

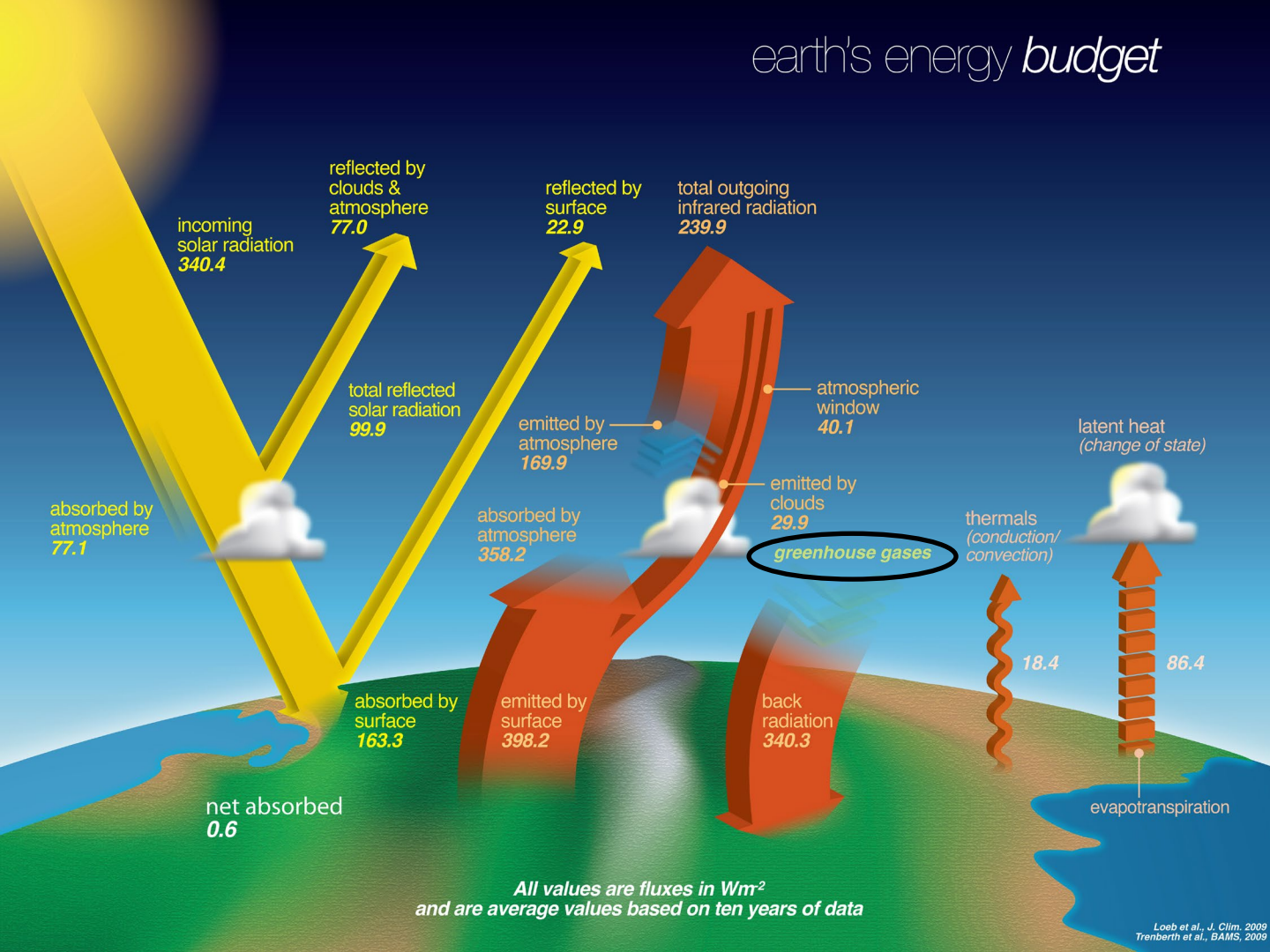
The Meaning of Net Zero

Joanna D. Haigh

Imperial College London

IES Burntwood Lecture 25 November 2021

earth's energy *budget*



All values are fluxes in Wm^{-2}
and are average values based on ten years of data

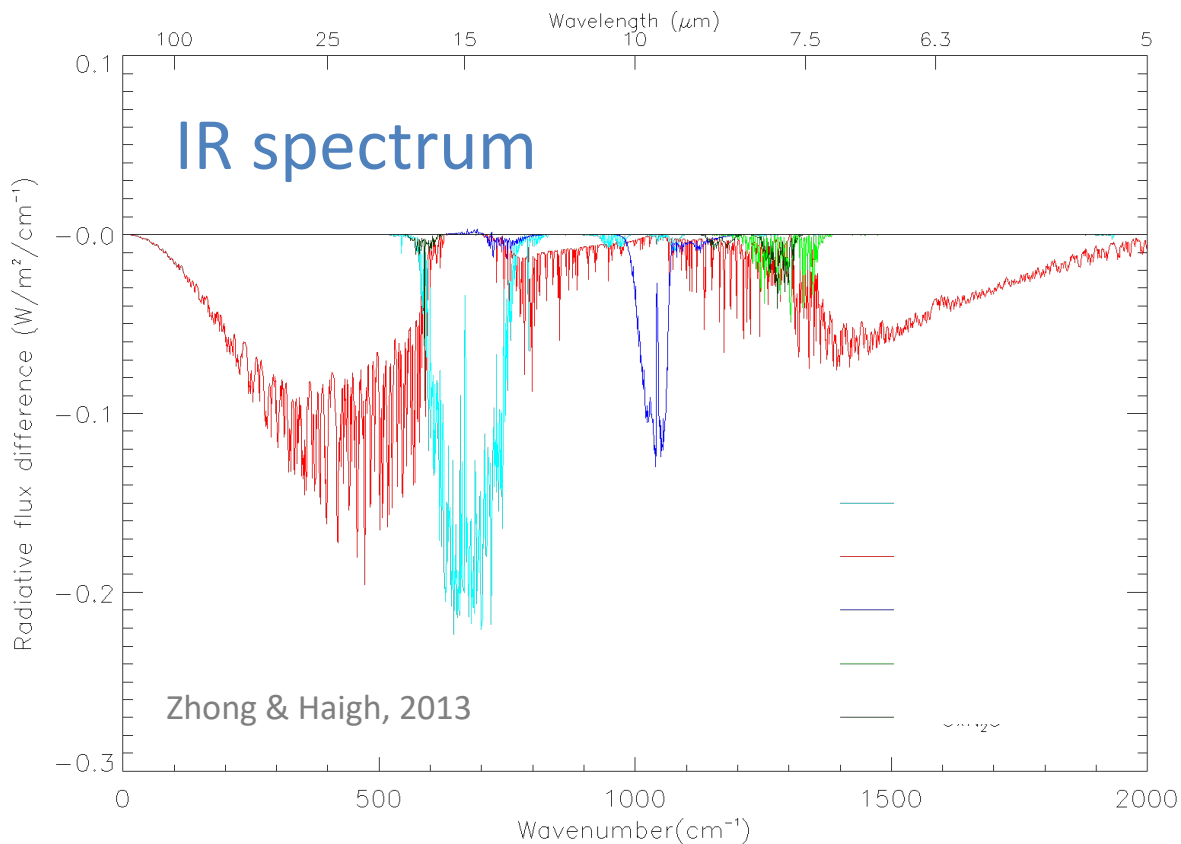
Loeb et al., *J. Clim.* 2009
Trenberth et al., *GAHS*, 2009

Greenhouse gases (GHGs) absorb and emit infrared radiation.

An increase in GHGs produces a “radiative forcing” causing surface to warm.

