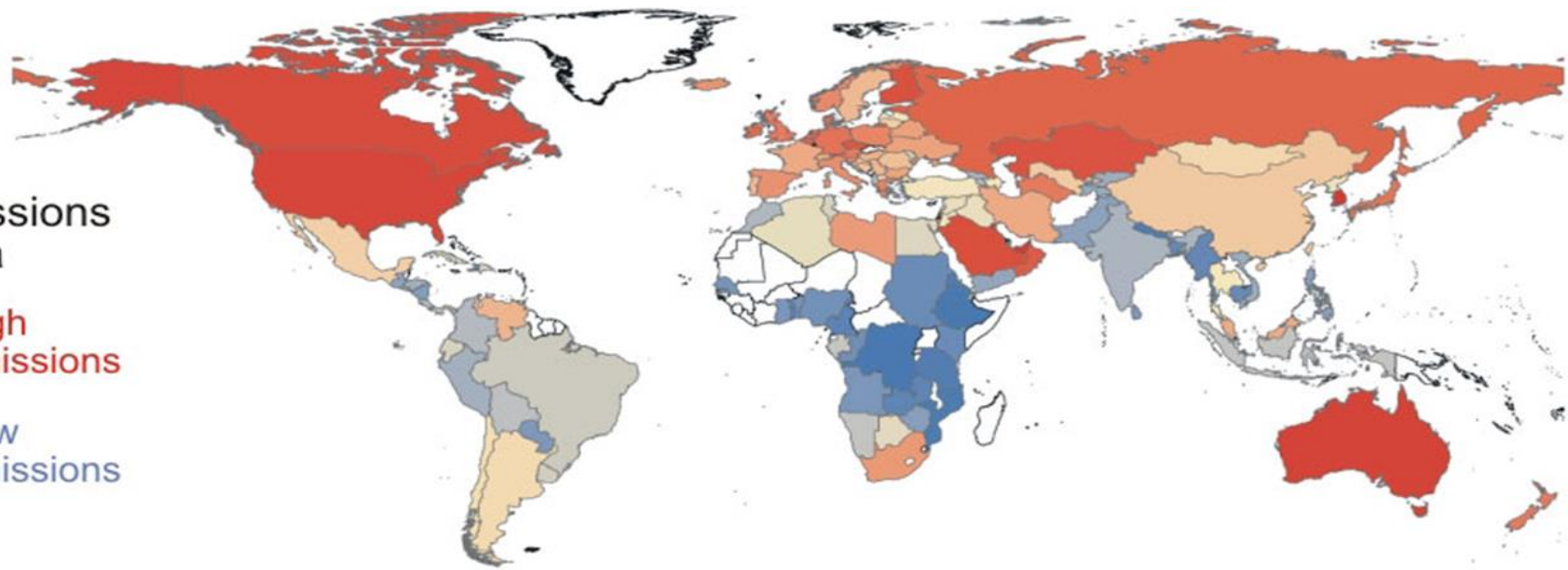
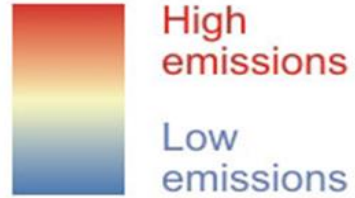
- Fossil Fuels
- Deforestation
- Food production
- Industry



Most important emitters?

