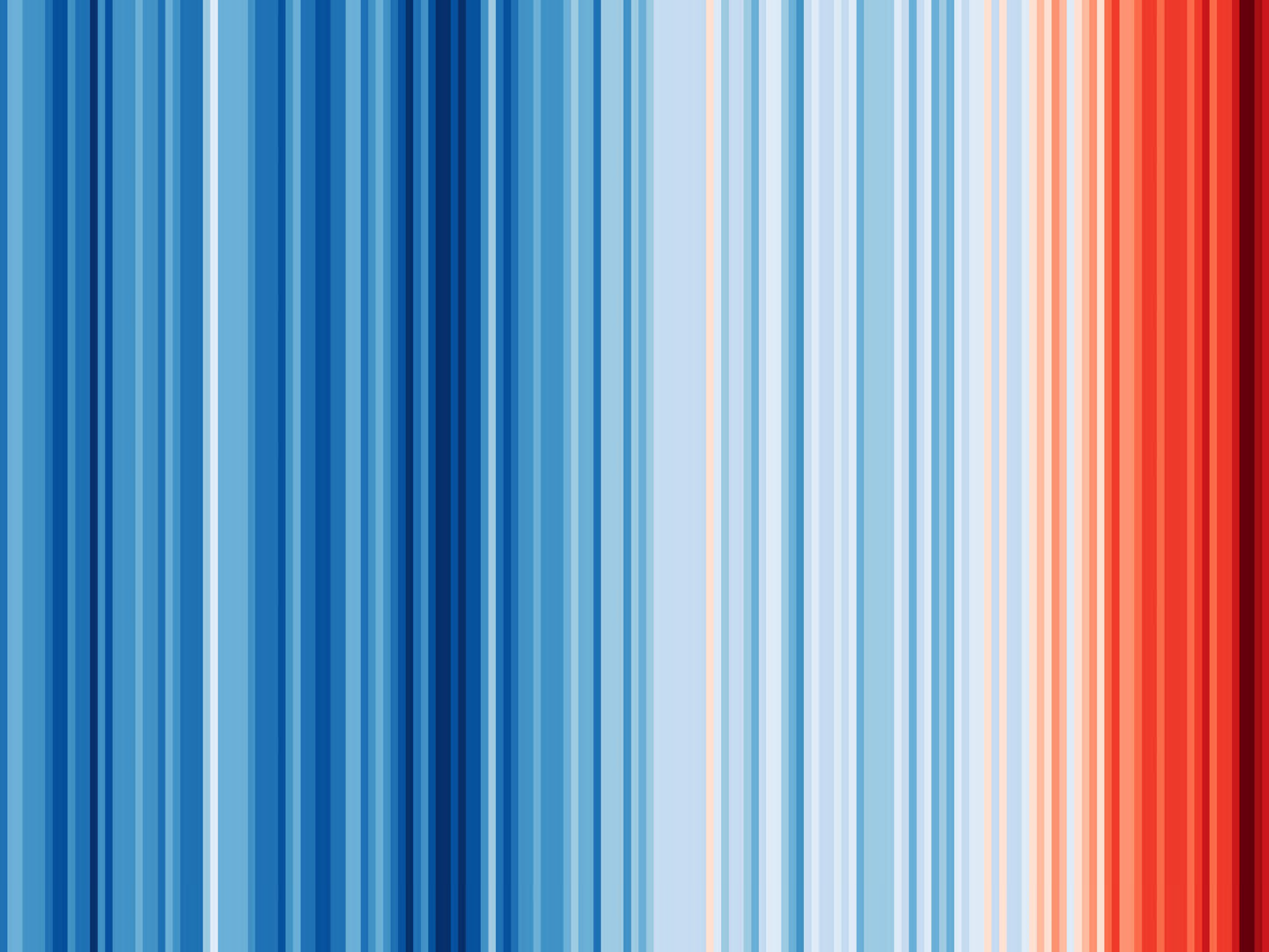
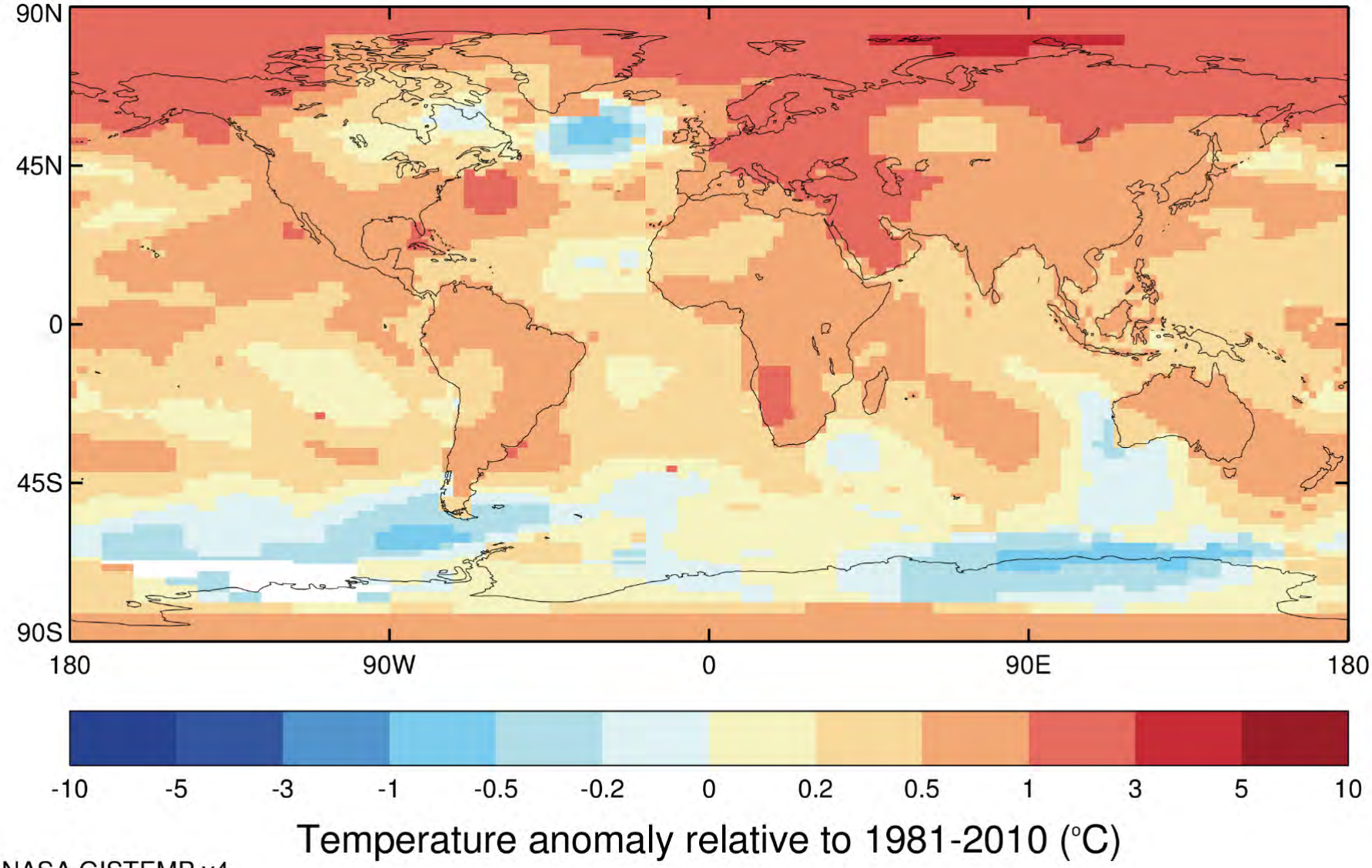


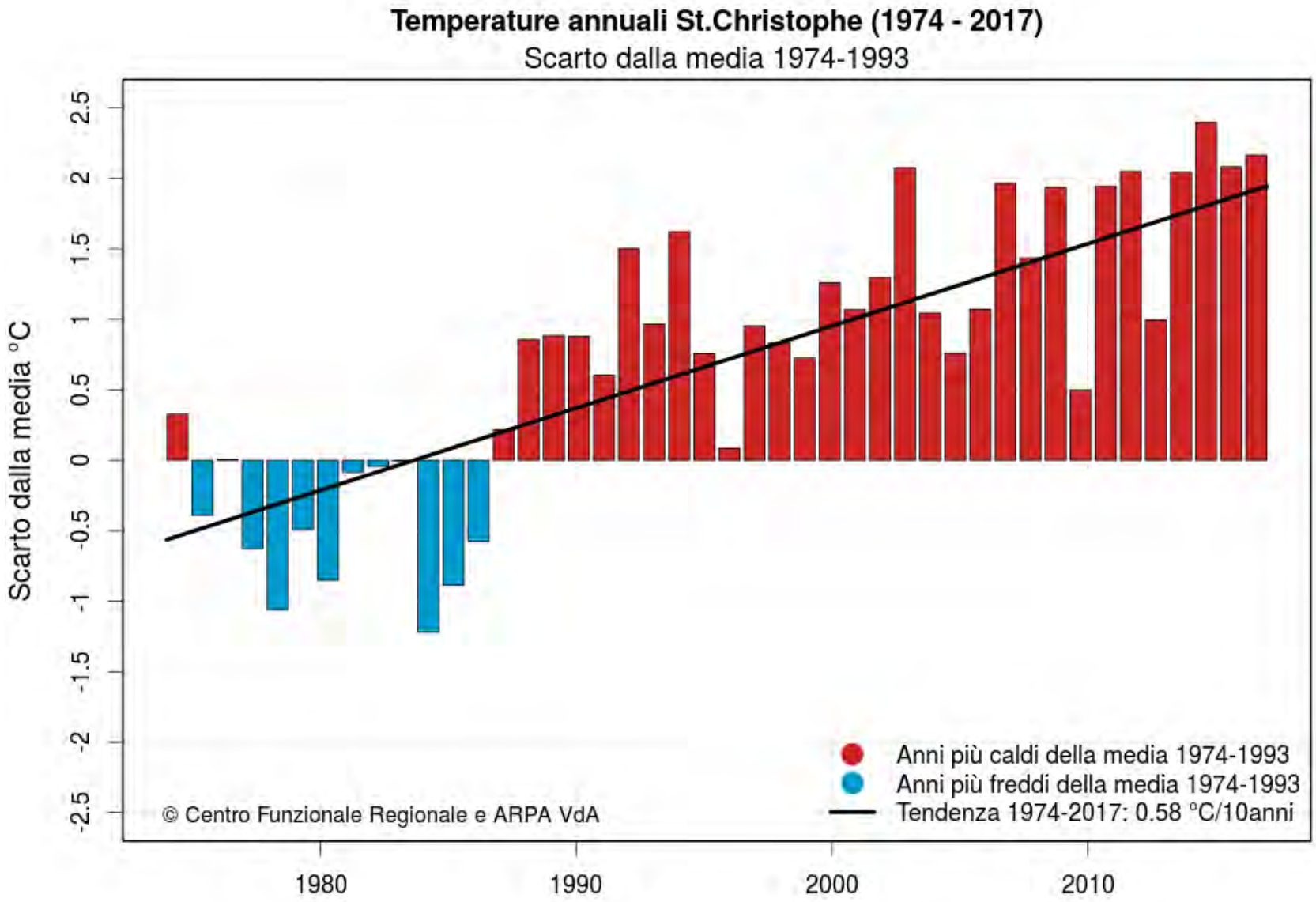
Accade su tutto il pianeta? SÍ



Source NASA GISTEMP v4

Anche qui? SÍ, anzi di più

Le montagne si stanno scaldando più di altre parti del pianeta (St. Christophe: +**0.58**°C/10 anni vs +**0.2**°C/10 anni a scala globale (IPCC SR15)