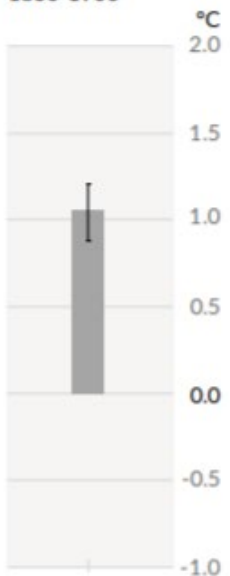
NASA (2017)

Impact of greenhouse gases on infrared radiation leaving top of atmosphere

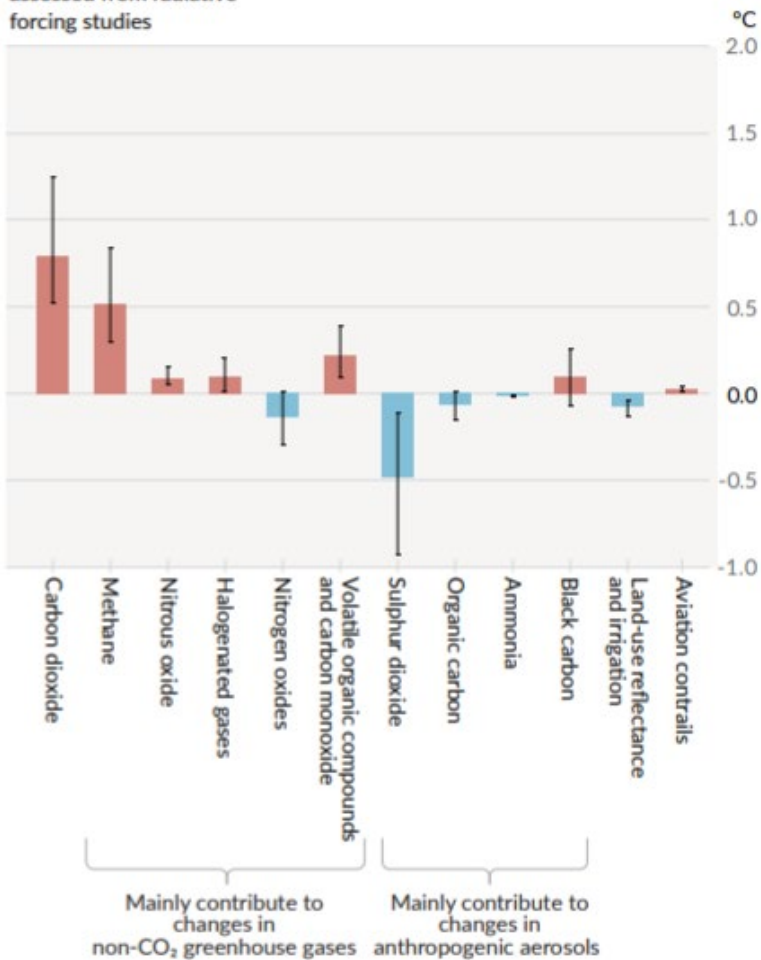


Gas	Impact (Wm^{-2})
H ₂ O	-70.6
CO ₂	-25.5
O ₃	-7.0
CH ₄	-1.7
N ₂ O	-1.8

a) Observed warming 2010-2019 relative to 1850-1900



c) Contributions to 2010-2019 warming relative to 1850-1900, assessed from radiative forcing studies



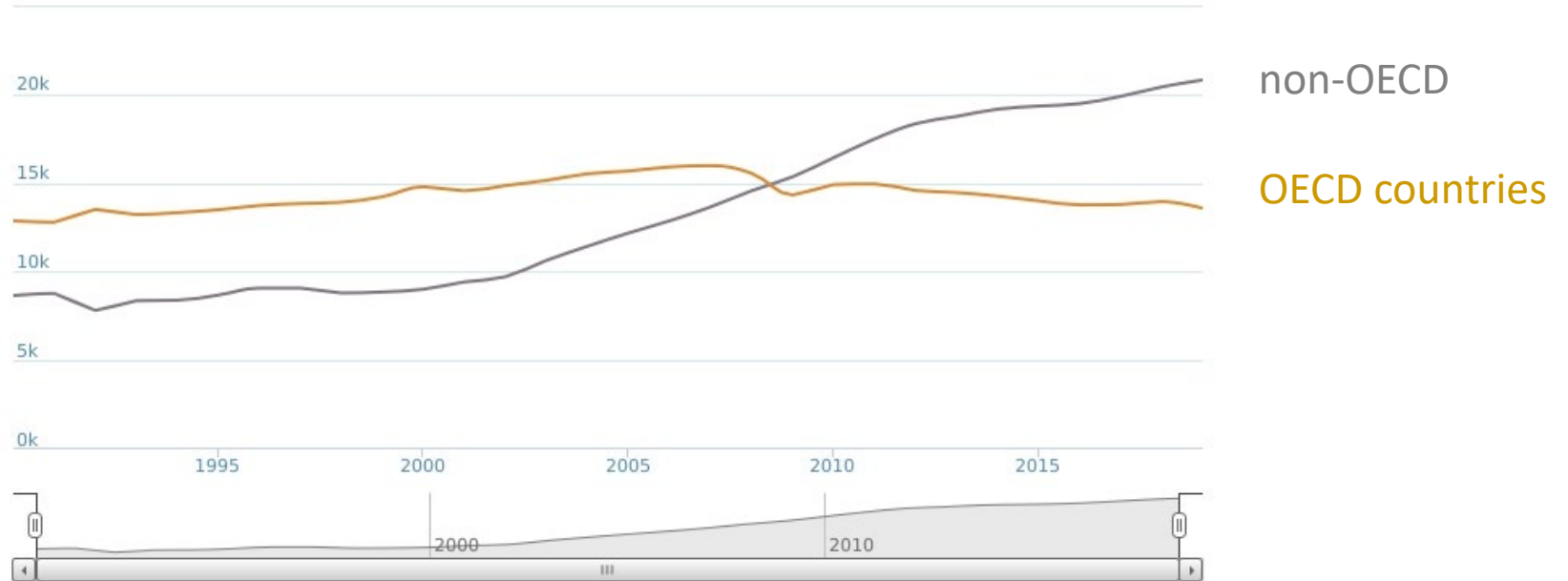
Contributions to warming

from Figure SPM.2 of IPCC* Sixth Assessment Report Working Group I (AR6 WGI, 2021)

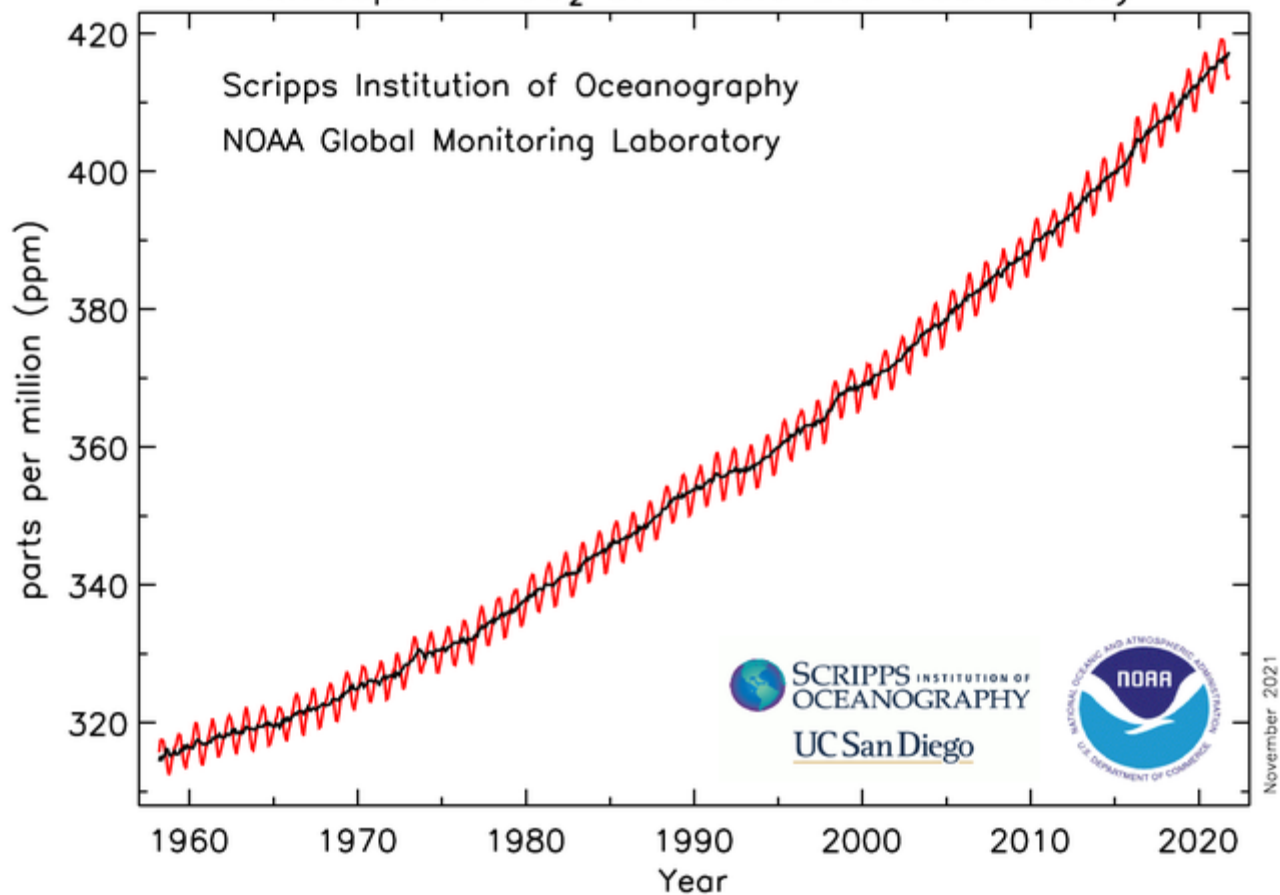
*UN Intergovernmental Panel on Climate Change