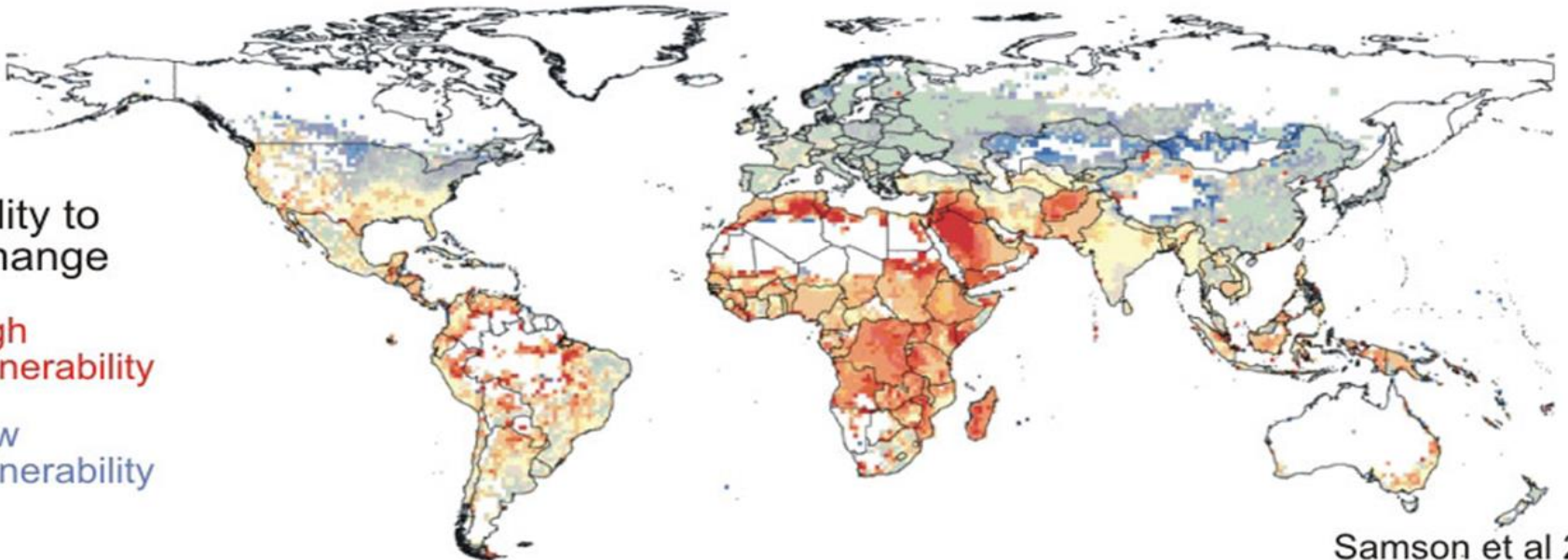


CO2 emissions
per capita



Those who contribute the least greenhouse gases
will be most impacted by climate change

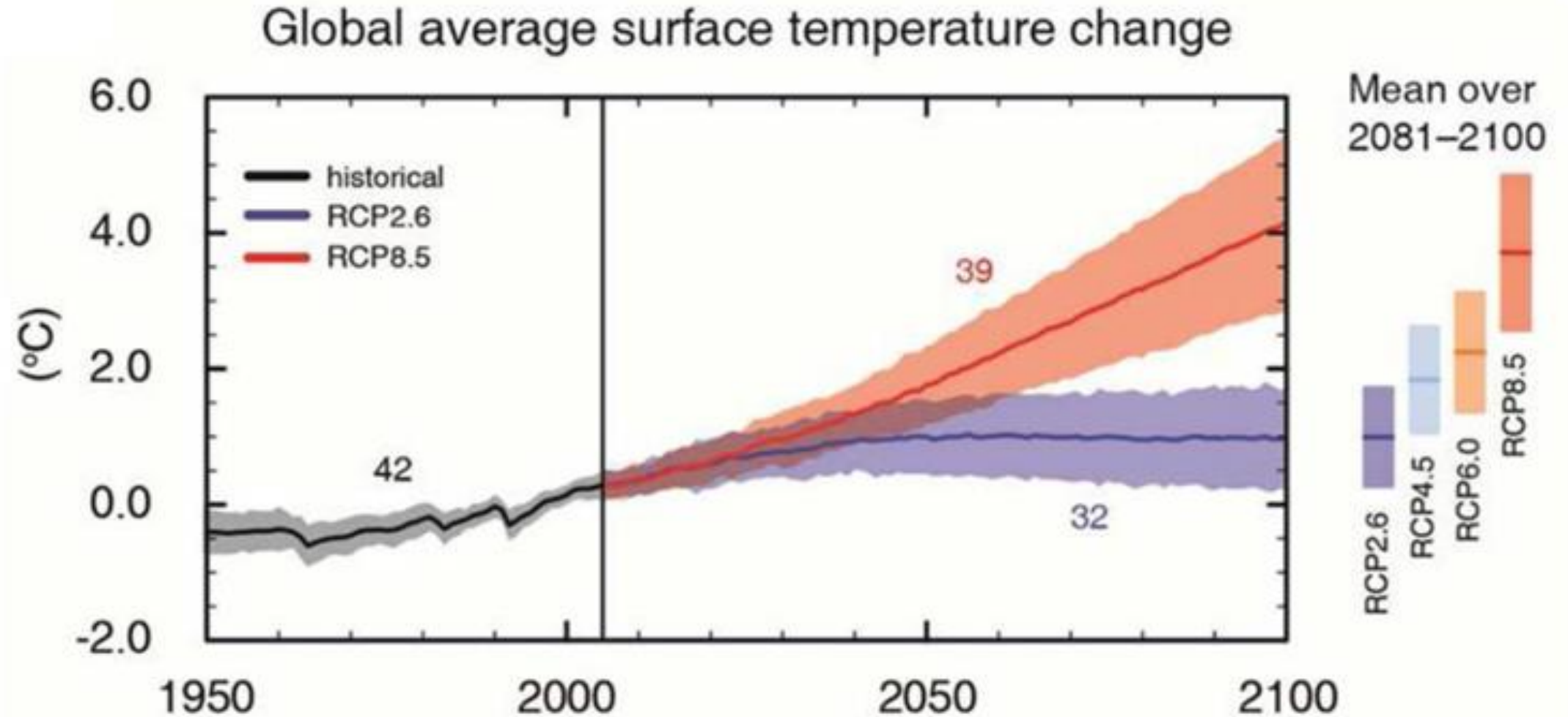
Vulnerability to
climate change



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IPCC model projections for global warming





[Credit: Peter John Maridable | Unsplash]

“ Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach.



[Credit: NASA]

“Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years.”