Sono cicli naturali? NO

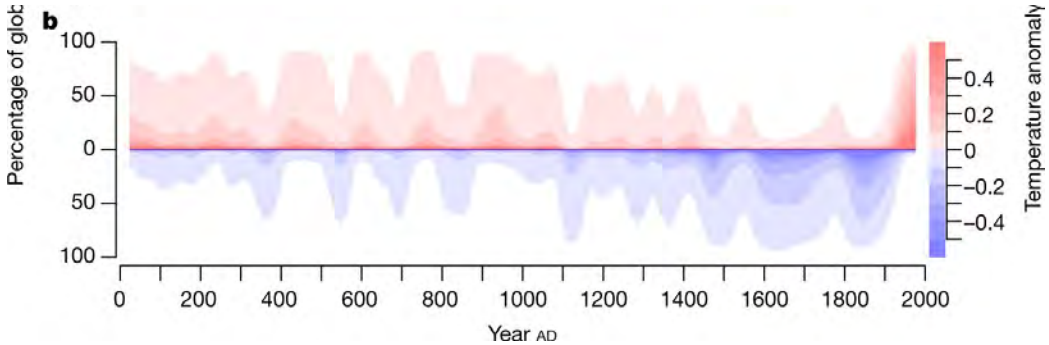
nature
International journal of science

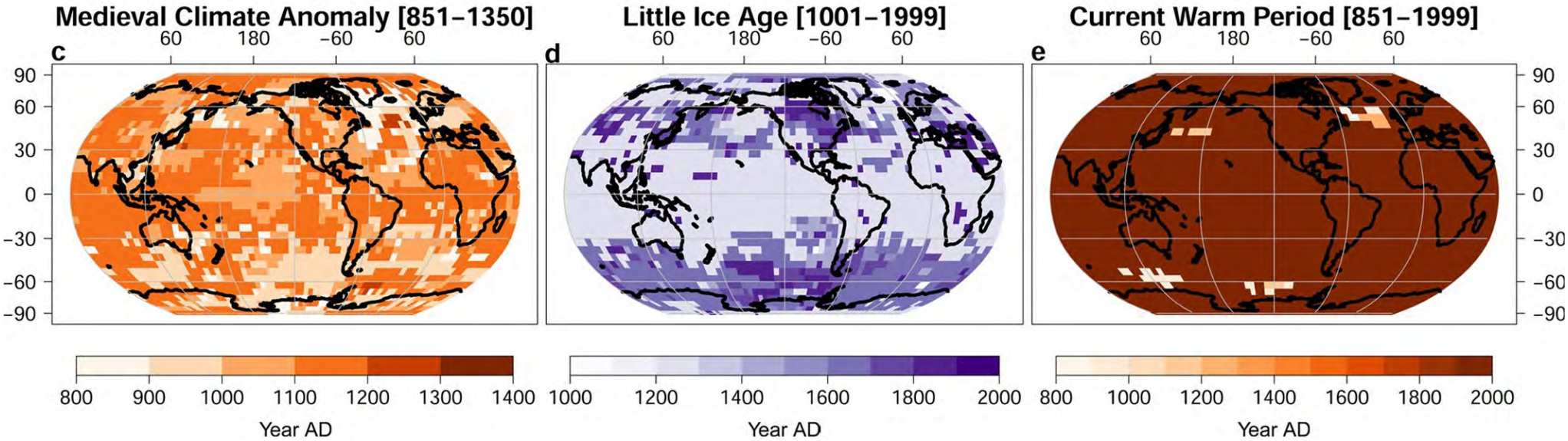
Letter | Published: 24 July 2019

No evidence for globally coherent warm and cold periods over the preindustrial Common Era

Raphael Neukom, Nathan Steiger, Juan José Gómez-Navarro, Jianghao Wang & Johannes P. Werner

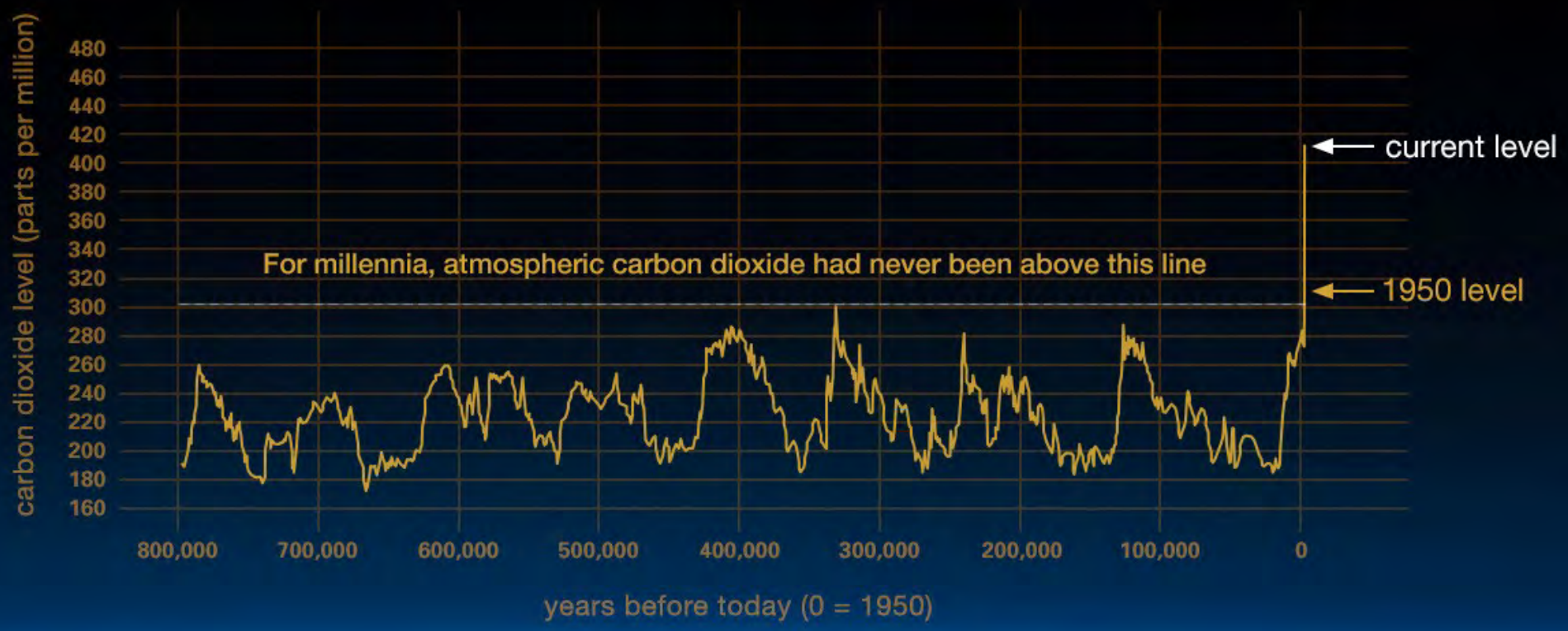
Nature **571**, 550–554 (2019) Download Citation



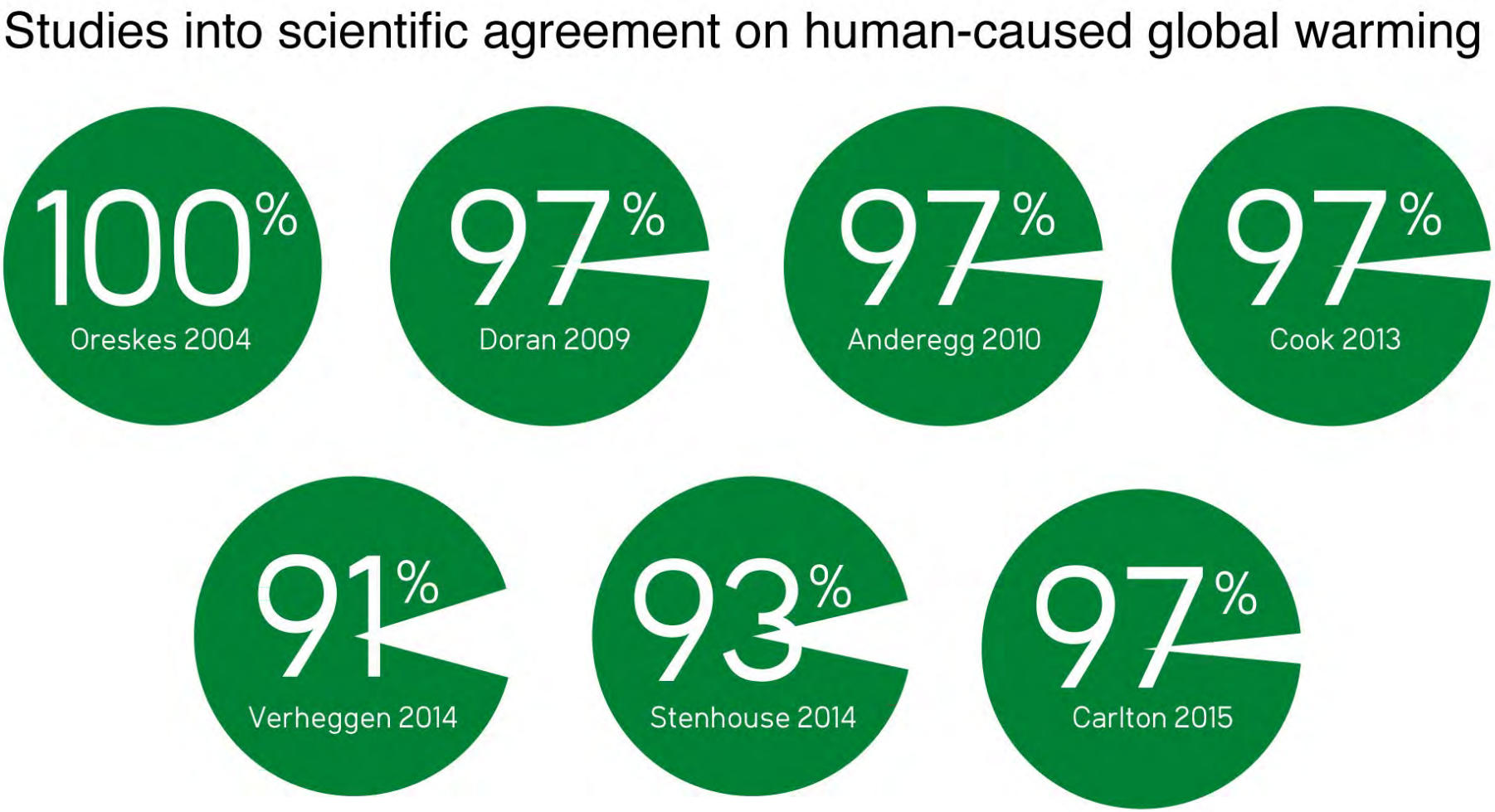


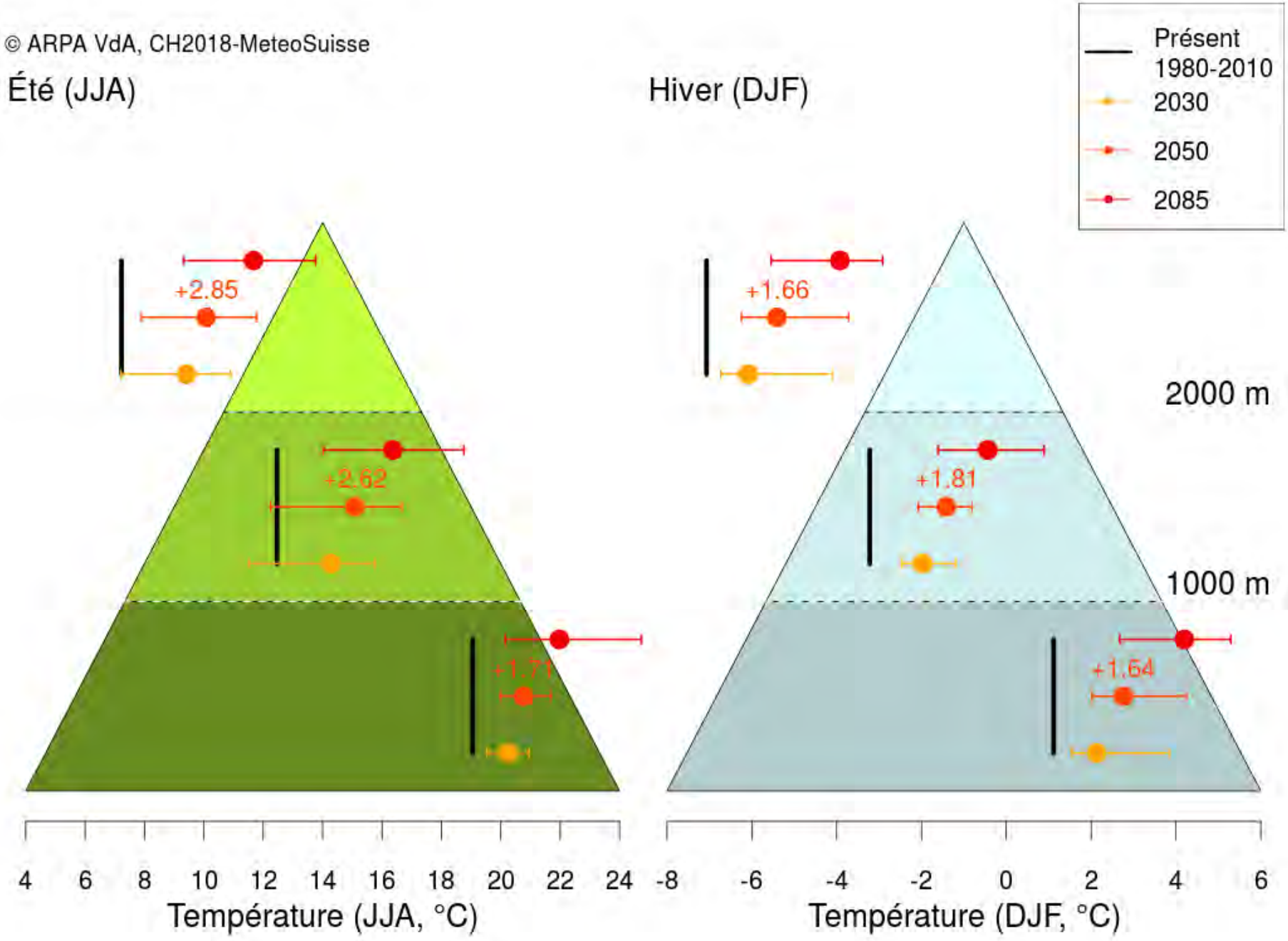
E’ colpa nostra? SÍ

Le attività umane rilasciano gas a effetto serra in atmosfera → incremento della temperatura