CO₂ emissions 1990-2019

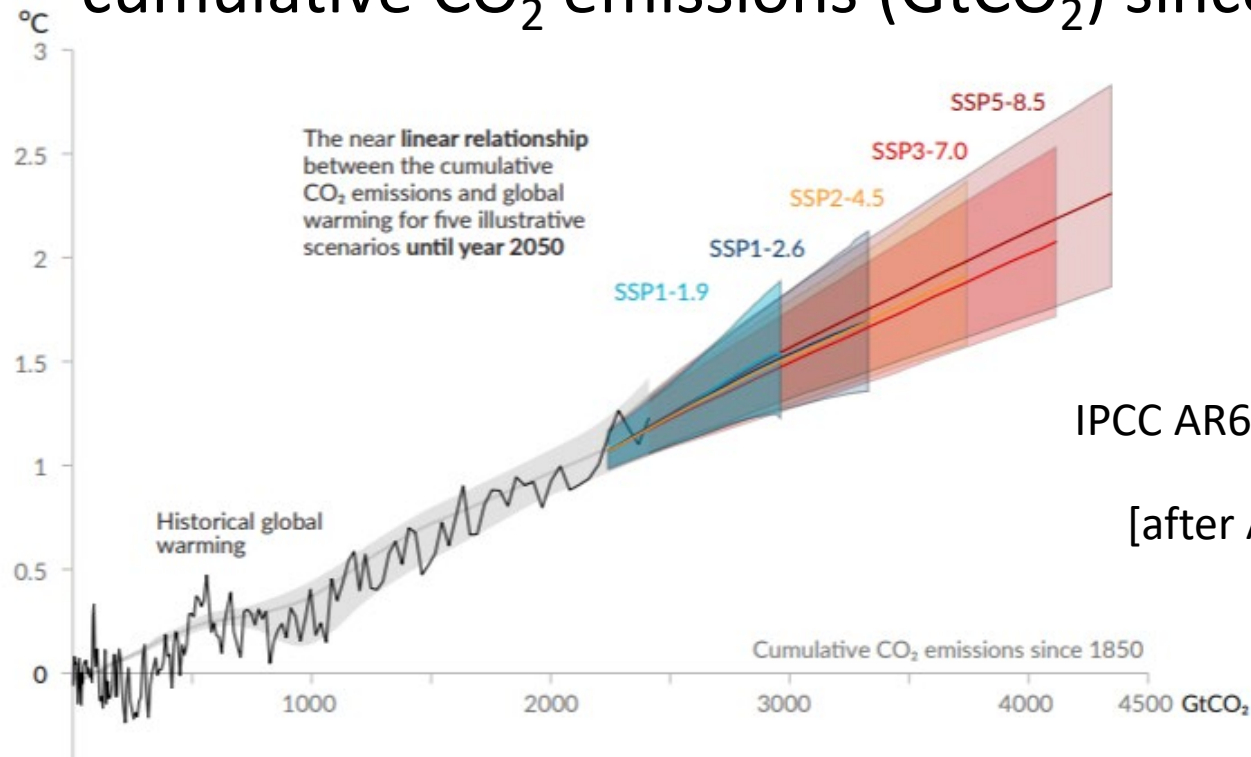
Consumption (MtCO₂)



Atmospheric CO₂ at Mauna Loa Observatory



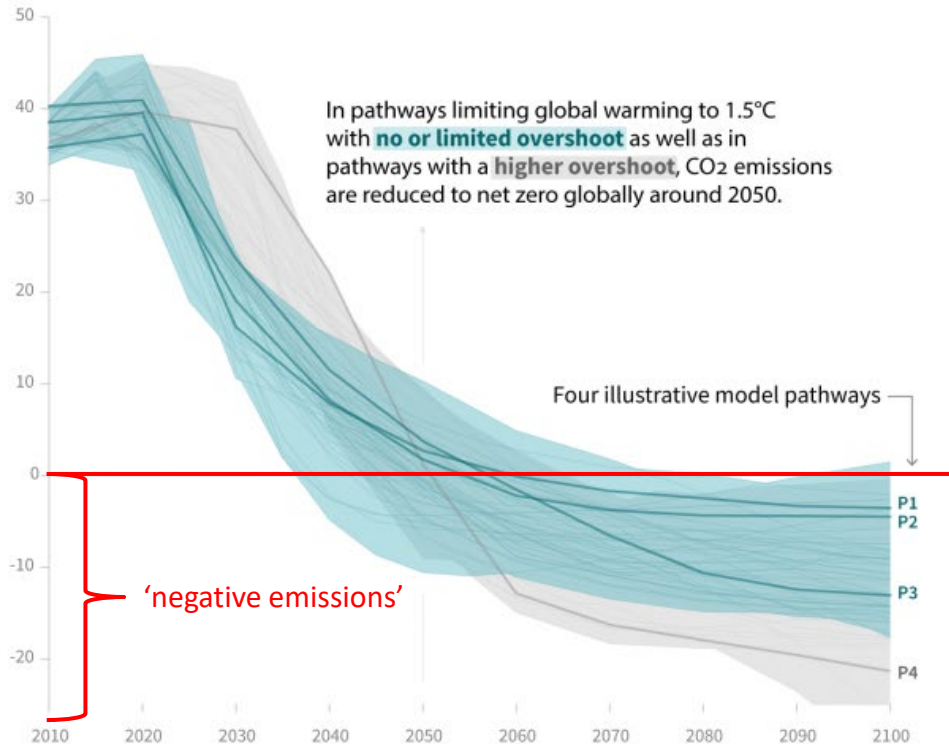
Global surface temperature increase ($^{\circ}\text{C}$) as function of cumulative CO_2 emissions (GtCO_2) since 1850



A limit on temperature increase implies a limit on accumulated CO_2 - and a cessation of emissions when this limit has been reached

Global total net CO₂ emissions

Billion tonnes of CO₂/yr



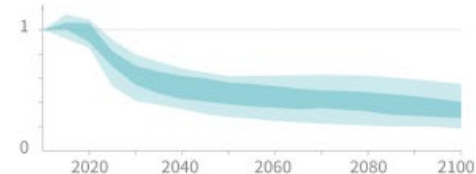
Timing of net zero CO₂
Line widths depict the 5-95th percentile and the 25-75th percentile of scenarios



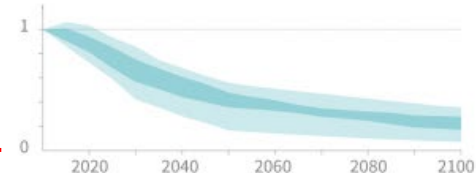
Non-CO₂ emissions relative to 2010

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.

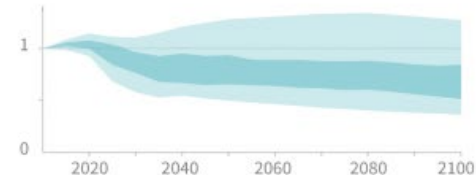
Methane emissions



Black carbon emissions



Nitrous oxide emissions



Global pathways which limit warming to 1.5°C

Figure SPM.3a
IPCC Special Report on
Global Warming of
1.5°C (2018)

Net-zero

UN Paris Agreement 2015 aim ‘... to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century.’

Issues:

- All greenhouse gases (GHGs) or just CO₂?
- Which emissions?

CO₂ – equivalent emissions (CO₂ eq)

The CO₂ emissions which would result in the same warming as all the GHGs in a given scenario.

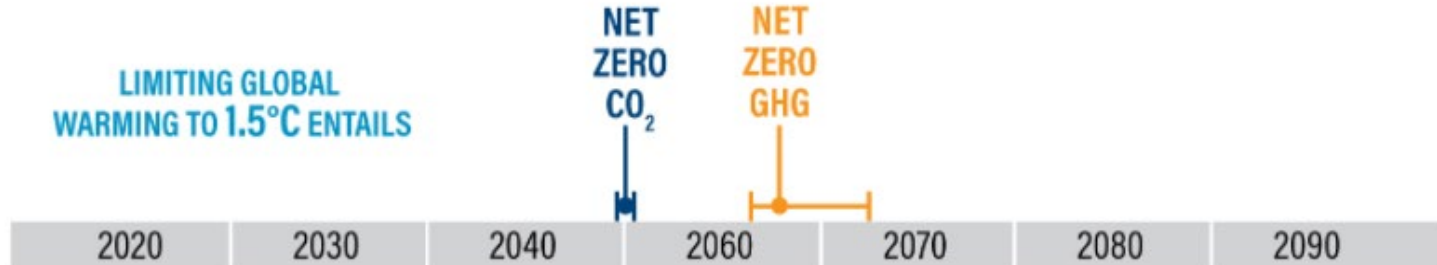
Often calculated from GWP* values.

*Global Warming Potential: the warming a gas produces over a given time period, taking account of its atmospheric lifetime, relative to the same mass of CO₂.