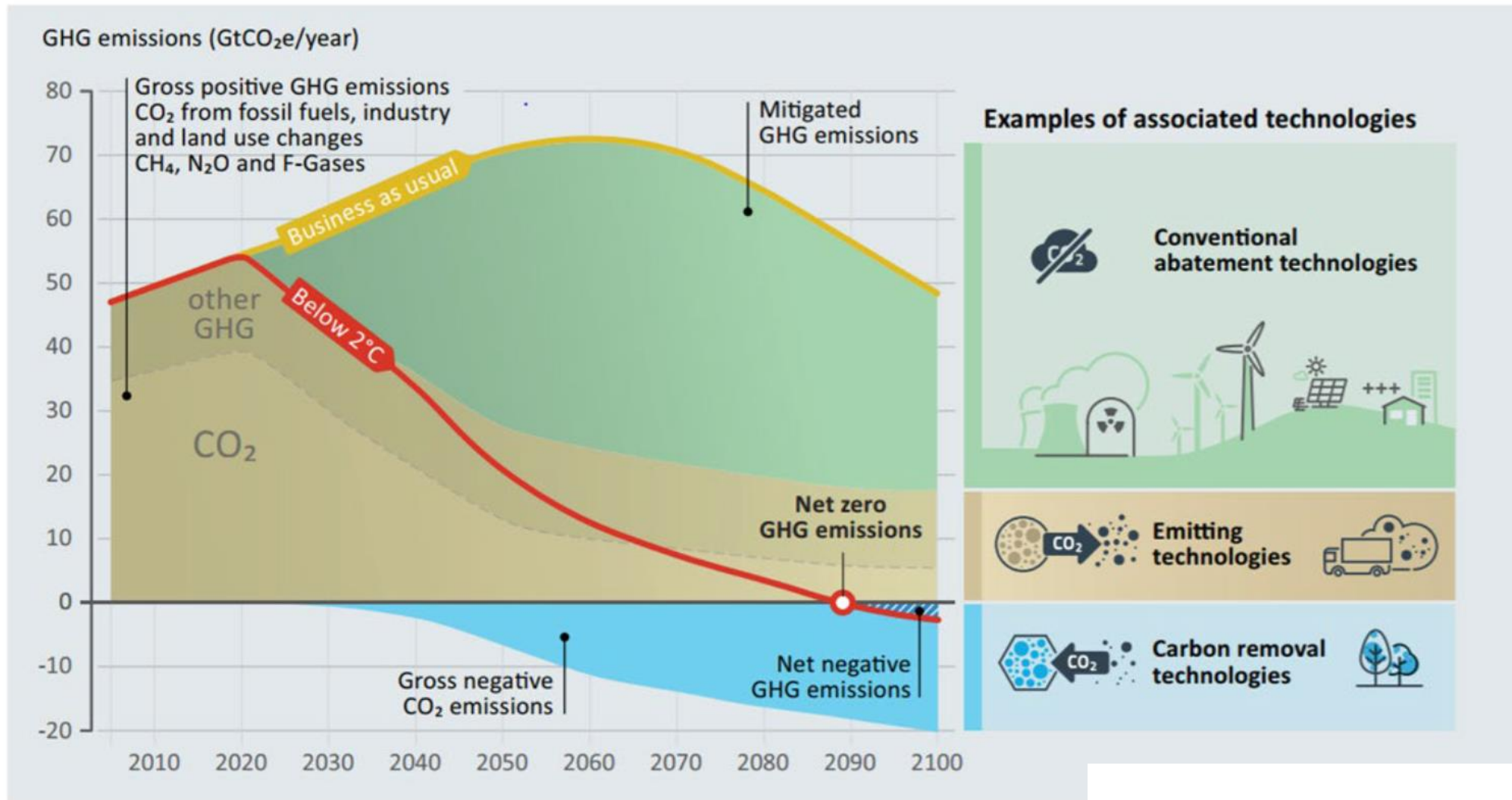
Paris Agreement

Long term goal:

“Holding the increase in the global average temperature to well below 2 °C (...) to pursue efforts to limit the temperature increase to 1.5 °C”



Limiting Warming to 1.5 degrees is still possible



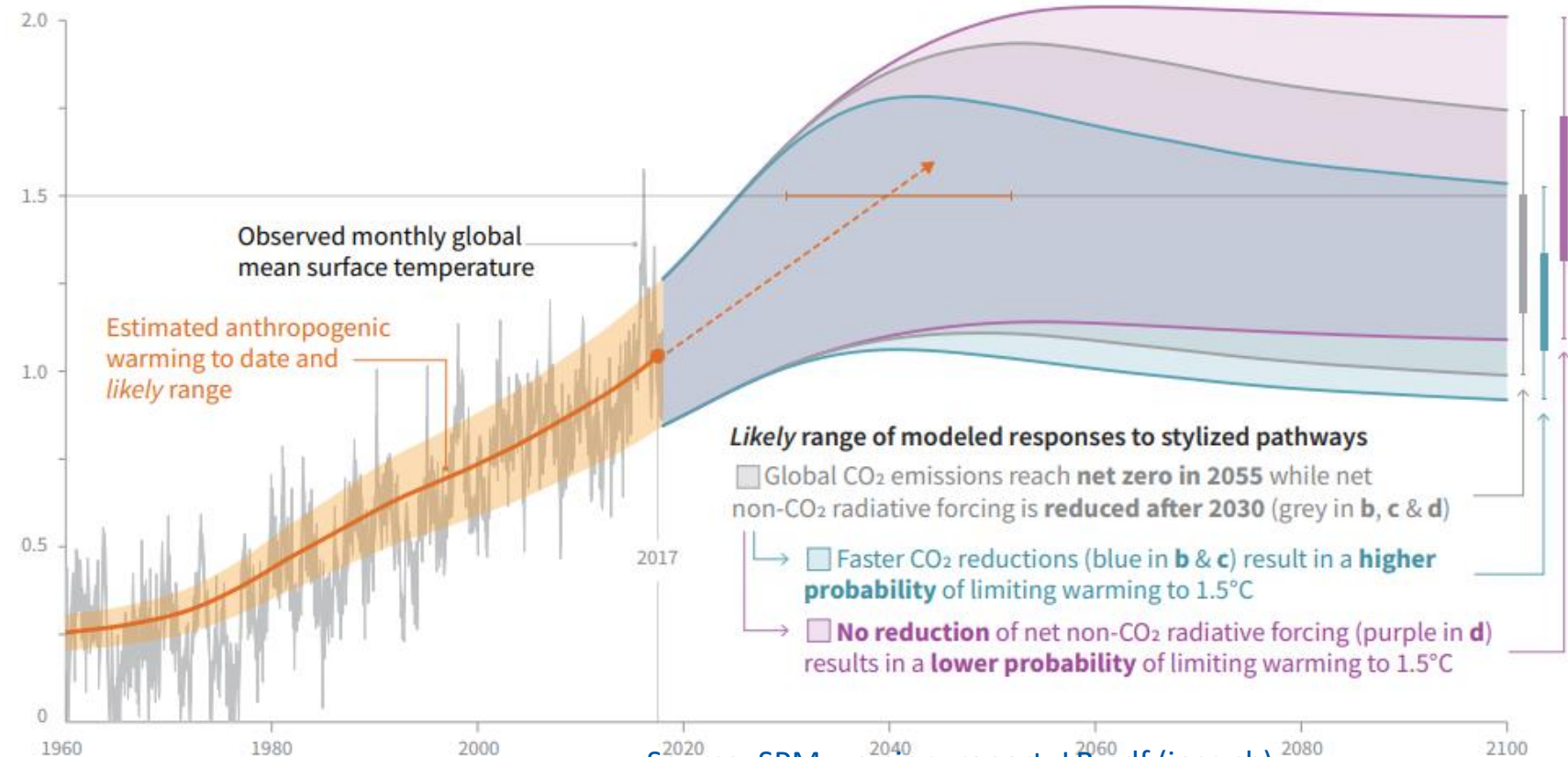
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IPCC 1.5°C Scenario: zero CO₂ and reduced non-CO₂ emissions after 2030

a) Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways

Global warming relative to 1850-1900 (°C)

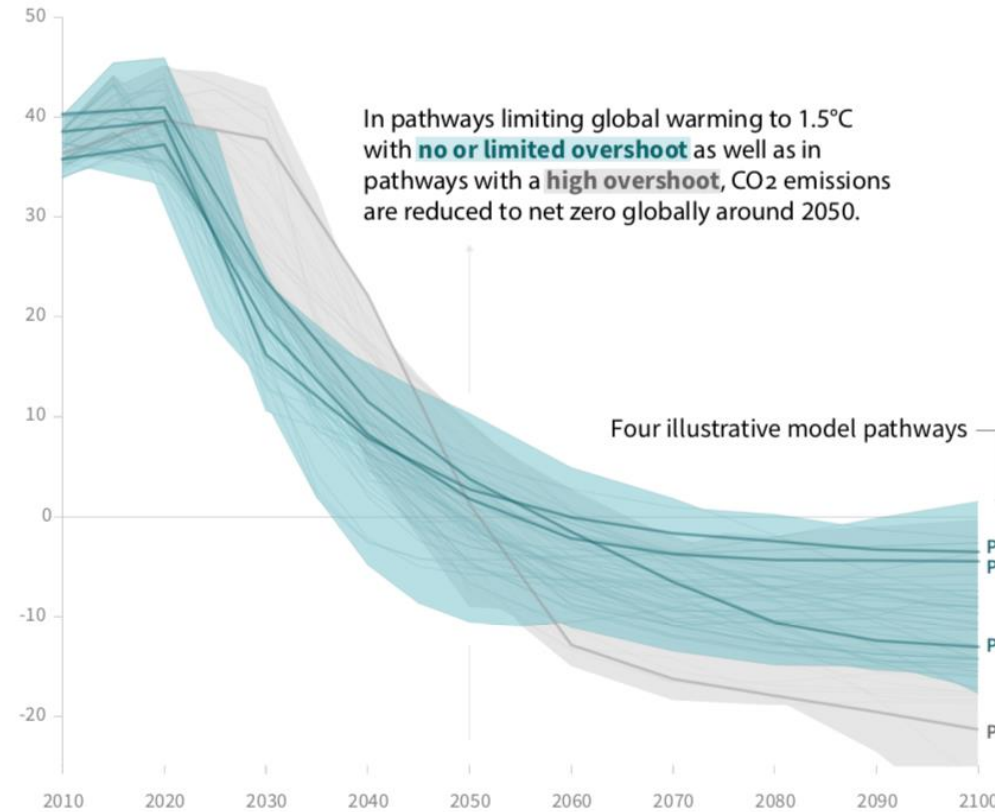


Source: SPM version report LR.pdf (ipcc.ch)

In optimistic futures it is difficult to reduce non-CO₂ greenhouse gas emissions

Global total net CO₂ emissions

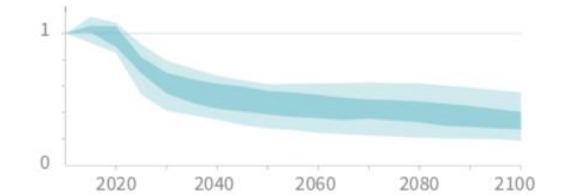
Billion tonnes of CO₂/yr



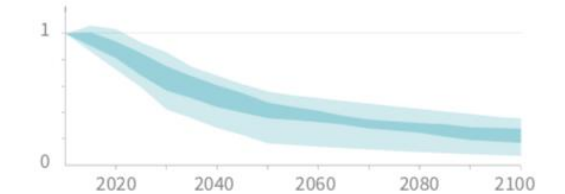
Non-CO₂ emissions relative to 2010

Emissions of non-CO₂ forcers are also reduced or limited in pathways limiting global warming to 1.5°C with **no or limited overshoot**, but they do not reach zero globally.