Gli scienzati sono d'accordo? SÍ



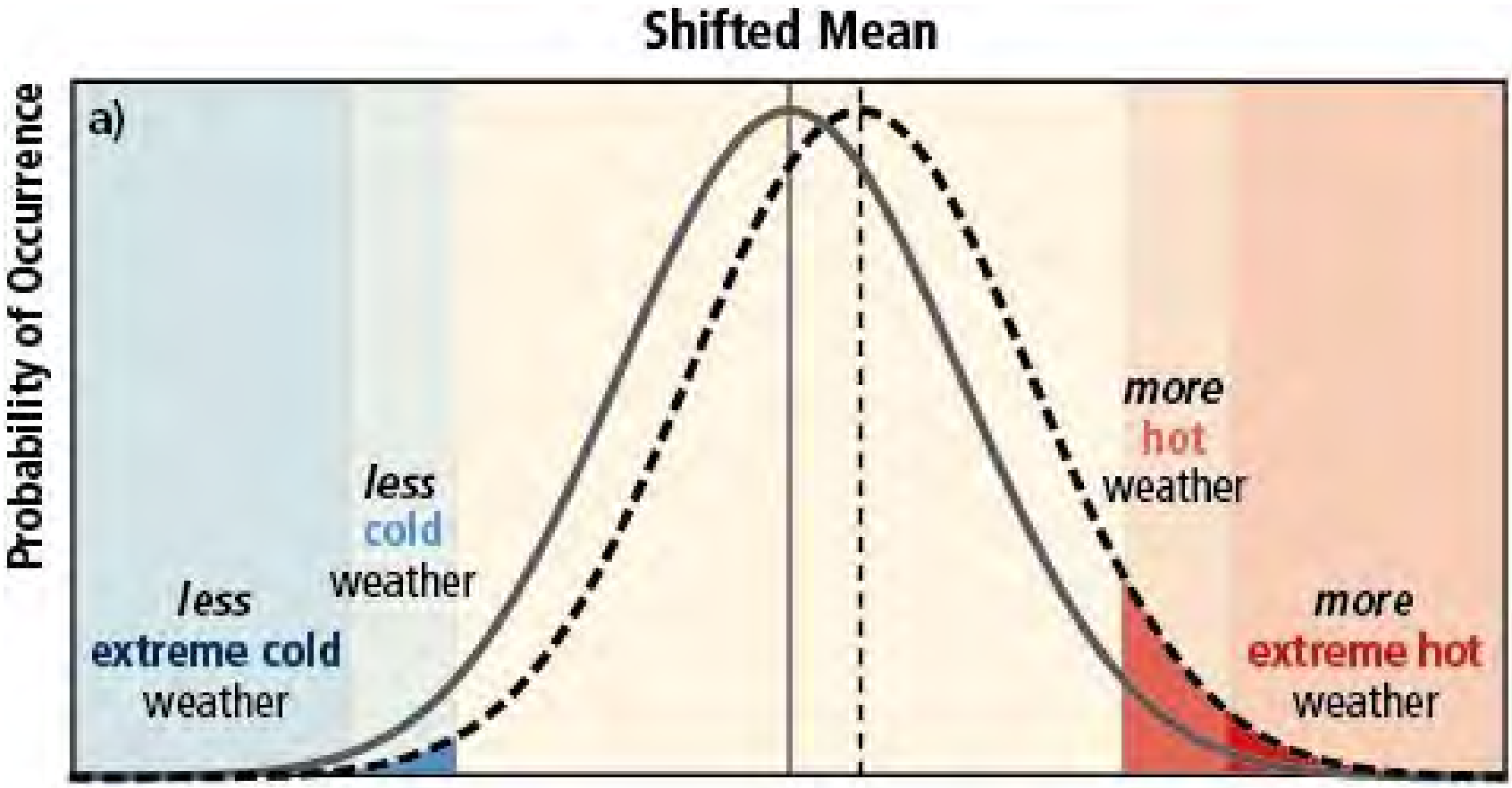

© ARPA VdA, CH2018-MeteoSuisse
Été (JJA)
Hiver (DJF)
Présent
1980-2010
2030
2050
2085
+2.85
+2.62
+1.71
+1.66
+1.81
+1.64
2000 m
1000 m
4 6 8 10 12 14 16 18 20 22 24
Température (JJA, °C)
-8 -6 -4 -2 0 2 4 6
Température (DJF, °C)

Cosa vuol dire 2 gradi C in più? E' tanto ? E' poco?

Effetto sugli estremi climatici

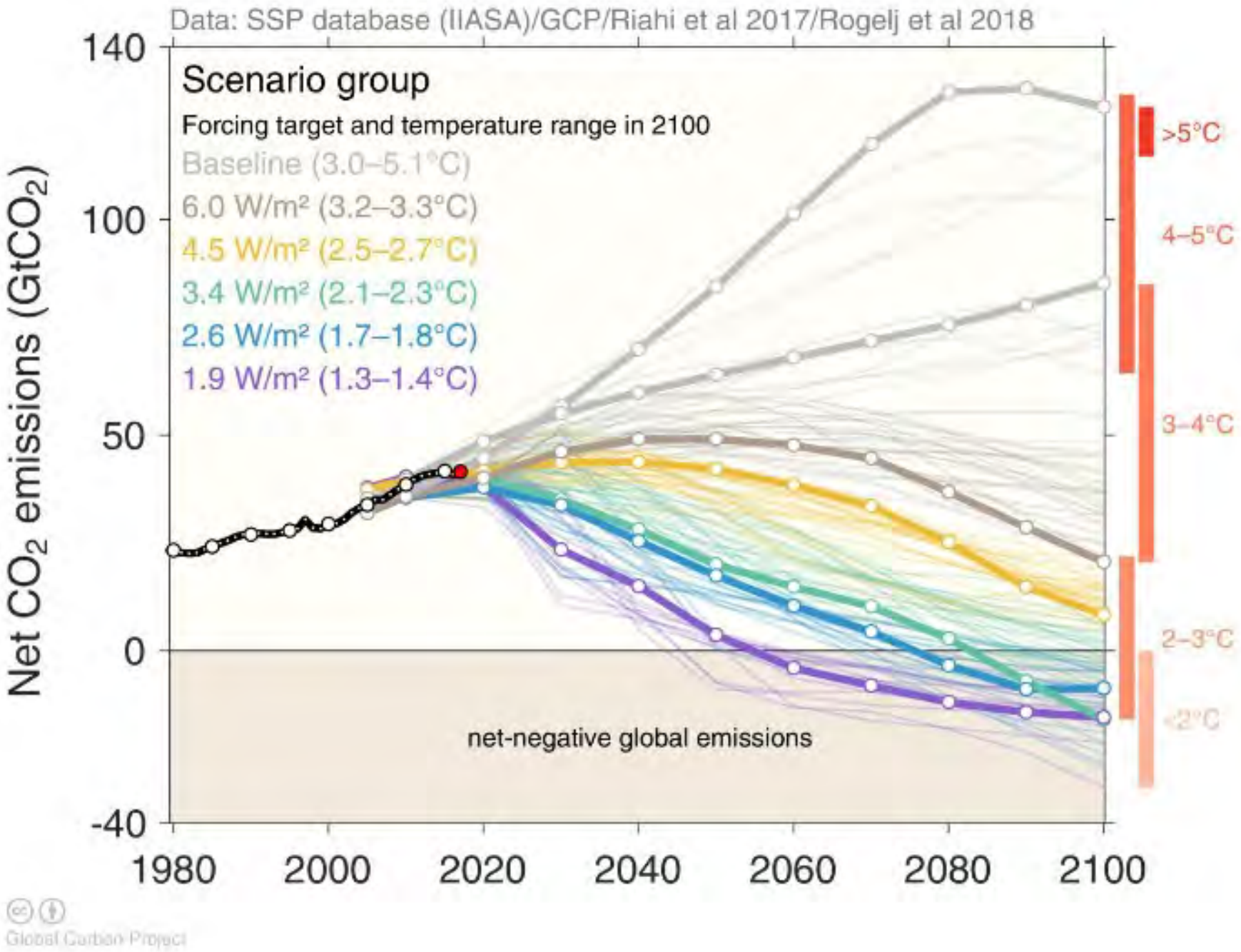
Esempio Monte Bianco (Colle Major 4750 m) estate 2019:

82 ore con temperatura sopra 0°C, 14 giornate in cui siamo andati sopra 0°C, Tmax 8.2°C, 18 ore consecutive sopra 0°C



Source : IPCC SREX2012

A cosa è dovuta l'incertezza degli scenari climatici?



… quindi che fare?