- methane lifetime ~12 years GWP₁₀₀ ~32
- nitrous oxide ~120 years ~280

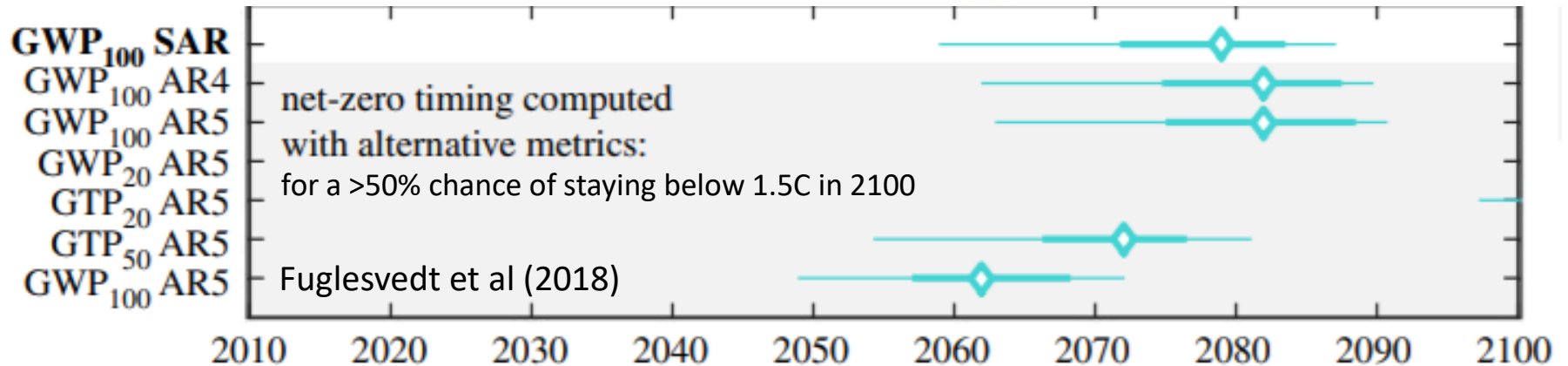
Net Zero CO₂ cf Net Zero GHGs

Global timeline to reach net-zero emissions



Source: IPCC Special Report on Global Warming of 1.5°C

 WORLD RESOURCES INSTITUTE



Nationally Determined Contributions (NDCs)

Commitments by Parties to UNFCCC* to reductions in terrestrial emissions of GHGs (or often just CO₂).

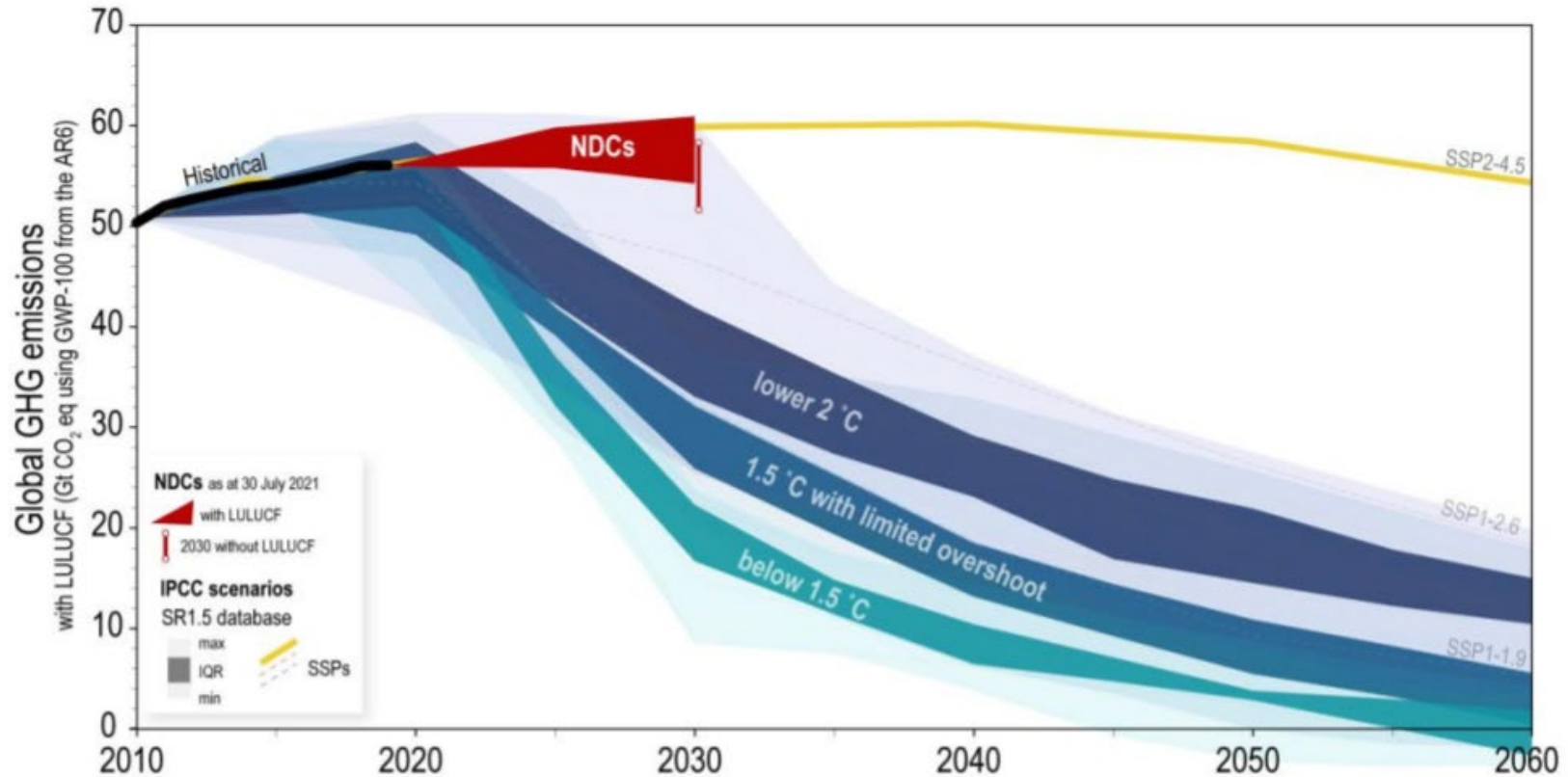
First introduced at COP21⁺ (Paris 2015).

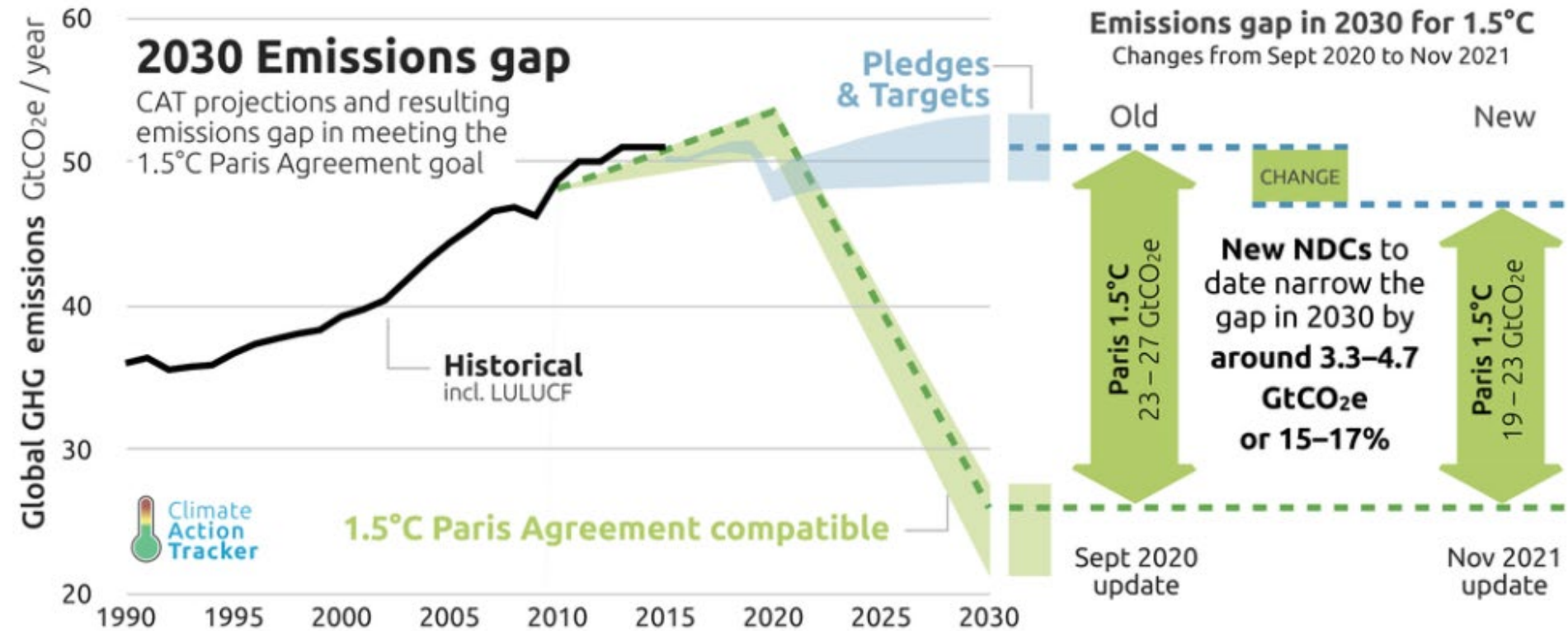
e.g. UK (2020) has committed to reduce economy-wide GHG emissions by at least 68% by 2030, compared to 1990 levels.