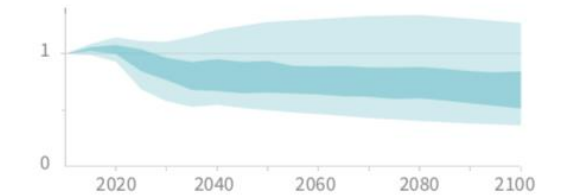
Methane emissions



Black carbon emissions



Nitrous oxide emissions



Timing of net zero CO₂

Line widths depict the 5-95th percentile and the 25-75th percentile of scenarios

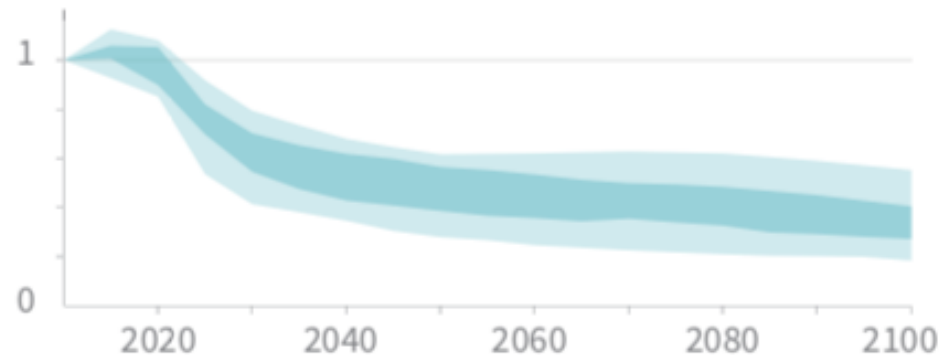


In optimistic futures it is difficult to reduce non-CO₂ greenhouse gas emissions from **food production**

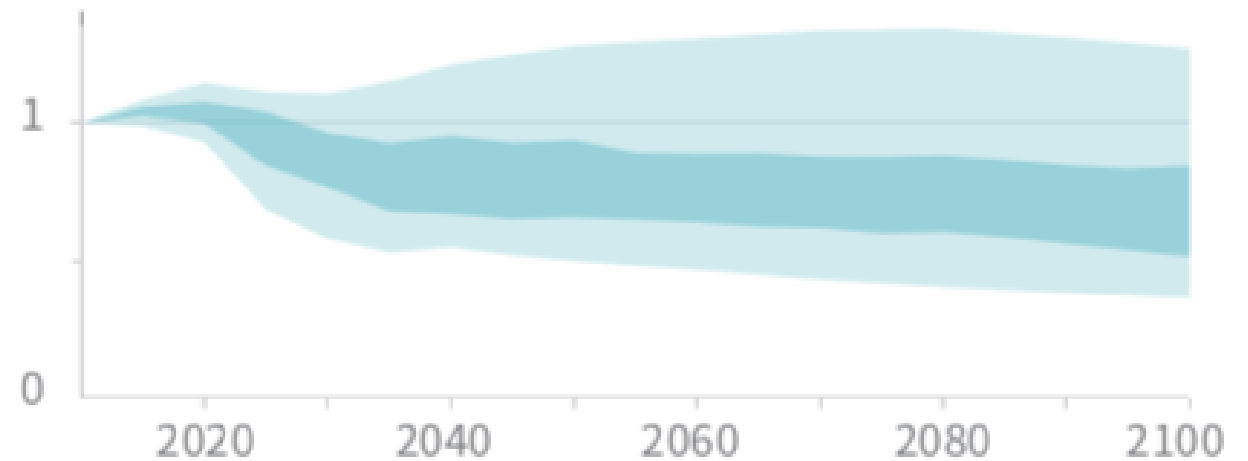
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Nitrous oxide emissions

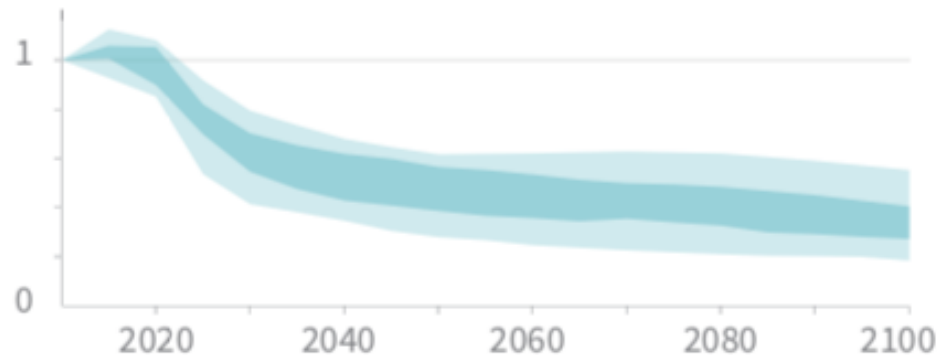


Needed: more efficient food production and changes in diets (protein transition)