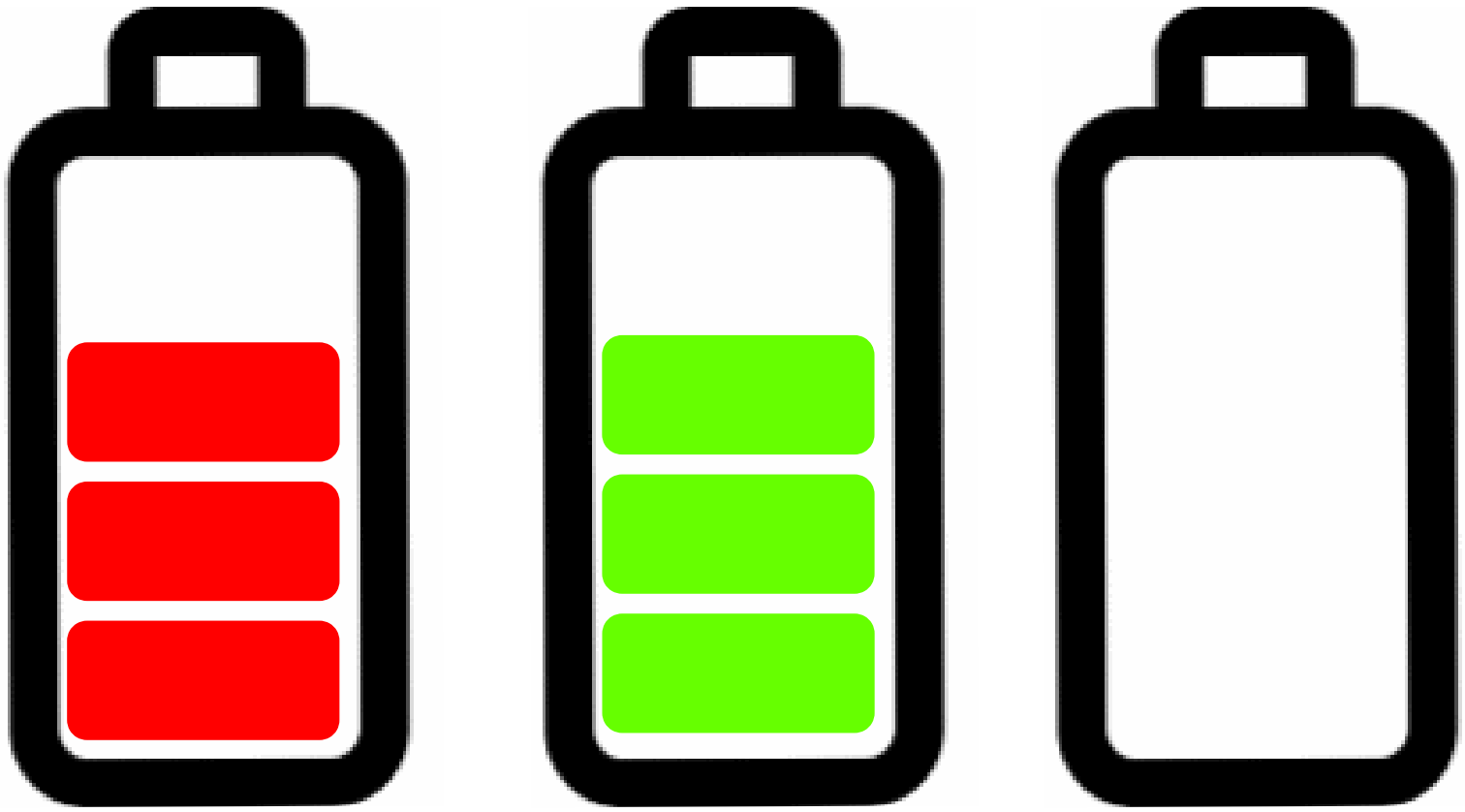
IMPACTS

ADAPT

MITIGATE

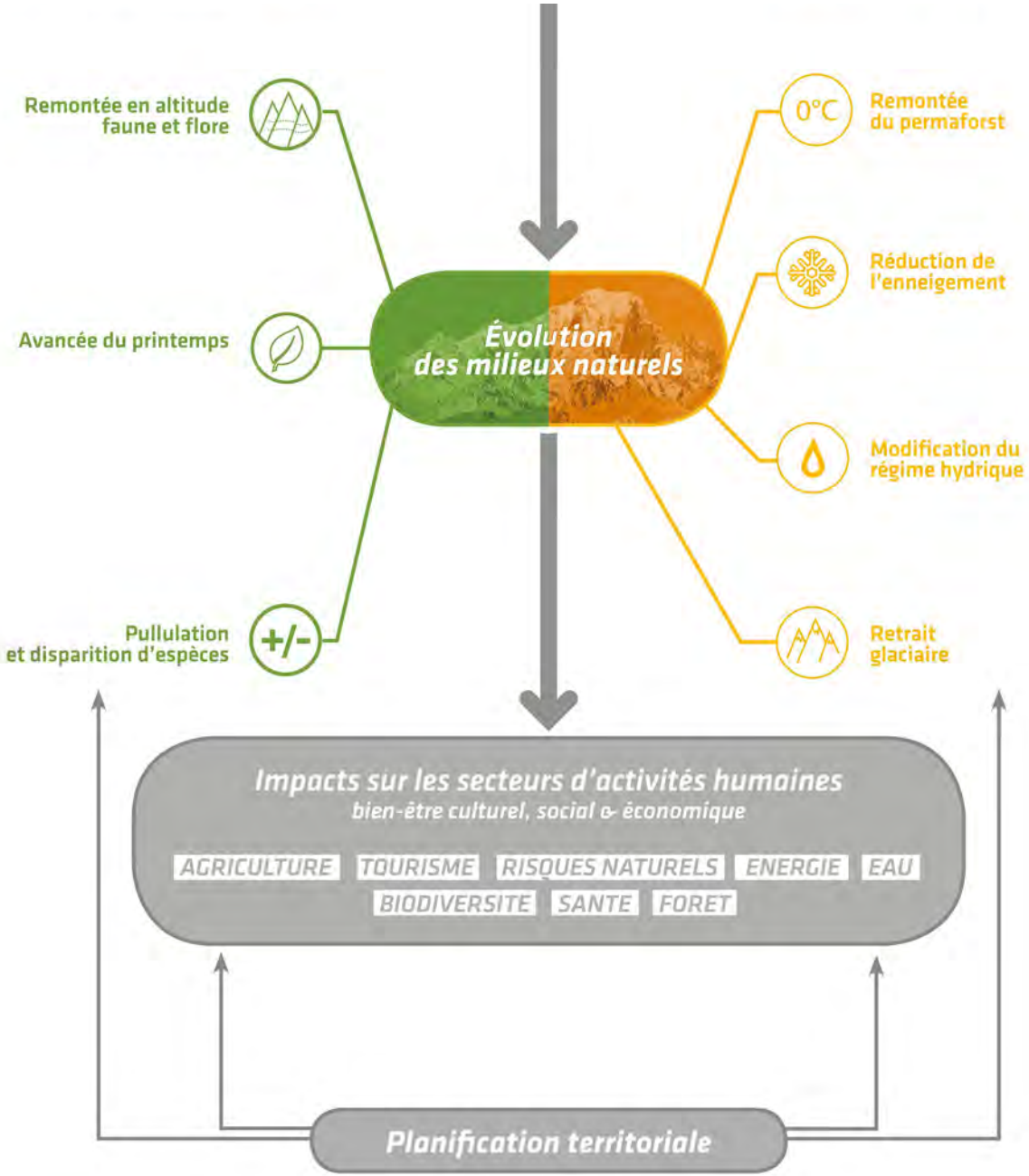
© NOVA, PBS

azioni di adattamento



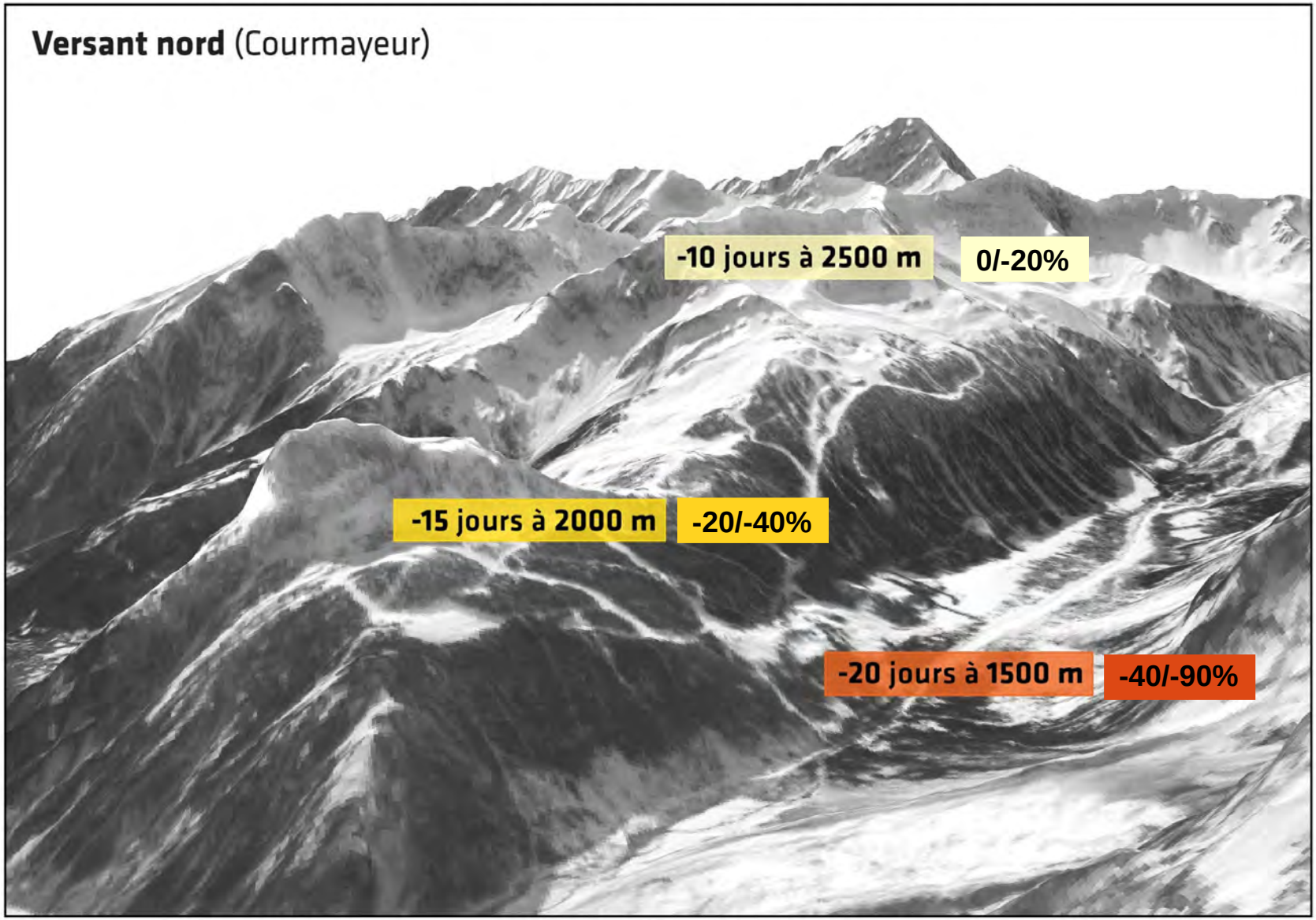
IMPACTS ADAPT MITIGATE

© NOVA, PBS


Remontée en altitude faune et flore
Avancée du printemps
Pullulation et disparition d'espèces
+/-
Évolution des milieux naturels
0°C
Remontée du permaforst
Réduction de l'enneigement
Modification du régime hydrique
Retrait glaciaire
Impacts sur les secteurs d'activités humaines
bien-être culturel, social & économique
AGRICULTURE
TOURISME
RISQUES NATURELS
ENERGIE
EAU
BIODIVERSITE
SANTE
FORET
Planification territoriale

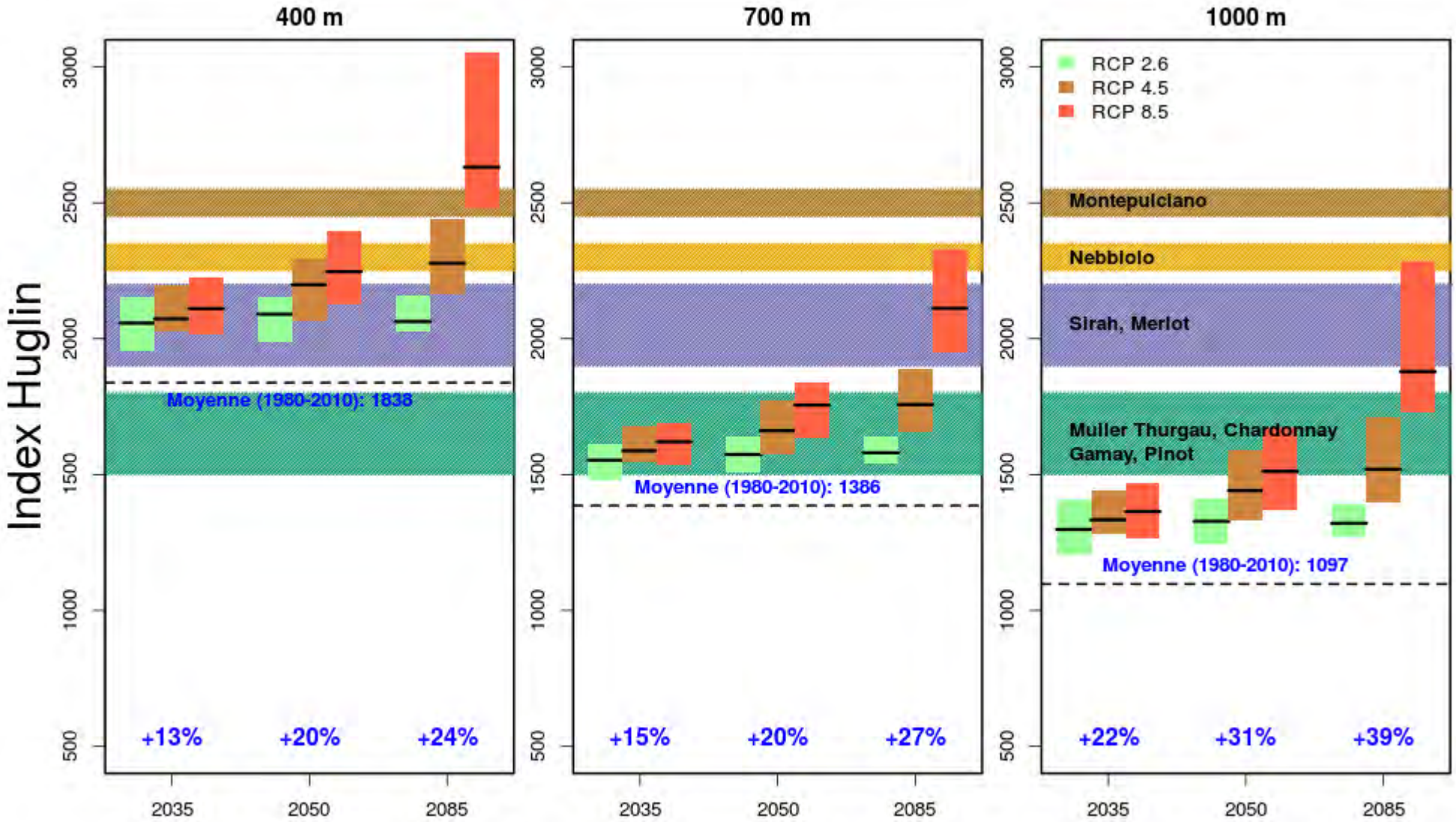
Riduzione innevamento (durata e quantità)