*UN Framework Convention on Climate Change ⁺21st Conference of the Parties

Figure 9

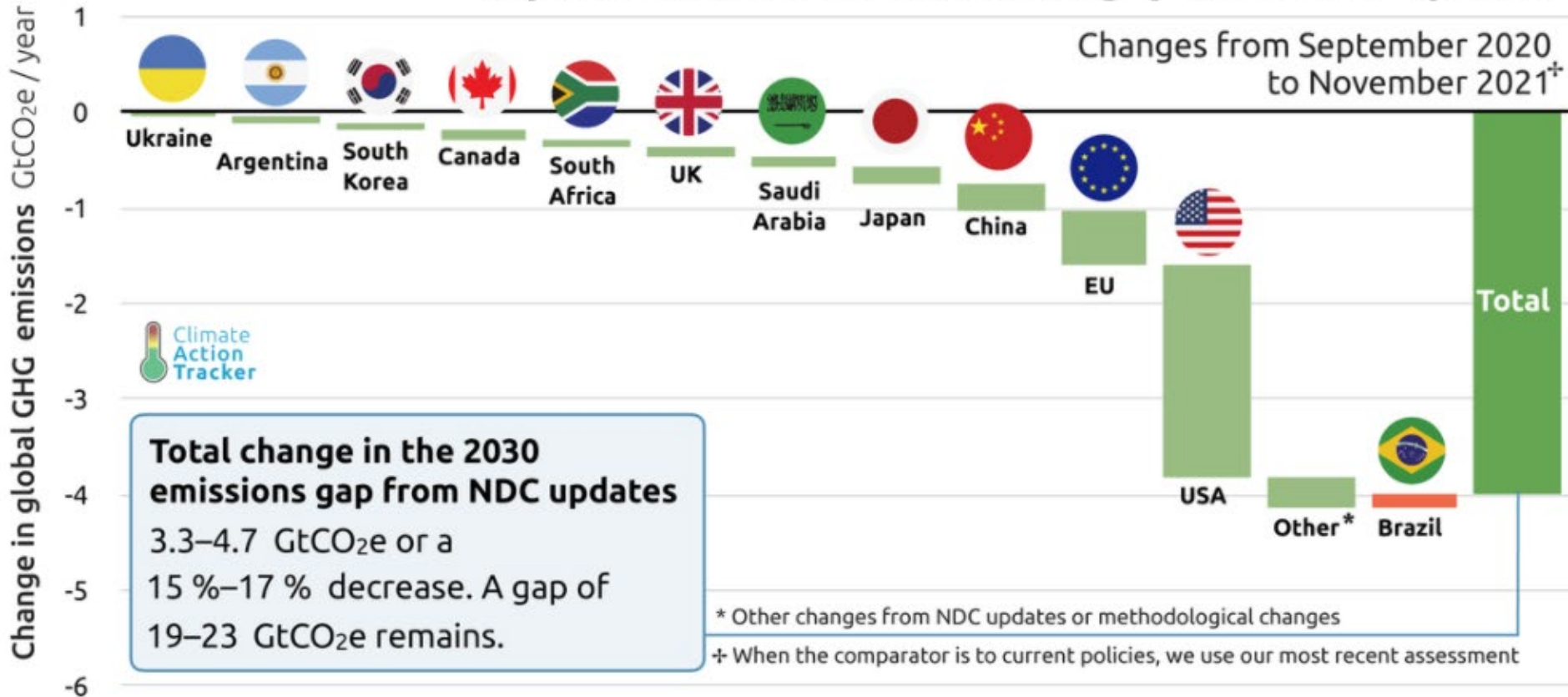
Comparison of global emissions under scenarios assessed in the Intergovernmental Panel on Climate Change Special Report on Global Warming of 1.5 °C with total global emissions according to nationally determined contributions