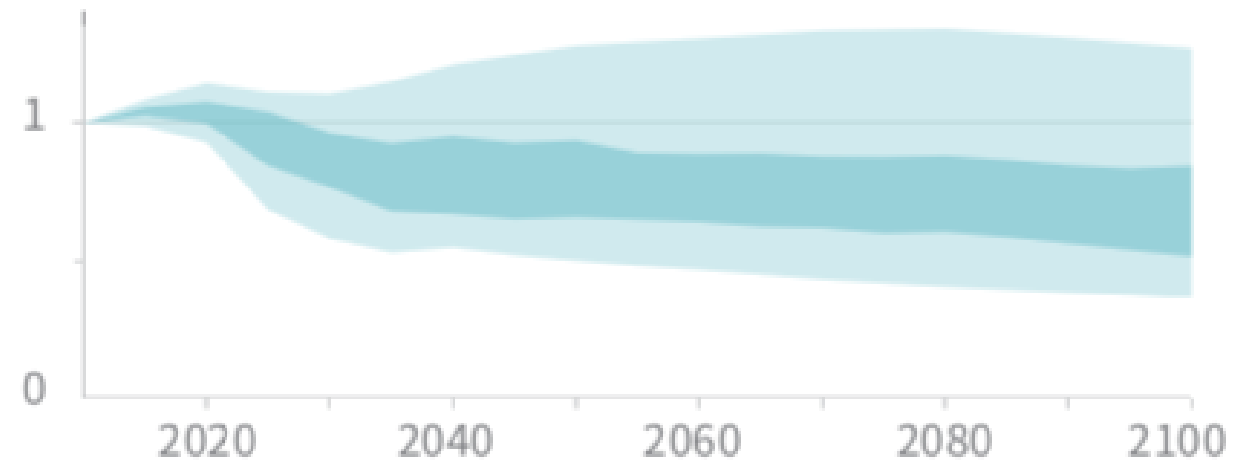
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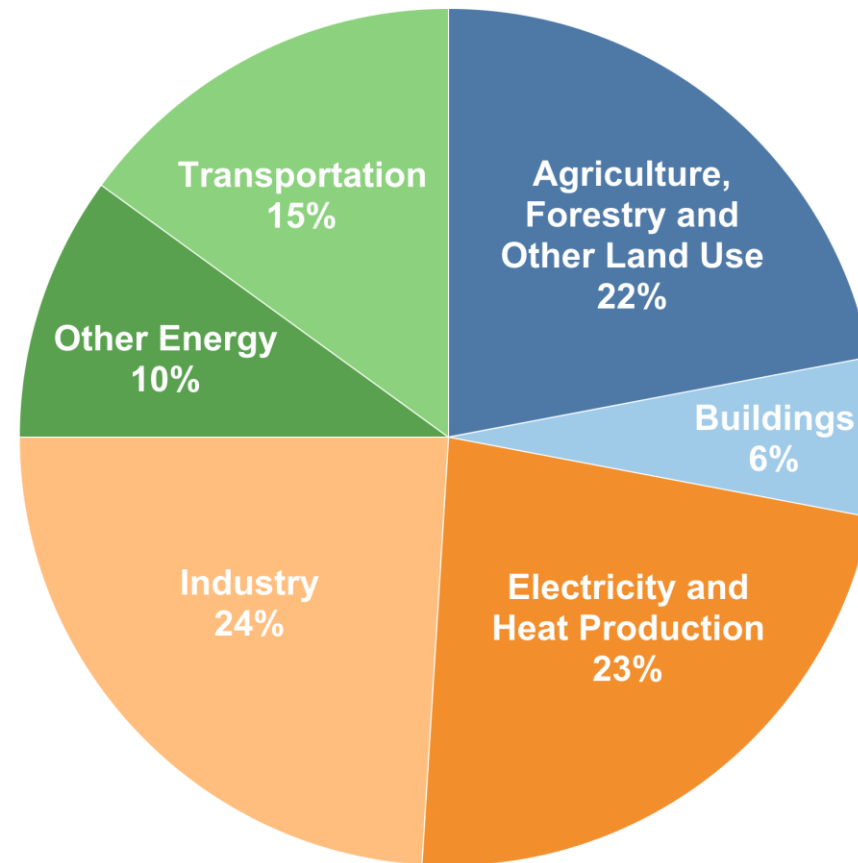


Nitrous oxide emissions



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GLOBAL GREENHOUSE GAS EMISSIONS BY ECONOMIC SECTOR
EMISSIONS DATA FROM 2019