Réduction de l'enneigement à l'horizon 2050 *- RCP 4.5*



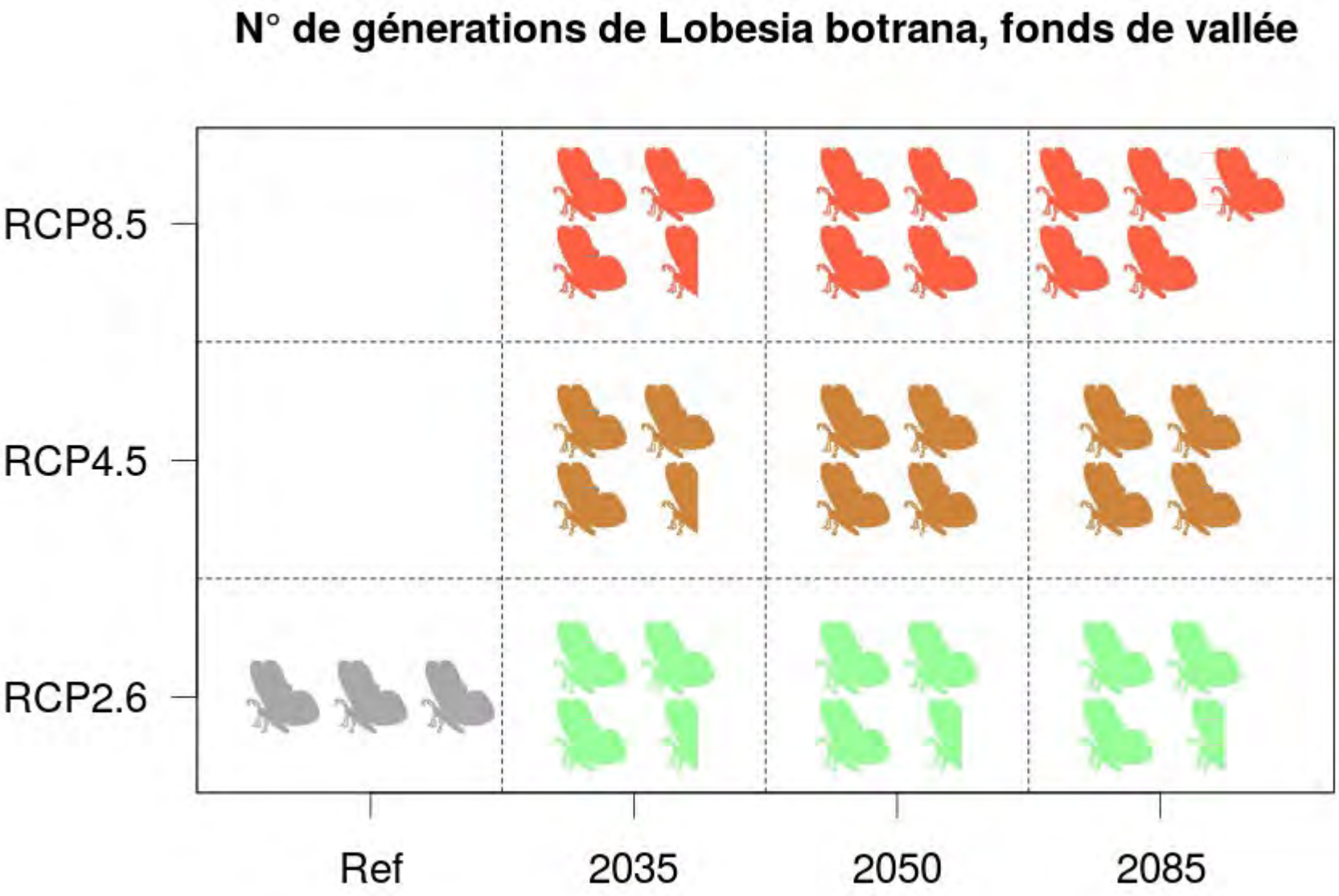
Source : WSL/CHELSA © CREA Mont-Blanc et ARPA VdA

AGRICOLTURA: es opportunità per la viticoltura



@ARPA VdA source: CH2018 Project Team (2018) CH2018 - Climate Scenarios for Switzerland. National Centre for Climate Services. doi: 10.18751/Climate/Scenarios/CH2018/1.0

AGRICOLTURA: impatti legati ai patogeni



azioni di adattamento

- disporre di **scenari climatici** a livello locale e quantificare gli **impatti su settori specifici** delle attività umane (culturali, sociali, economiche): agricoltura, turismo, salute, energia, risorse naturali

- **comunicare in modo diverso**

  → da qualcosa di lontano, drammatico e per cui non possiamo fare nulla (distanza, tragedia e impotenza)

  → a qualcosa di vicino, pratico e per cui sentiamo di avere un margine di azione e di controllo (vicinanza, partecipazione e condivisione)

- **strategie e piani di adattamento**

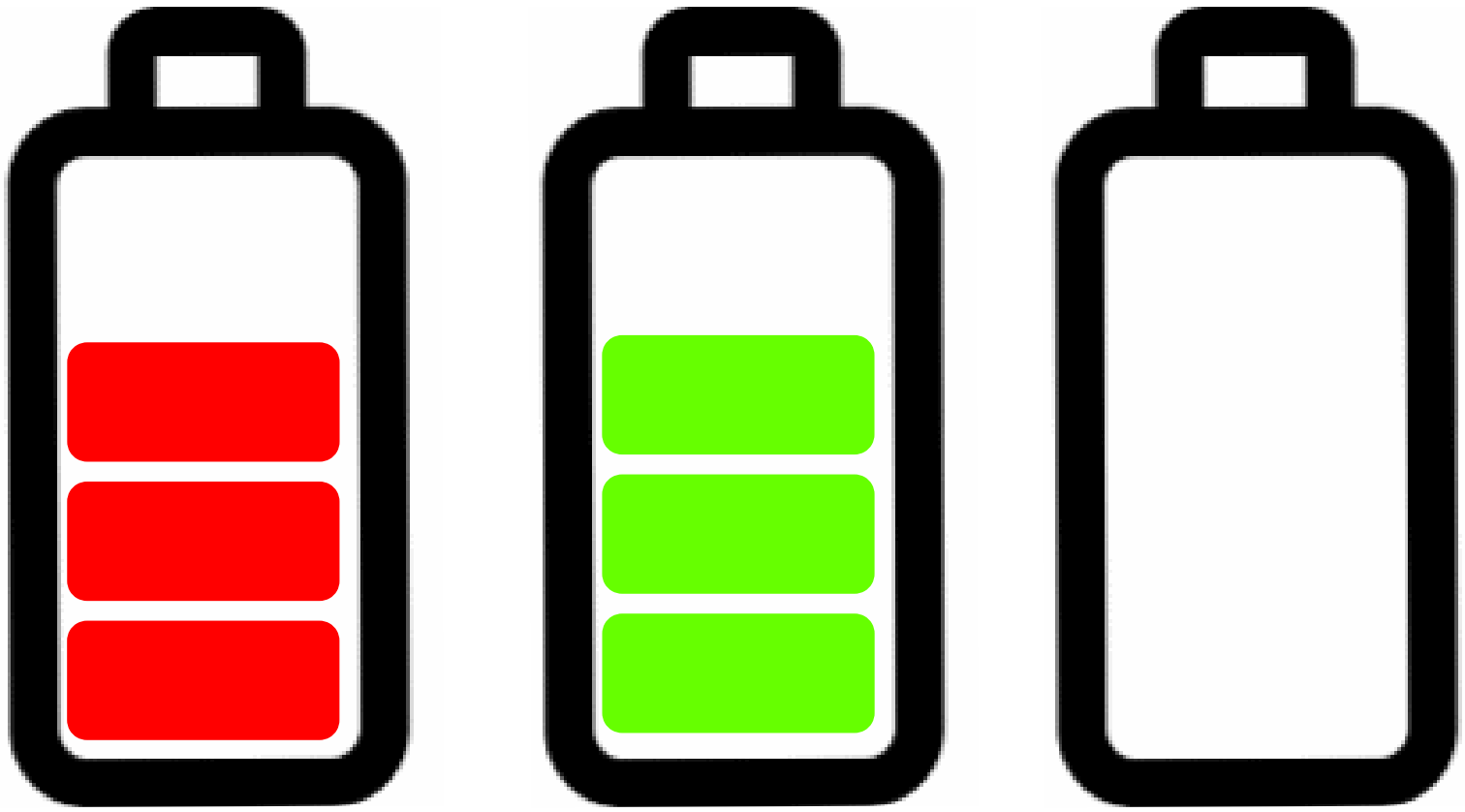
  → ridurre la vulnerabilità dei diversi settori socio-economici

  → pianificazione territoriale / settoriale

  → imprenditorialità per sapere anticipare e sfruttare le opportunità

  → settore pubblico e stakeholders privati (associazioni di categoria, imprese, operatori economici), cittadini, …

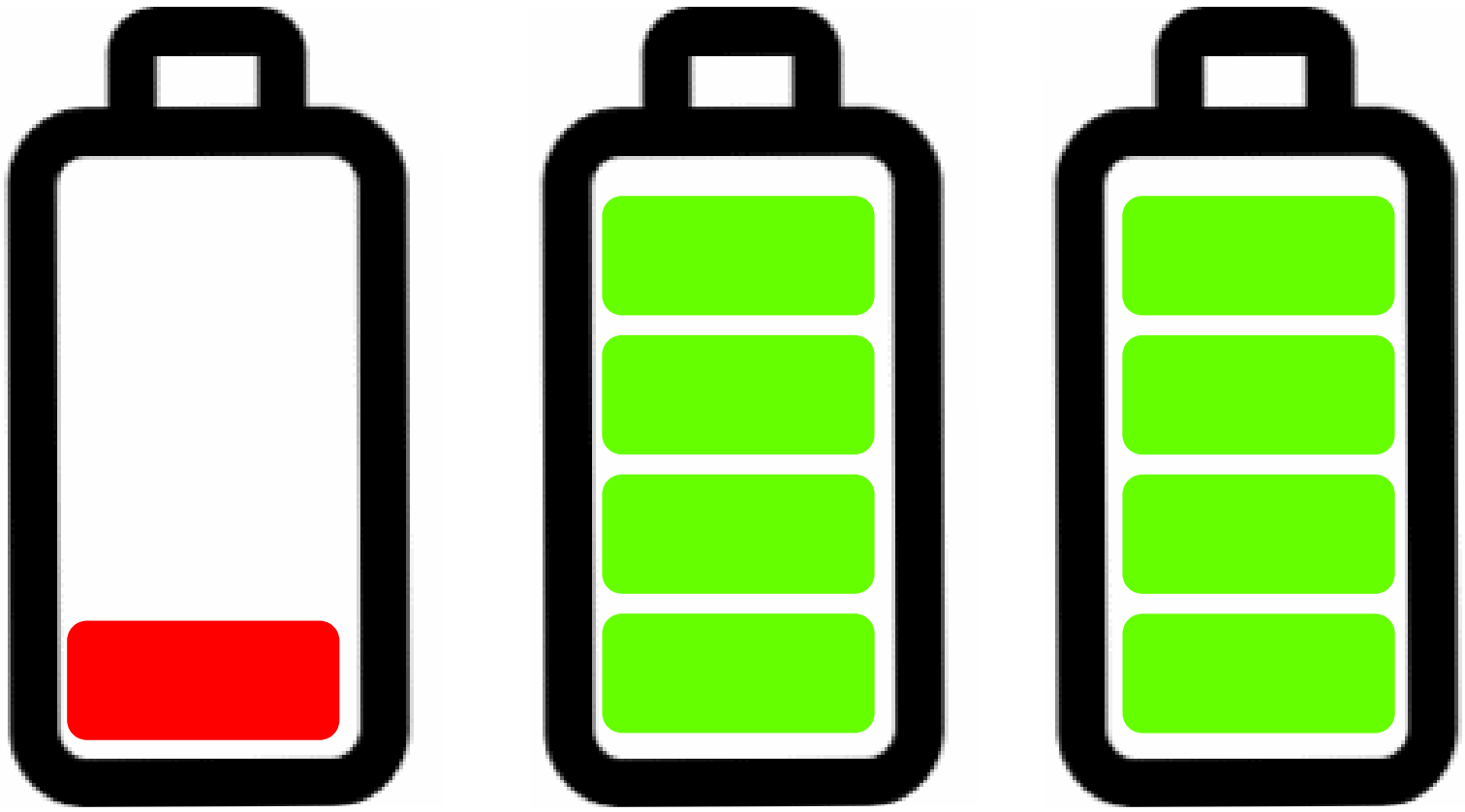
azioni di adattamento



IMPACTS ADAPT MITIGATE

© NOVA, PBS

adattamento e mitigazione



IMPACTS ADAPT MITIGATE

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Cosa vuol dire mitigazione?