COP26

Impact on the 2030 emissions gap from NDC updates

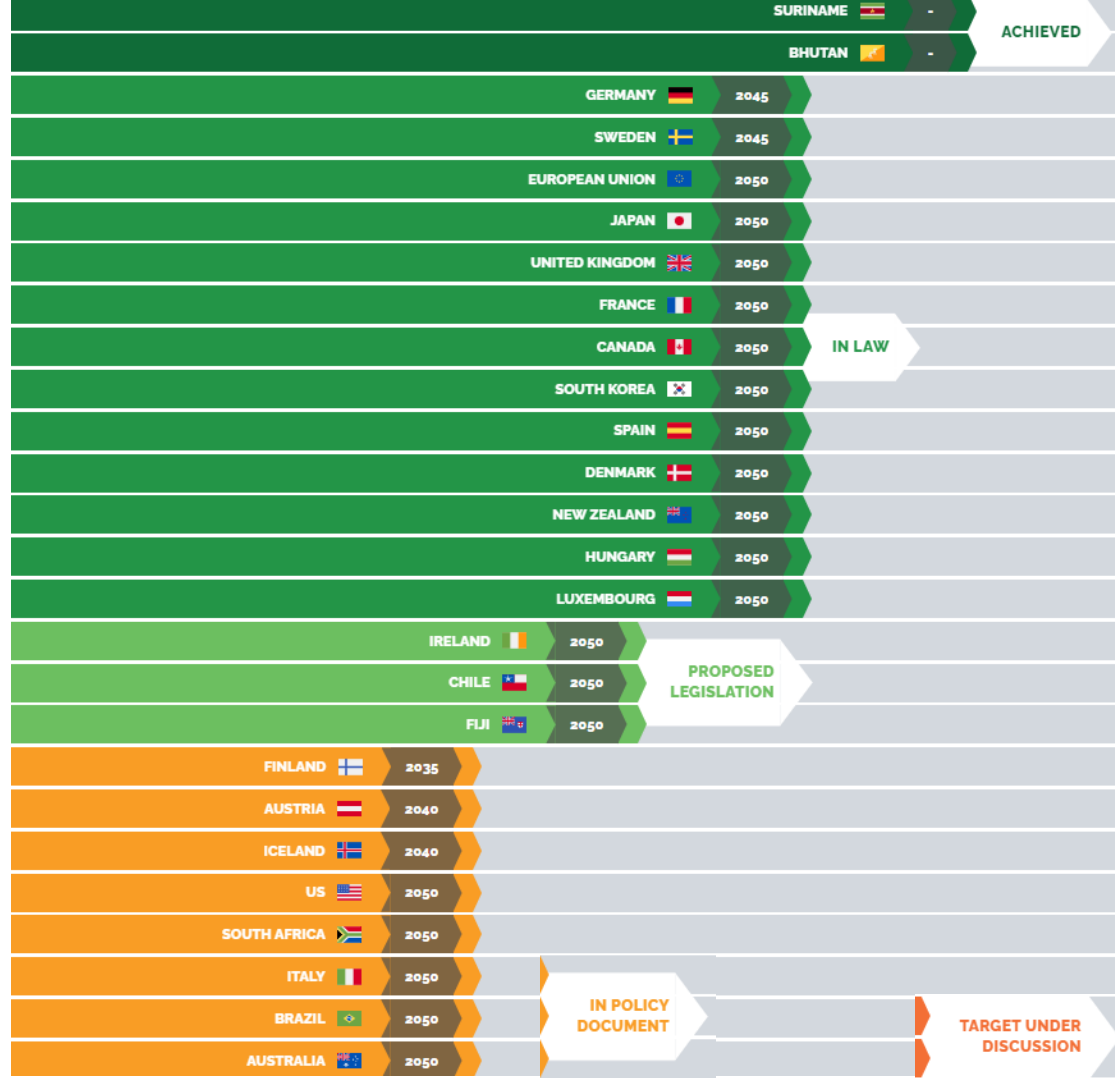


ENERGY & CLIMATE INTELLIGENCE UNIT NET ZERO EMISSIONS RACE

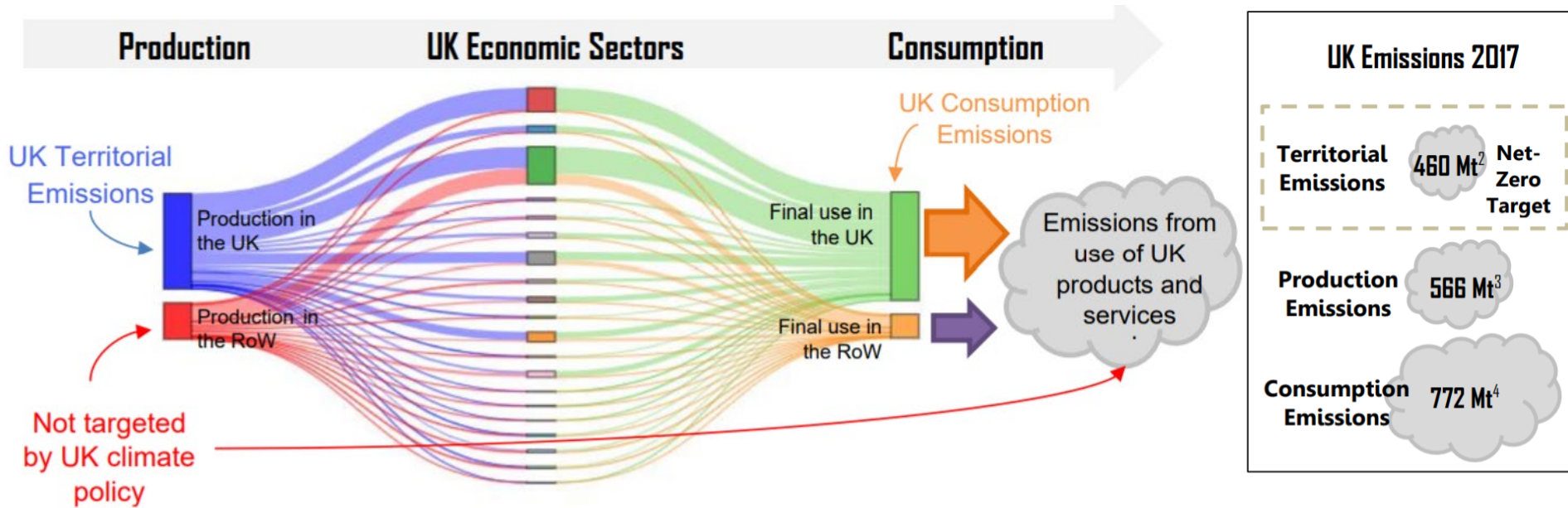
2021 SCORECARD

>150 countries

<https://eciu.net/netzerotracker>

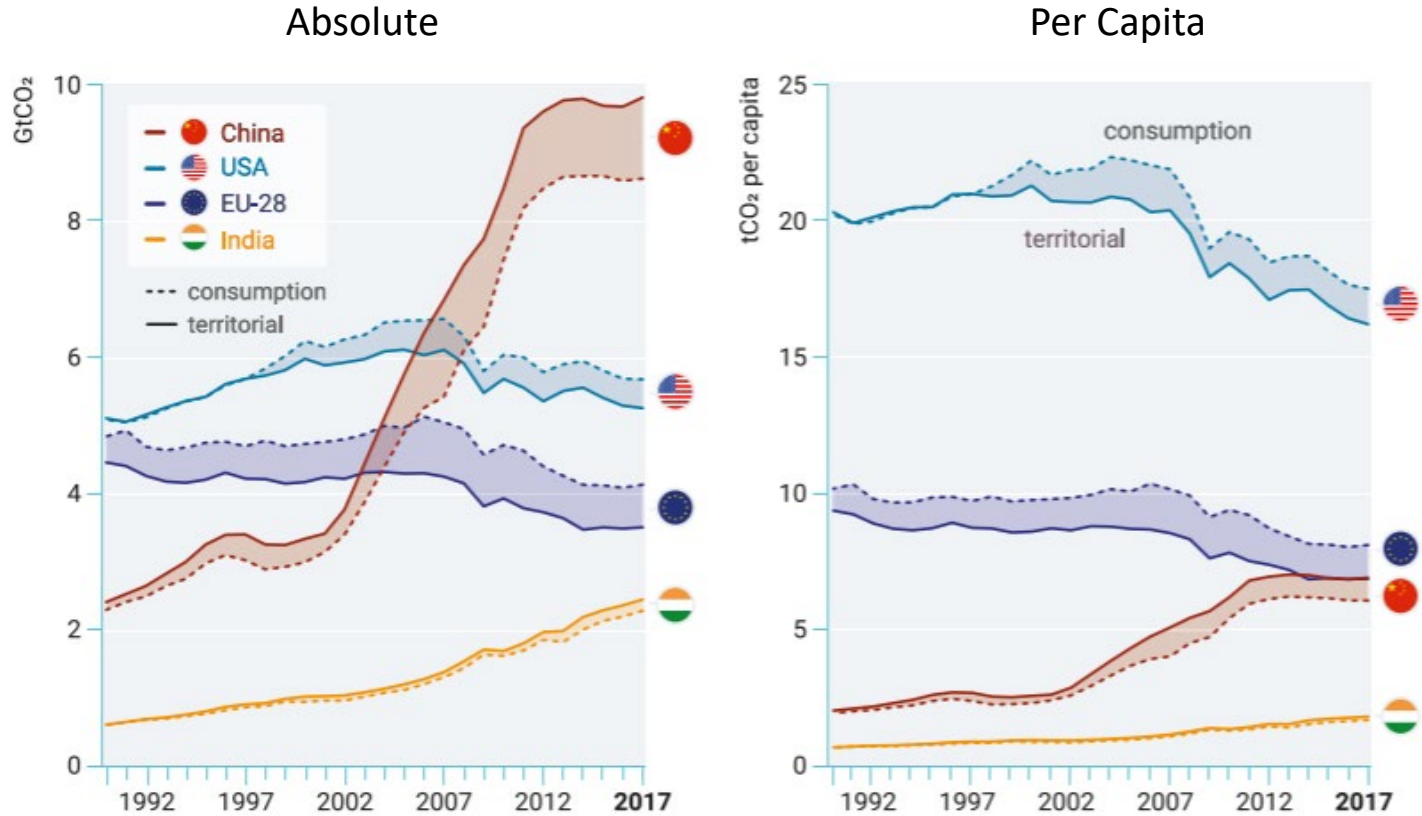


Territorial & Consumption Emissions



Winkler, Rogelj & Gilbert (2020)