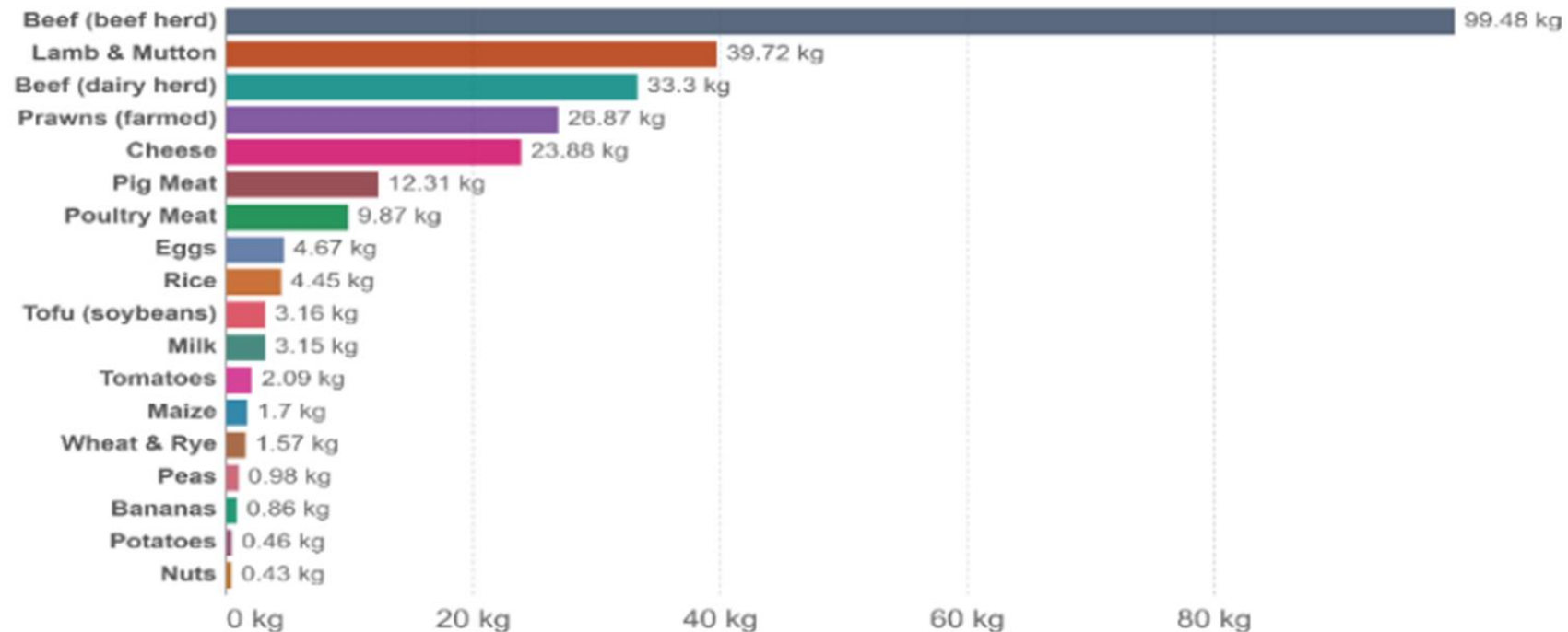


GHG emissions of meat are larger than of vegetables

Greenhouse gas emissions per kilogram of food product

Our World
in Data

Emissions are measured in carbon dioxide equivalents (CO₂eq). This means non-CO₂ gases are weighted by the amount of warming they cause over a 100-year timescale.