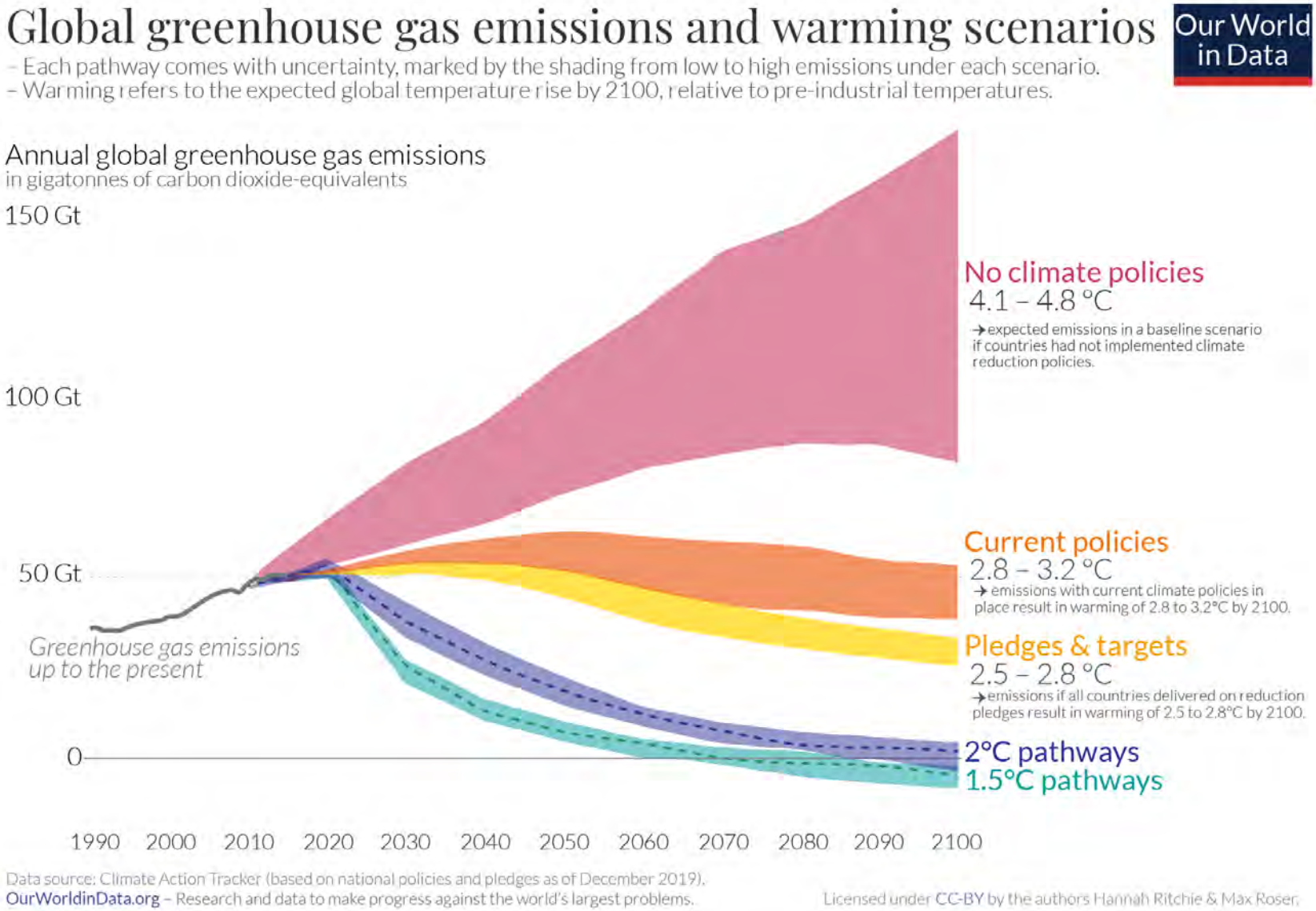
Ridurre le emissioni di gas a effetto serra

1. transizione energetica: decarbonizzare economia
2. tassazione del carbonio e finanza climatica (investimenti, mercato, regolamentazione, responsabilità)
3. transizione industriale e R&D
4. nature based solutions
5. azioni locali/città

www.un.org

Siamo sulla buona strada? NO, si deve fare di più

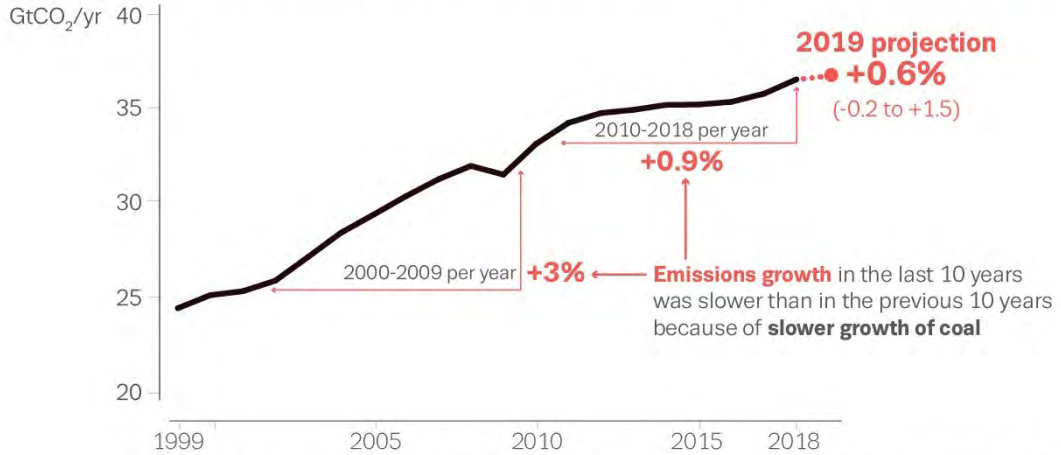
Si deve arrivare a emissioni zero al 2050



Global Carbon Budget 2019

CO_2 emissions grow amidst slowly emerging climate policies

Fossil CO_2 emissions grow more slowly... but do not yet decline



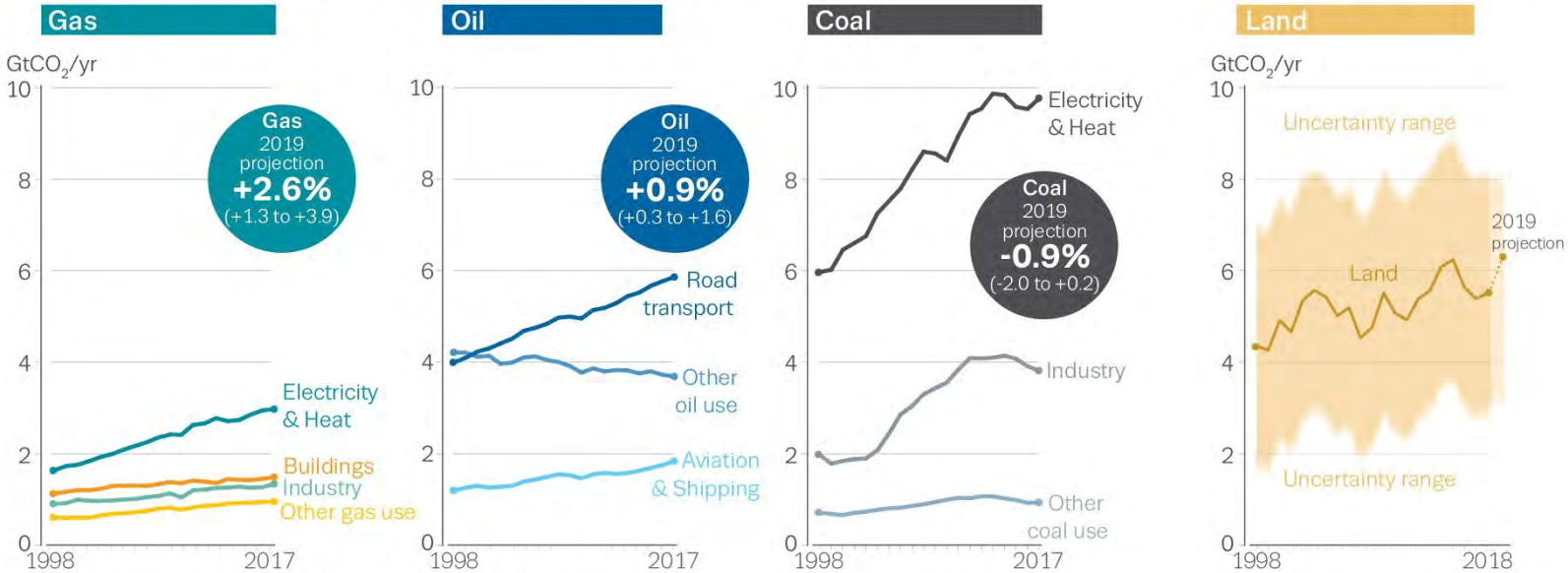
Source: Global Carbon Project based on UNFCCC/CDIAC/BP/USGS. Units: Billion tonnes of carbon dioxide per year (GtCO2/yr)

CO_2 emissions need to decline rapidly to net-zero around mid-century to pursue the Paris Agreement 1.5°C goal

Natural gas and oil now drive global emissions growth

Continued support for low-carbon technologies needs to be combined with policies that phase out fossil fuels.

Deforestation fires in 2019 drive emissions up on land

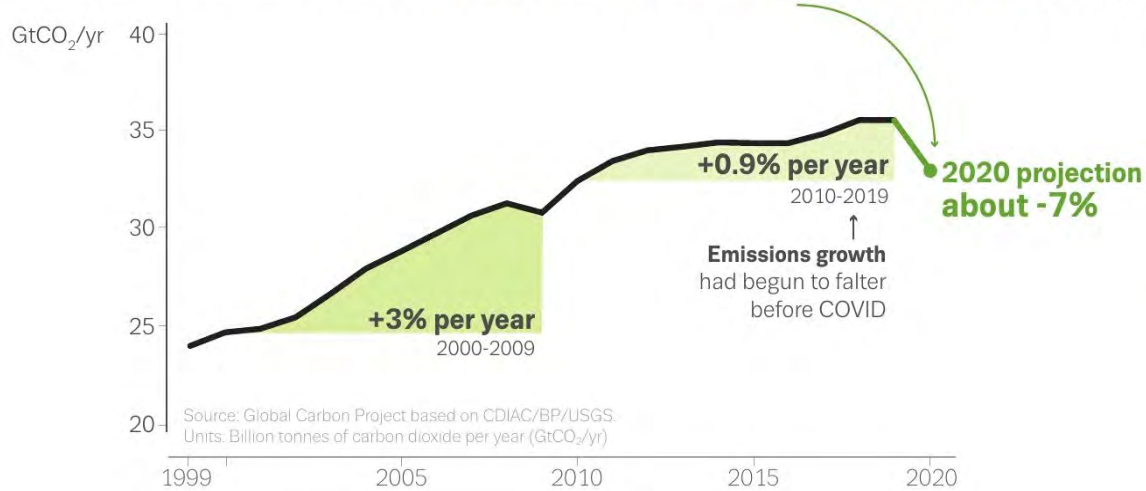


Source: 2019 projection by the Global Carbon Project. Trend to 2017 based on data from the IEA (2019) CO_2 Emissions from Fuel Combustion, www.iea.org/statistics. All rights reserved.

Global Carbon Budget 2020

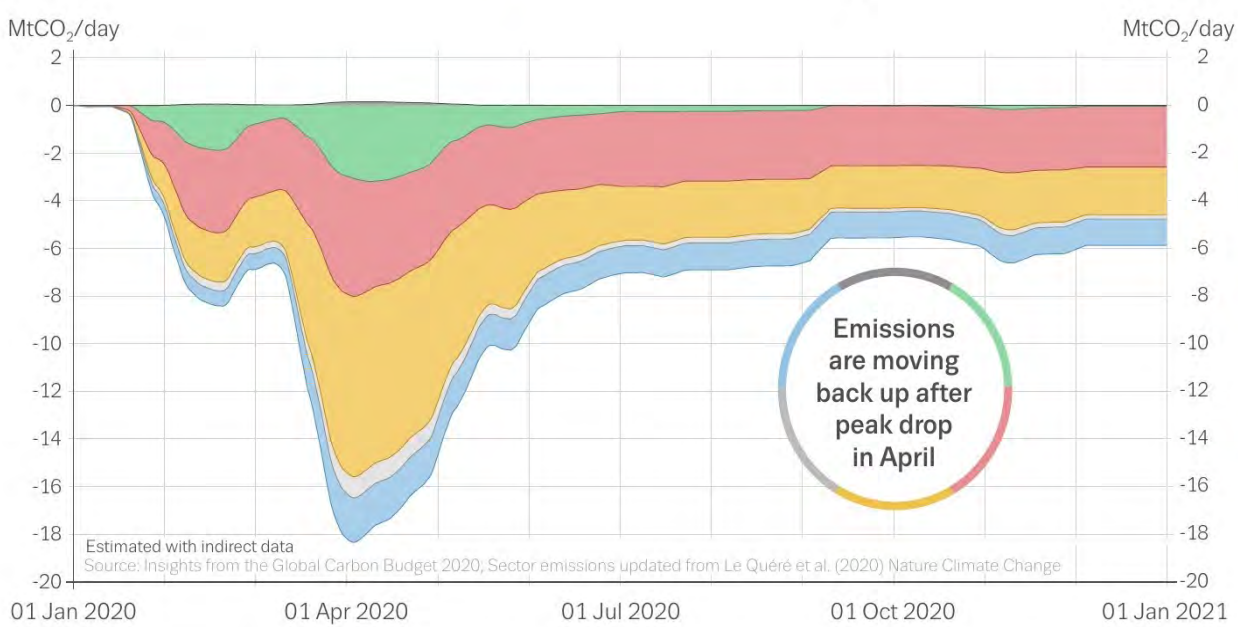
COVID lockdown causes record decrease in CO_2 emissions for 2020