Territorial production and consumption CO₂ emissions

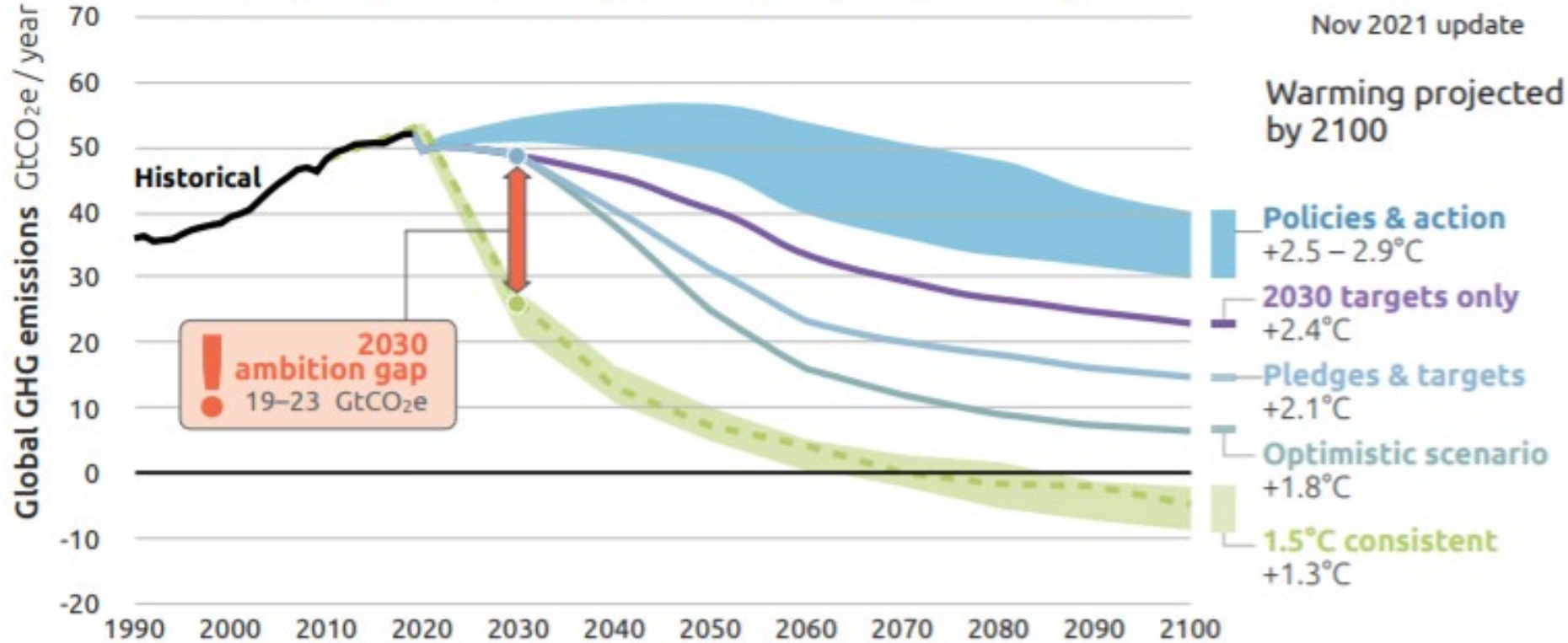


2100 WARMING PROJECTIONS

Emissions and expected warming based on pledges and current policies



Nov 2021 update



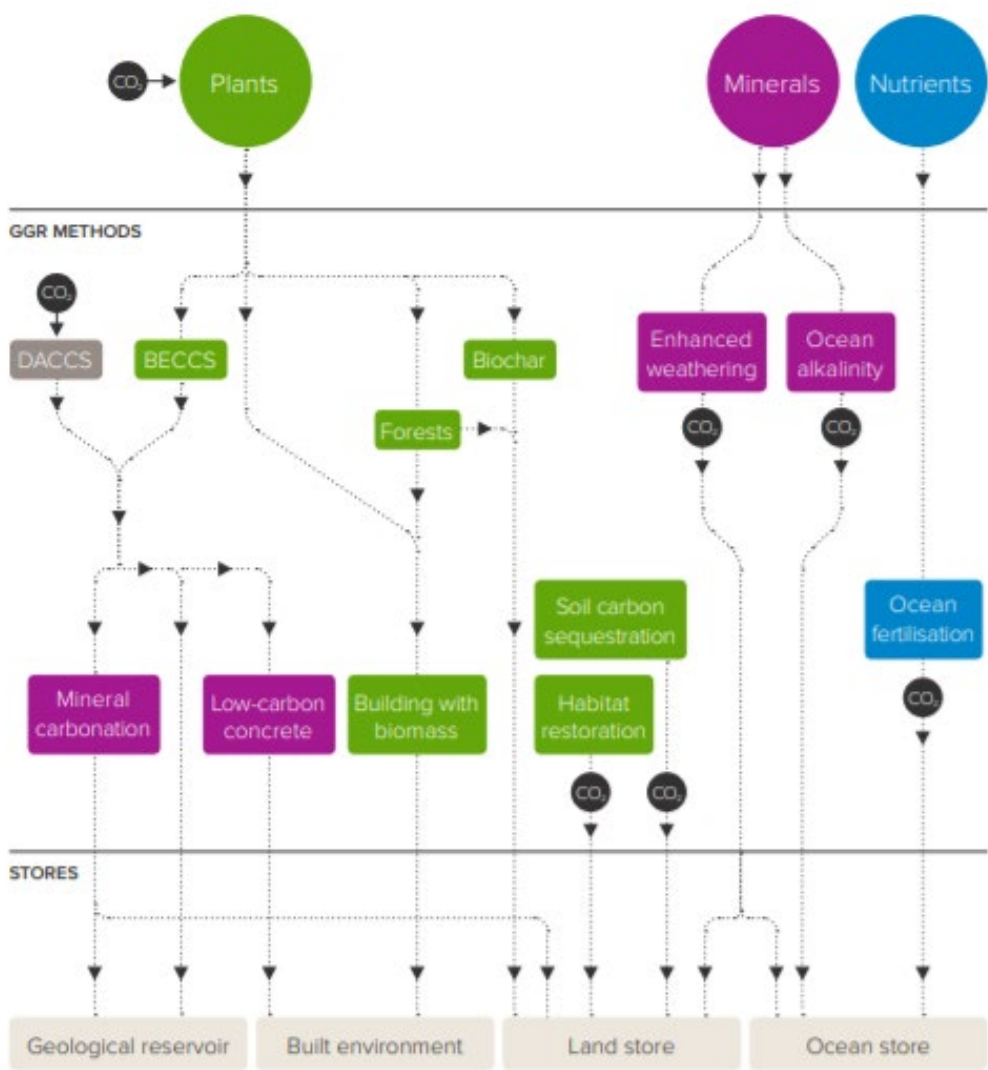
Glasgow's Credibility Gap (Climate Action Tracker Nov 2021)

Negative emissions

Needed in nearly all 1.5°C pathways.

Methods for GHG removal and storage
Royal Society report (2018)

DACCS: Direct Air Carbon Capture and Storage
BECCS: Bio-Energy with Carbon Capture and Storage



Offsetting

Offsetting: a polluter pays another party to take on additional mitigation activities which can then be included (as negative emissions) in the polluter's carbon inventory.

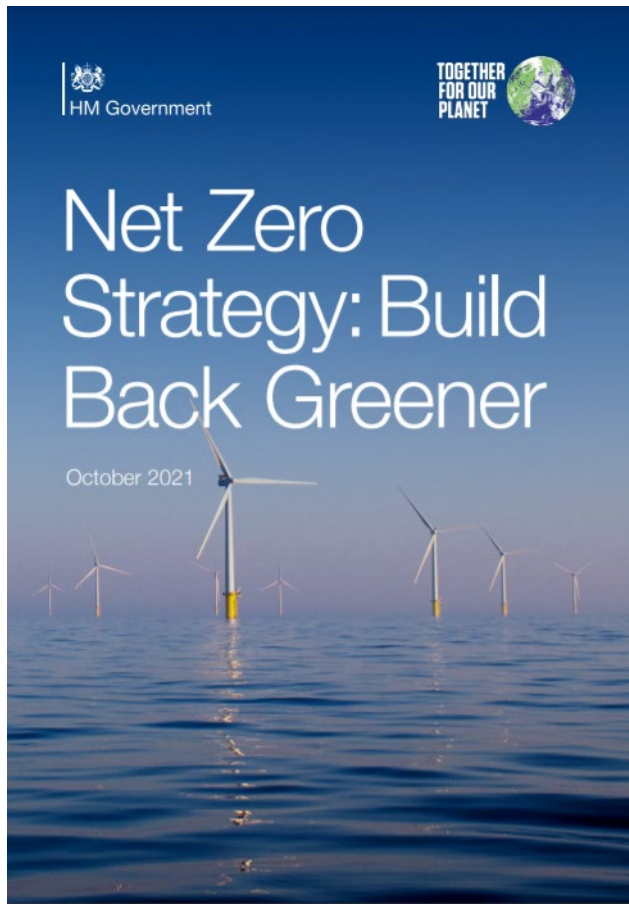
Carbon offsetting does not necessarily result in a reduction of emissions and can provide a disincentive (can pay to pollute).

Is basis for Carbon Markets and Emissions Trading.

Voluntary (unregulated) schemes used by companies and individuals can result in "Greenwashing".

Achievements of COP26

Progress
Agreement to update country commitments in 2022 towards a 1.5°C future
Agreement to end inefficient fossil fuel subsidies
Doubling of climate adaptation finance to developing countries by 2025
Paris Rulebook agreed including a coherent framework for carbon trading
Over 100 countries commit to end deforestation by 2030 with £14bn funding
Pledge to cut methane emissions by 30% by 2030, led by USA and EU
More to do
GFANZ alliance of financial institutions formed with \$130tn assets under management, but no concrete pledge to stop or reduce fossil fuel finance
USA and China agree to cooperate on climate issues
India announced a net zero target, but for 2070 and without signing pledges to reduce methane emissions and coal use
A long way to go
The world is not on track for a 1.5°C future
No commitment to phase out coal (only to phase down)
\$1bn annual climate finance target by 2020 missed (reset for 2022)
No agreement to compensate developing countries for climate-related loss and damage
Weaknesses highlighted in the agreed carbon trading framework

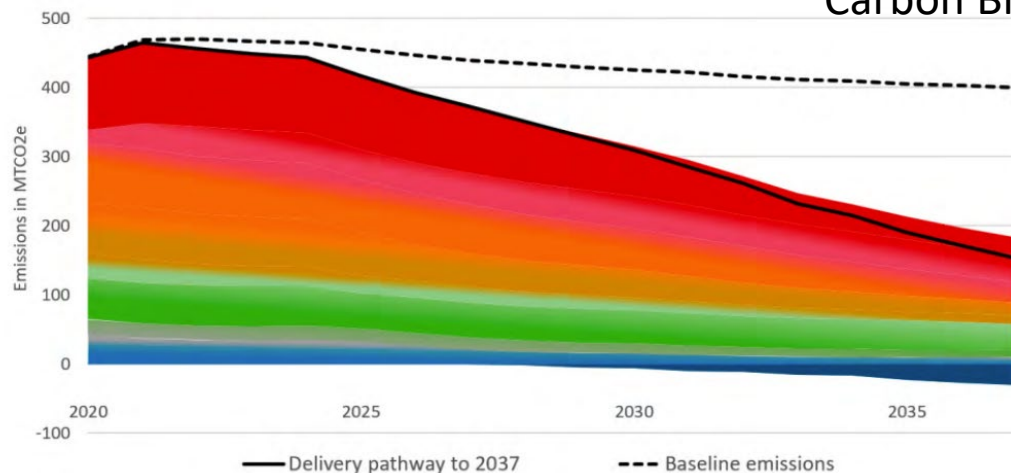


BEIS Net Zero Strategy

(Oct 2021)

www.gov.uk/government/publications/net-zero-strategy

Carbon Brief



Sectoral emissions under the indicative delivery pathway in the UK net-zero strategy, millions of tonnes of CO₂e. The dashed line shows what would have happened to emissions without the new strategy. Source: Net-zero strategy.