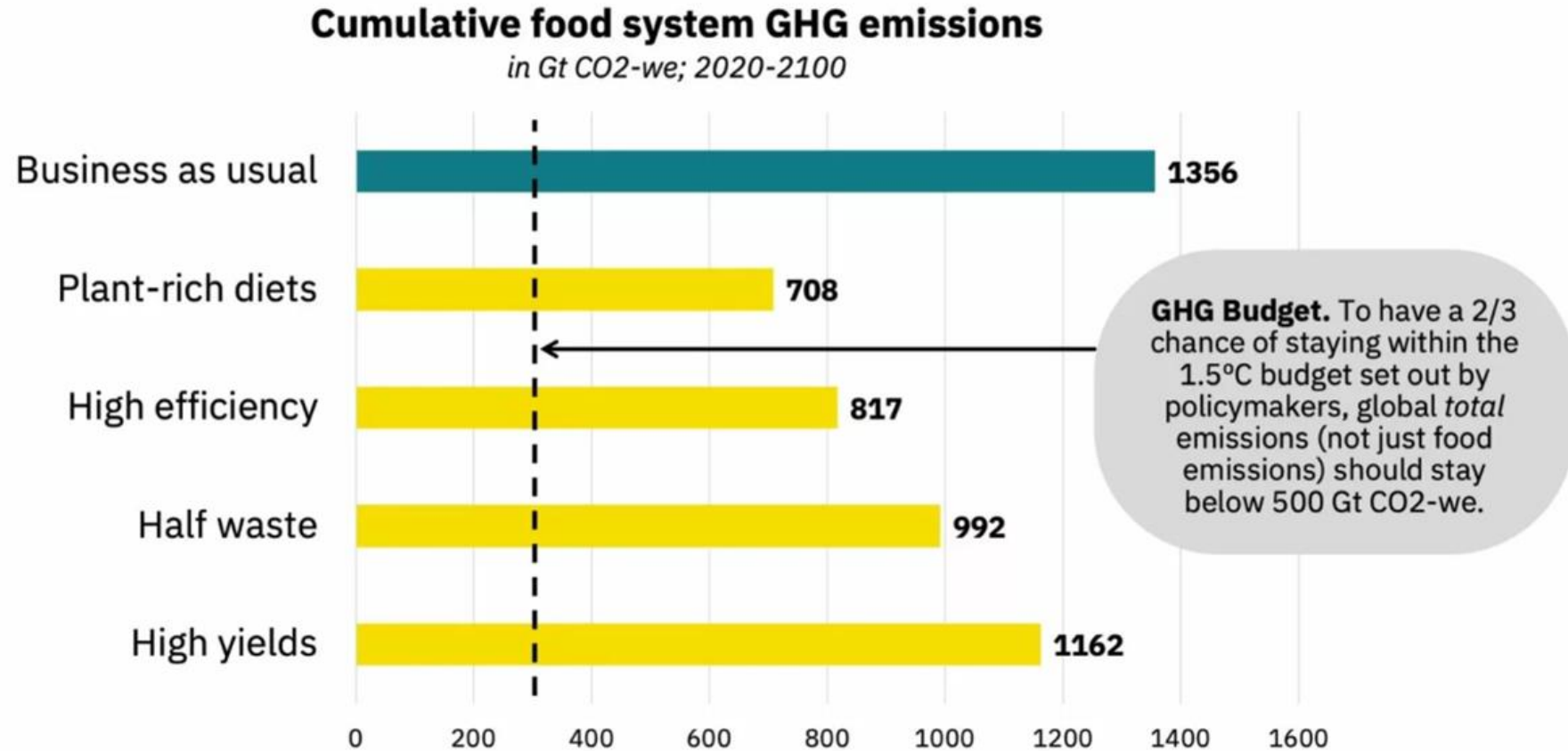


Source: Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers.

Note: Greenhouse gases are weighted by their global warming potential value (GWP100). GWP100 measures the relative warming impact of one molecule of a greenhouse gas, relative to carbon dioxide, over 100 years.

OurWorldInData.org/environmental-impacts-of-food • CC BY

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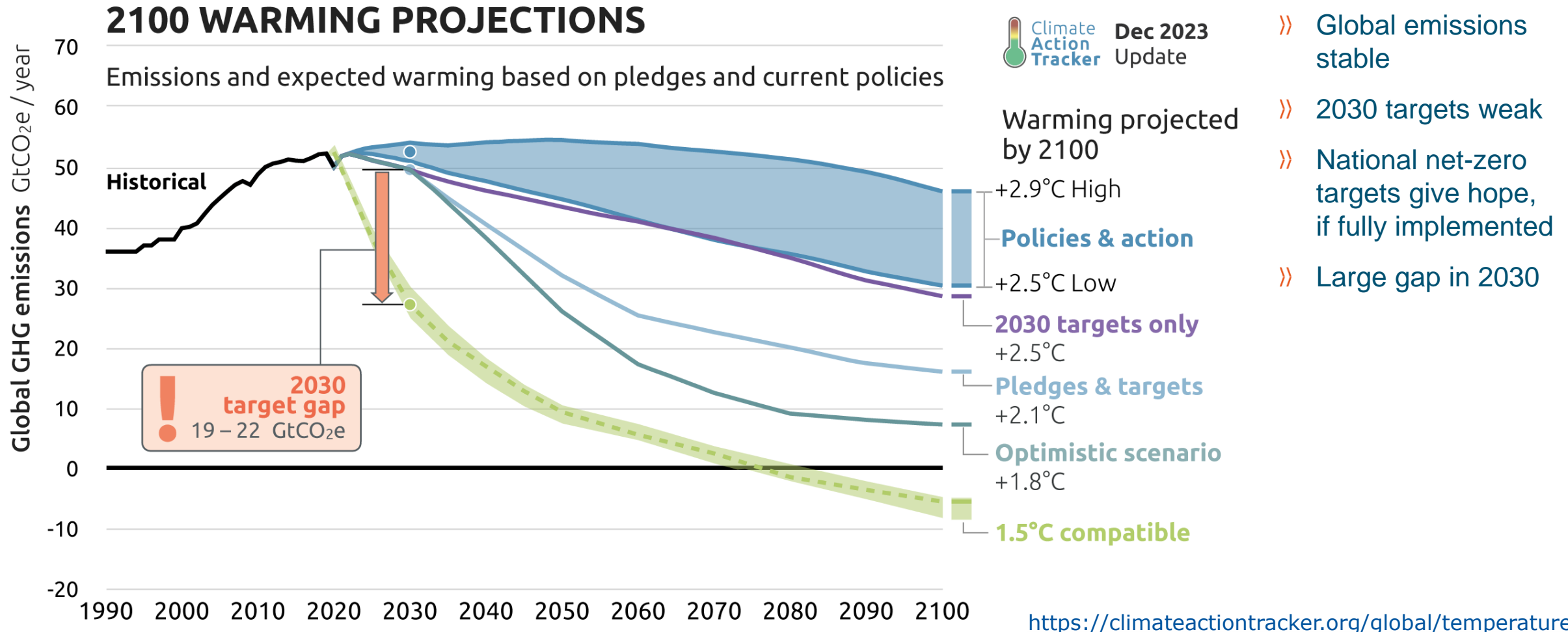
Source: Michael A. Clark, et al. Global food system emissions could preclude achieving the 1.5° and 2°C climate change targets. *Science*. 2020.



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Temperature increase by 2100



5 shifts that give hope

SHIFT 5

Electrification & industry

Electrification in transport and buildings has **progressed significantly** and all industry is now working on zero carbon strategies.

SHIFT 1

Awareness & civil action

Climate change discourse has become mainstream. **Civil and legal action** pushes governments and companies.

SHIFT 4

Energy supply

Renewables reached cost parity with fossils and power systems are **shifting to decentralised, flexible models**.



SHIFT 3

Investors & business

Every investor and every business feels **pressure to act on climate**.

SHIFT 2

Vision, goals & policies

Widely recognised that **emissions have to be reduced** to zero by every country across the economy.

[Source: Five major shifts since the Paris Agreement that give hope in a just, Paris-compatible transition | NewClimate Institute](#)

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