2020 fossil emissions decrease of 2.4 billion tonnes is largest ever recorded



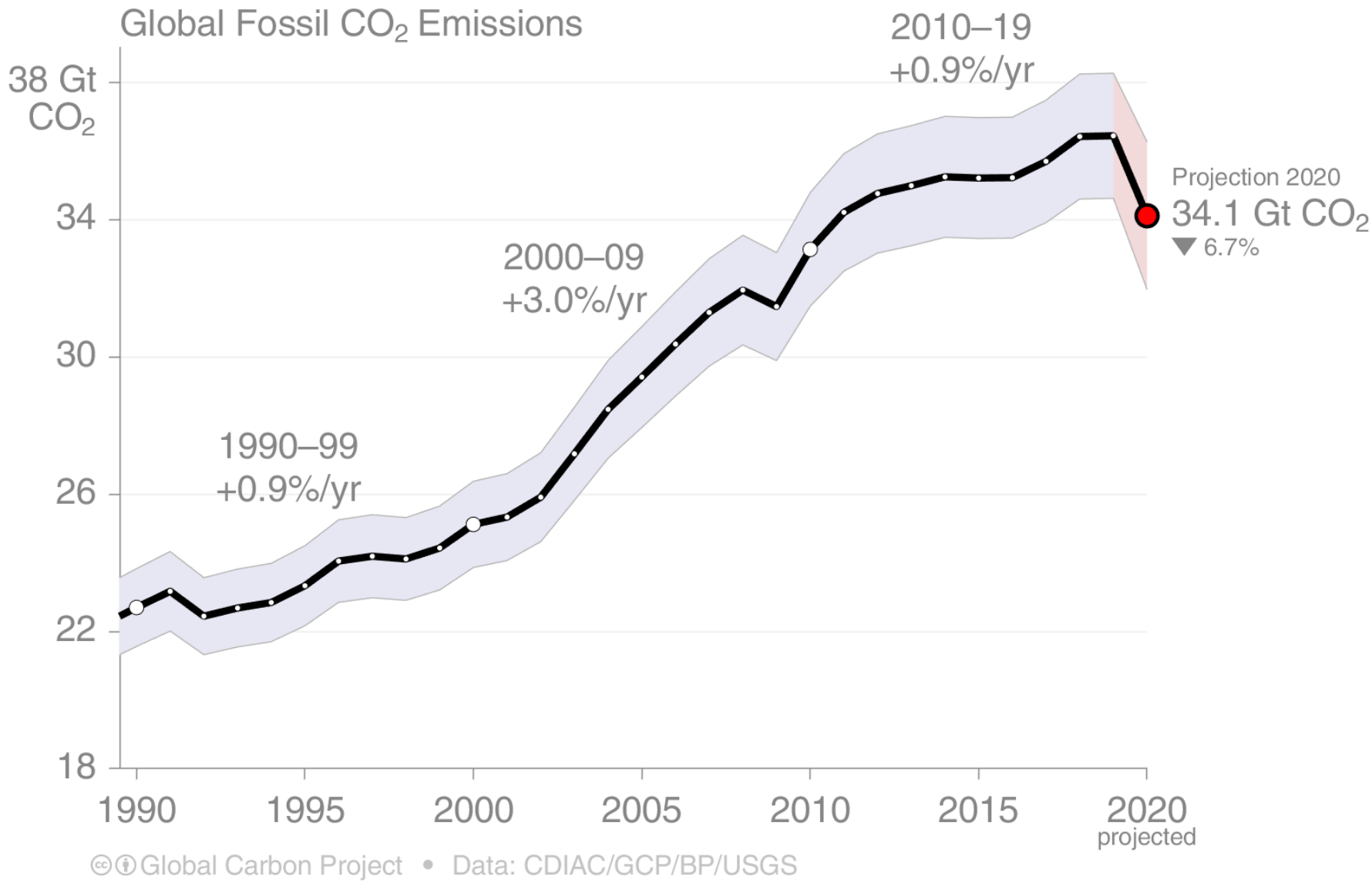
CO_2 emissions
cuts of 1 to 2 billion tonnes are needed each year between 2020 and 2030 to limit climate change in line with Paris Agreement goals

Emissions from road transport cause the largest share of the global 2020 decrease



Effect of COVID-19 restrictions on emissions

- **Residential**
- **Power**
- **Industry**
  Early data from CarbonMonitor suggest emissions from industry now exceed 2019 levels, pushed up by other factors
- **Surface transport**
  Emissions from road transport were still below their 2019 levels by the end of the year
- **Public**
- **Aviation**
  Emissions from aviation were cut by the most (by 75%) and were still below 2019 levels. This had a smaller effect than emissions from surface transport because aviation accounts for only 2.8% of global emissions

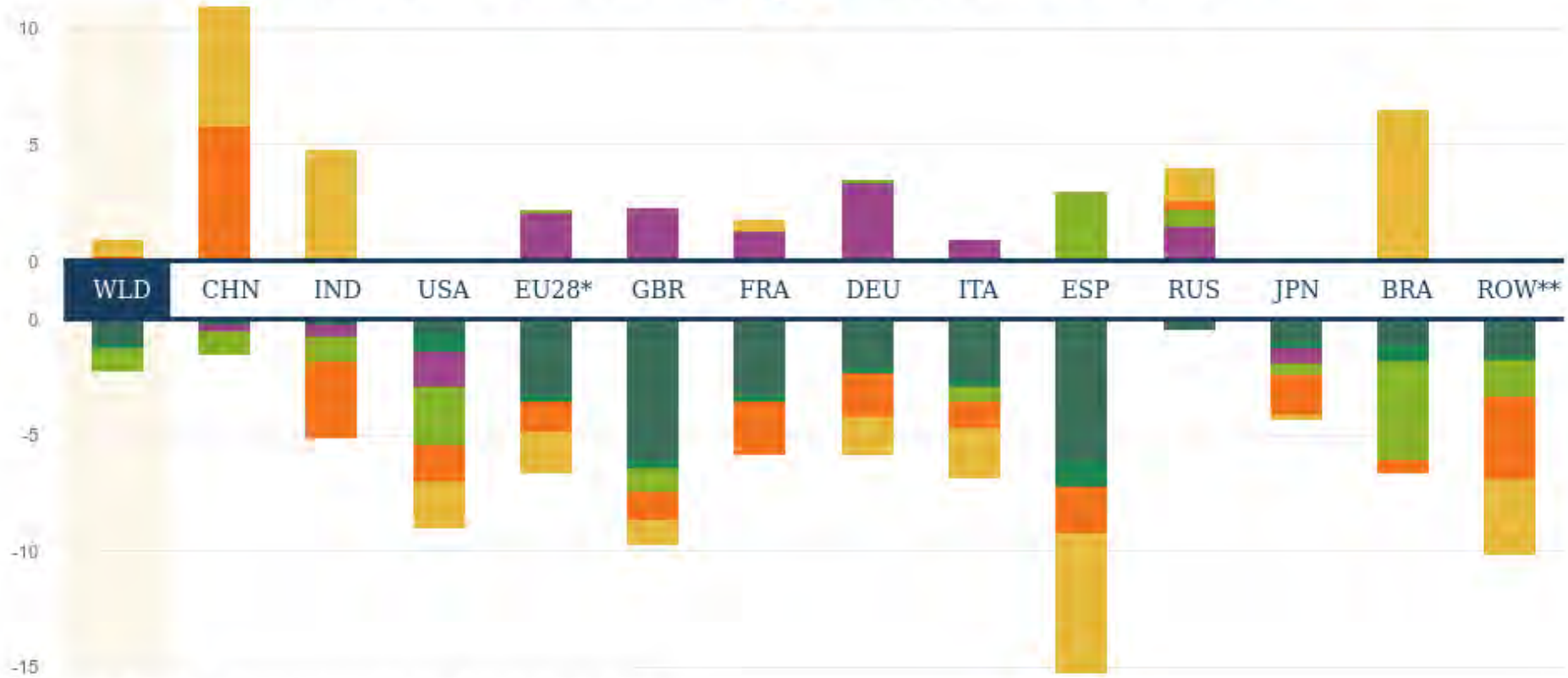


https://folk.universitetetioslo.no/roberan/GCB2020.shtml

Last data update: May 28th, 2021

CO_2 EMISSIONS VARIATION (%)

January 1st → April 30th, 2021 VS January 1st → April 30th, 2019



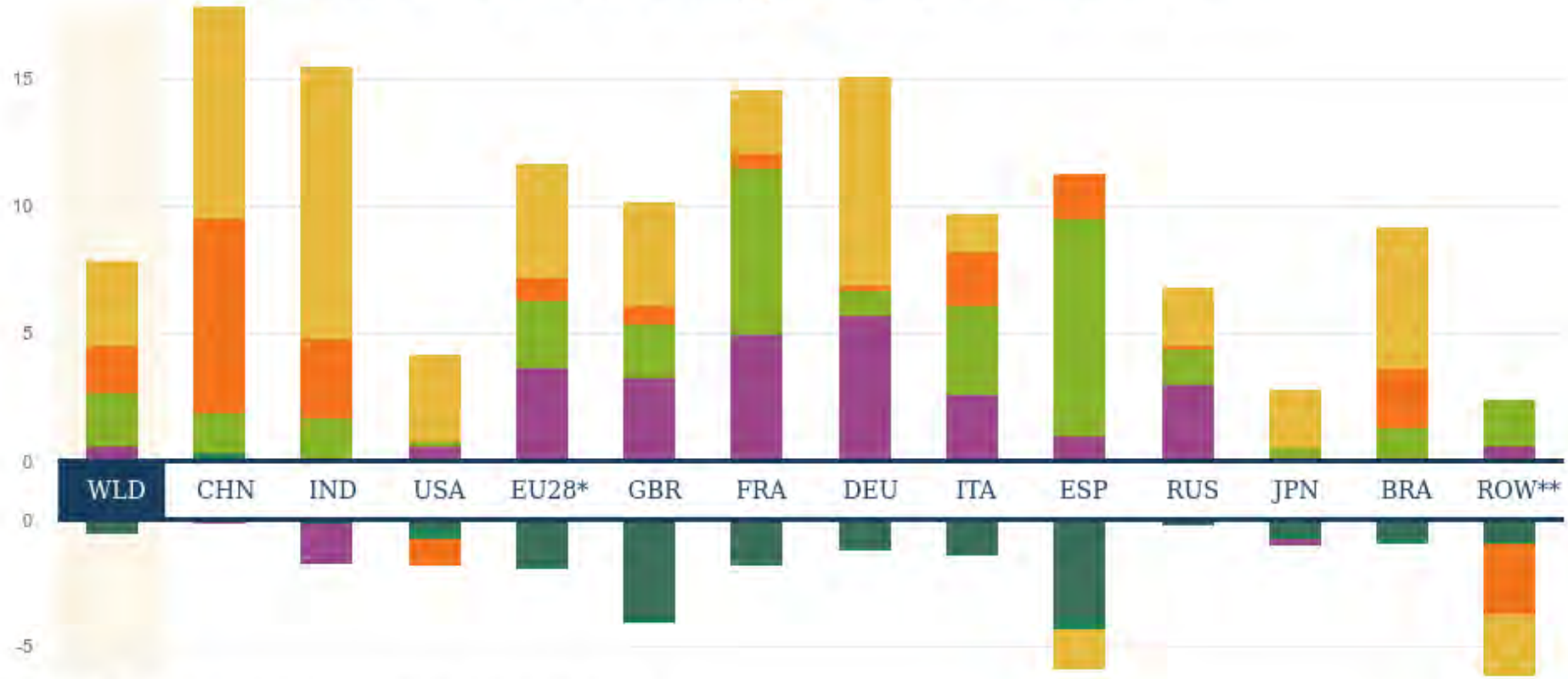
*EU28 : EU27 + United Kingdom **ROW : Rest of the world

carbonmonitor.org - May 31st, 2021

Last data update: May 28th, 2021

CO_2 EMISSIONS VARIATION (%)