Net Zero will become a core delivery objective across the public sector.

Press release

UK to enshrine mandatory climate disclosures for largest companies in law

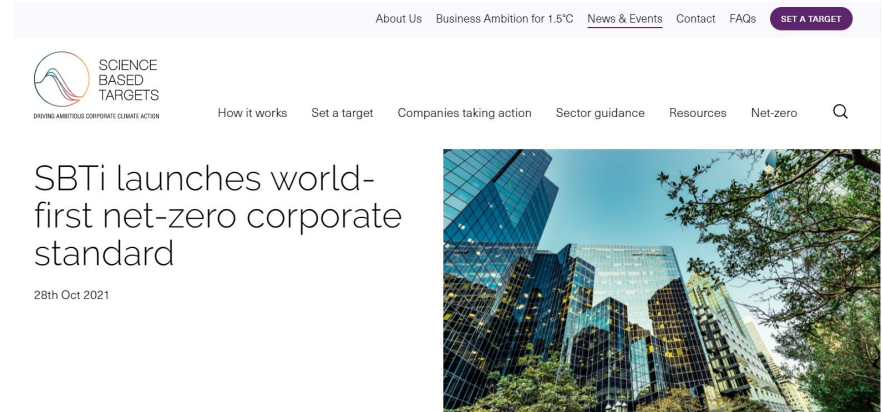
Firms will be required to disclose climate-related financial information, ensuring they consider the risks and opportunities they face as a result of climate change.

From: [Department for Business, Energy & Industrial Strategy](#), [HM Treasury](#), [John Glen MP](#), and [The Rt Hon Greg Hands MP](#)

Published 29 October 2021

Comes into force April 2022.
Will affect 1300 of UK's largest companies and financial institutions

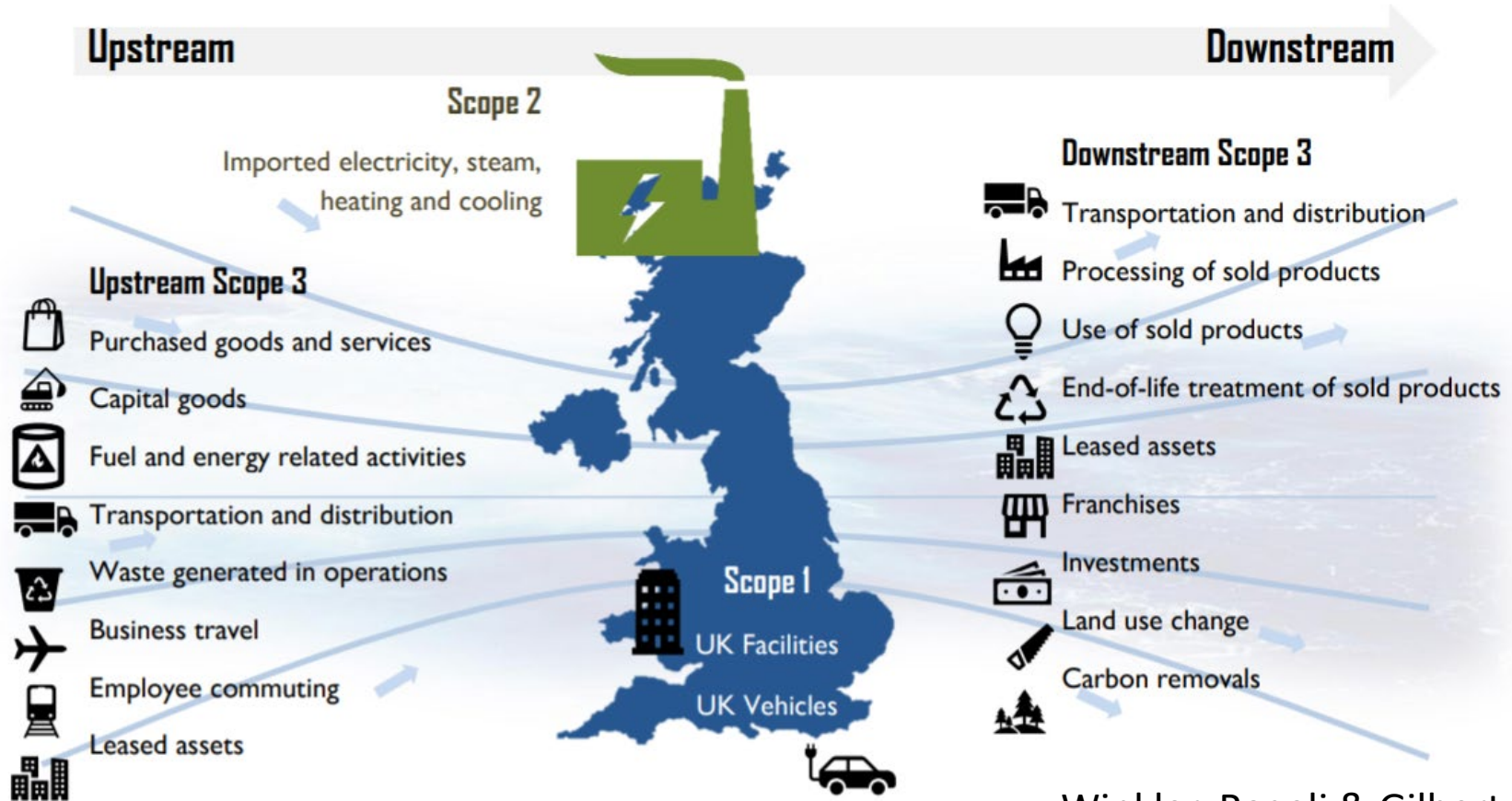
Corporate action



The screenshot shows the website for Science Based Targets (SBTi). The header includes navigation links: "About Us", "Business Ambition for 1.5°C", "News & Events", "Contact", "FAQs", and a "SET A TARGET" button. The main content area features the SBTi logo, which includes the text "SCIENCE BASED TARGETS" and "DRIVING AMBITIOUS CORPORATE CLIMATE ACTION". Below the logo are navigation links: "How it works", "Set a target", "Companies taking action", "Sector guidance", "Resources", and "Net-zero", along with a search icon. The main headline reads "SBTi launches world-first net-zero corporate standard" with a sub-headline "28th Oct 2021". To the right of the text is a photograph of modern glass skyscrapers under a clear blue sky, with some greenery in the foreground.

<https://sciencebasedtargets.org/>

Corporate emissions responsibility



Winkler, Rogelj & Gilbert (2020)

Decarbonisation plans of world's largest publicly-traded companies

NAME	COUNTRY	SECTOR	ANNUAL REVENUE	TARGET YEAR	TARGET TYPE	END TARGET STATUS	INTERIM TARGET	DETAILED PLAN	REPORTING MECHANISM	SCOPE 3 COVERAGE	CARBON CREDITS
↑↓	↑↓ All ▾	↑↓ All ▾	↓	↑↓ All ▾	↑↓ All ▾	↑↓	↑↓ All ▾	↑↓	↑↓	↑↓	↑↓

Walmart	USA		\$523bn	2040	Net zero	In corporate strategy	2025	●	●	●	●
Royal Dutch Shell	NLD	Oil & gas processing	\$421.1bn	2050	Net zero	In corporate strategy	2030	●	●	●	●
Sinopec	CHN		\$369.2bn	2050	Carbon neutral(ity)	Proposed / in discussion	2030	●	●	●	●
PetroChina Co	CHN		\$364.1bn	2050	Zero carbon	Proposed / in discussion	2025	●	●	●	●
Saudi Aramco	SAU		\$329.8bn	2050	Net zero	Declaration / pledge		●	●	●	●
Amazon	USA		\$280.5bn	2040	Net zero	In corporate strategy	2025	●	●	●	●
Toyota Motor	JPN	Transportation equipment	\$280.5bn	2050	Zero emissions	In corporate strategy	2030	●	●	●	●
Volkswagen	DEU	Transportation equipment	\$275.2bn	2050	Carbon neutral(ity)	In corporate strategy	2030	●	●	●	●

Resources to support net zero planning

Smaller businesses SME Climate Hub <https://businessclimatehub.org/>

Larger organisations Carbon Trust <https://www.carbontrust.com/>

Non-executive directors Chapter Zero <https://chapterzero.org.uk/>

FE/HE Sector Environmental Association of Universities
and Colleges <https://www.eauc.org.uk/>

Schools Let's Go Zero <https://letsgozero.org/>

9 things you can do about climate change

<https://www.imperial.ac.uk/grantham/>