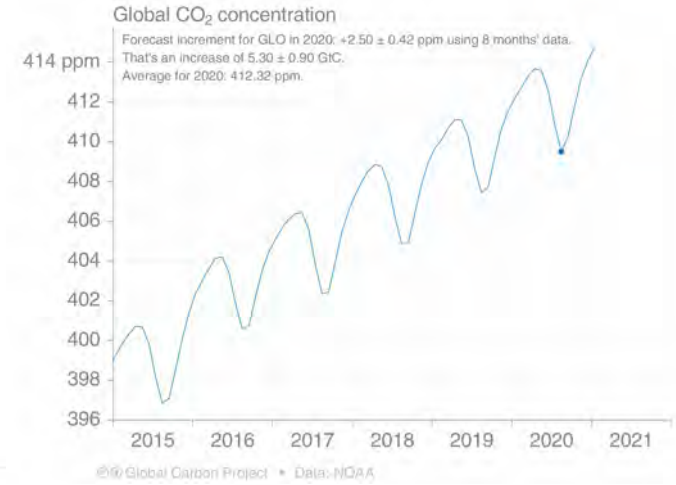
January 1st → April 30th, 2021 VS January 1st → April 30th, 2020

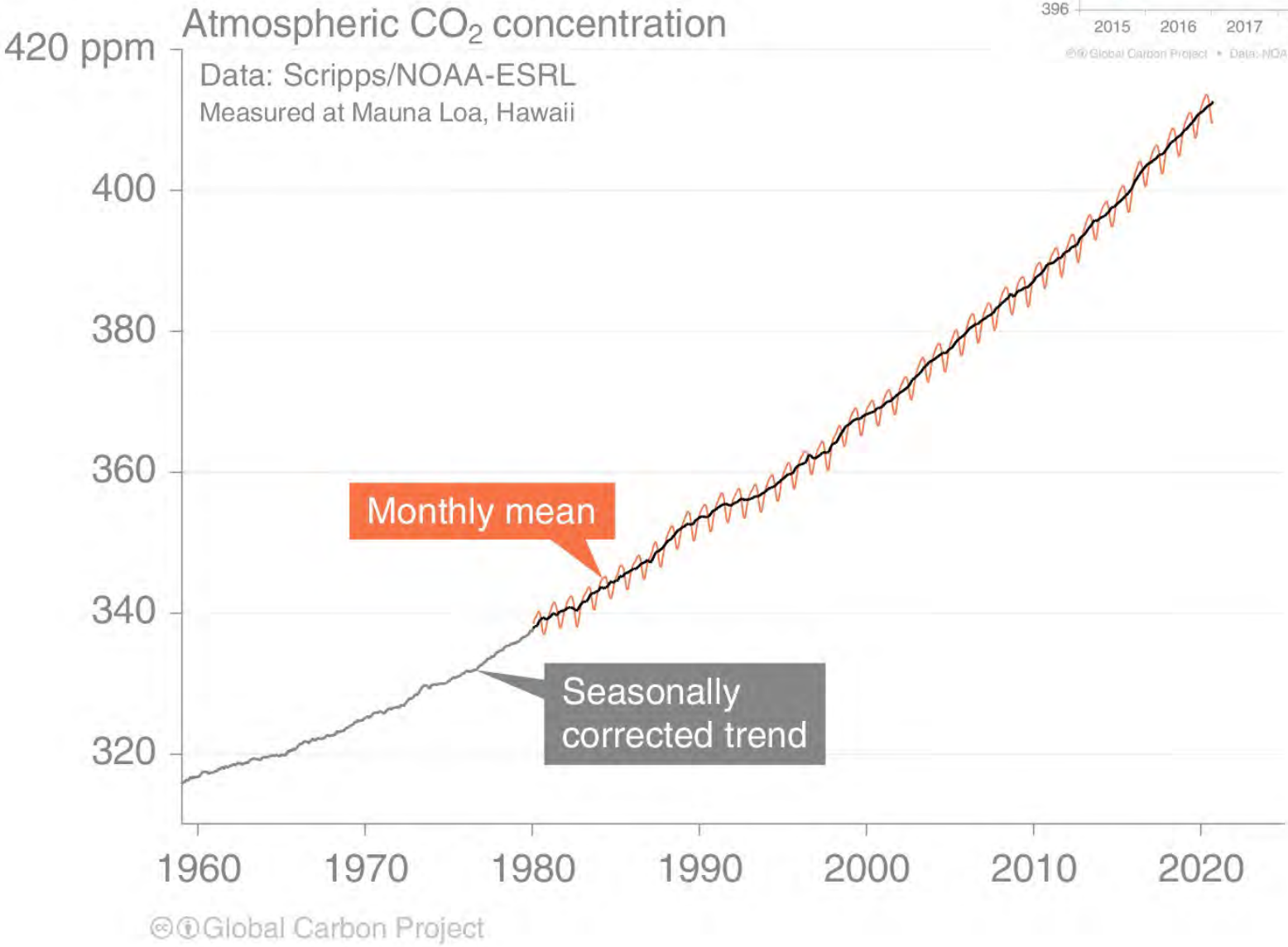


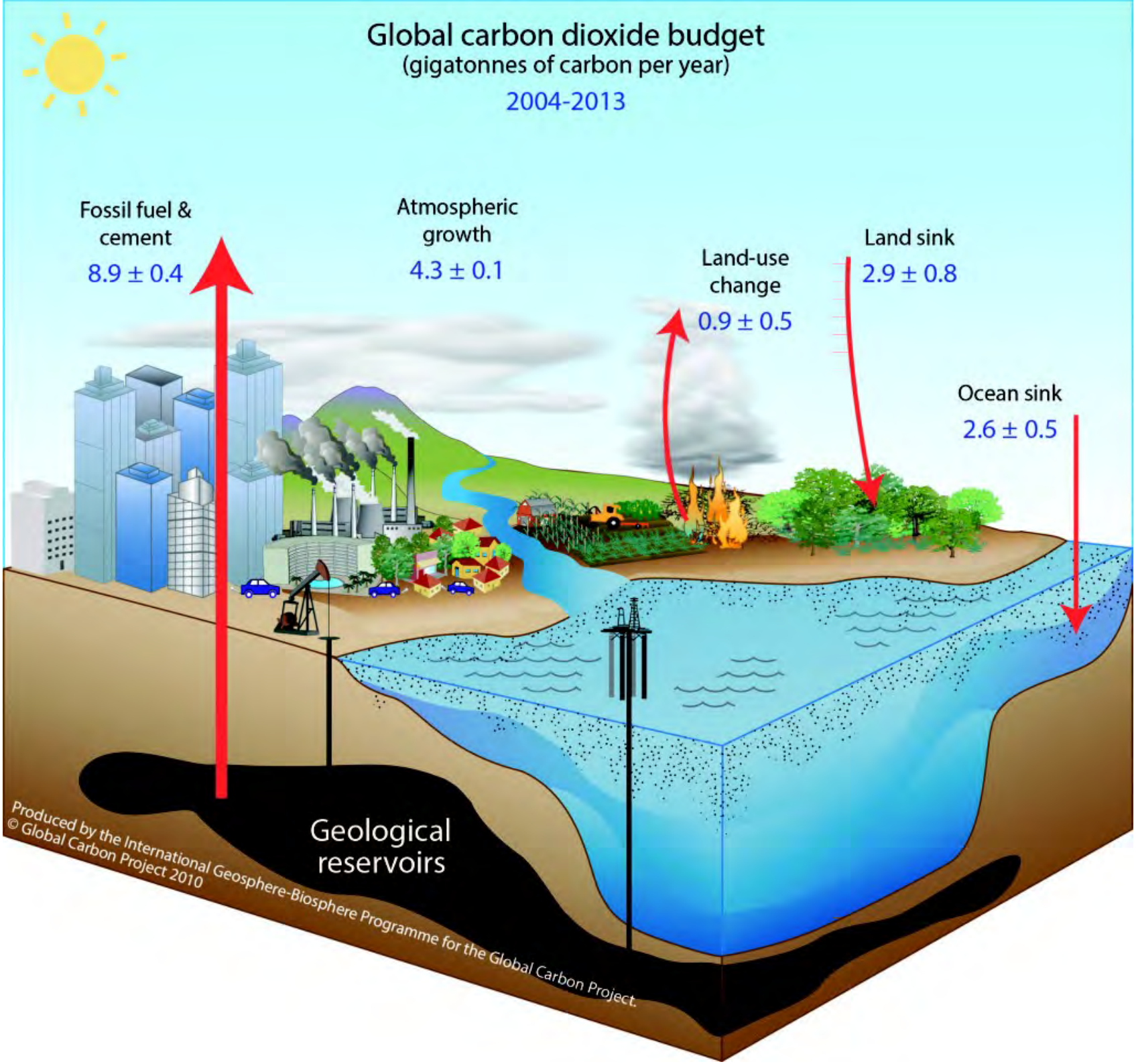
*EU28 : EU27 + United Kingdom **ROW : Rest of the world

carbonmonitor.org - May 31st, 2021

Emissioni CO2 vs. concentrazione atm di CO2

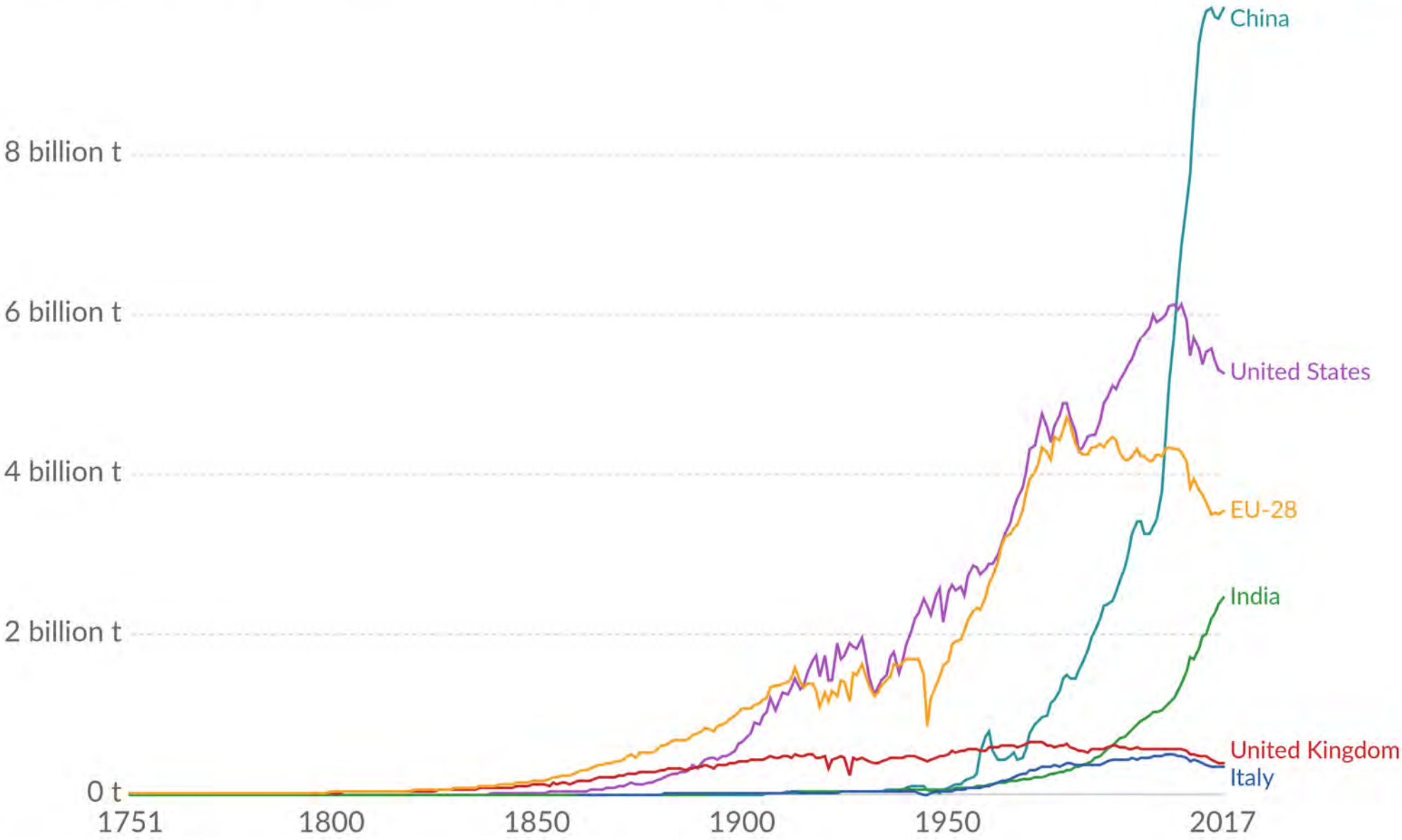





Global carbon dioxide budget
(gigatonnes of carbon per year)
2004-2013
Fossil fuel & cement
8.9 ± 0.4
Atmospheric growth
4.3 ± 0.1
Land-use change
0.9 ± 0.5
Land sink
2.9 ± 0.8
Ocean sink
2.6 ± 0.5
Geological reservoirs
Produced by the International Geosphere-Biosphere Programme for the Global Carbon Project.
© Global Carbon Project 2010

Annual CO_2 emissions

Annual carbon dioxide (CO_2) emissions, measured in tonnes per year.

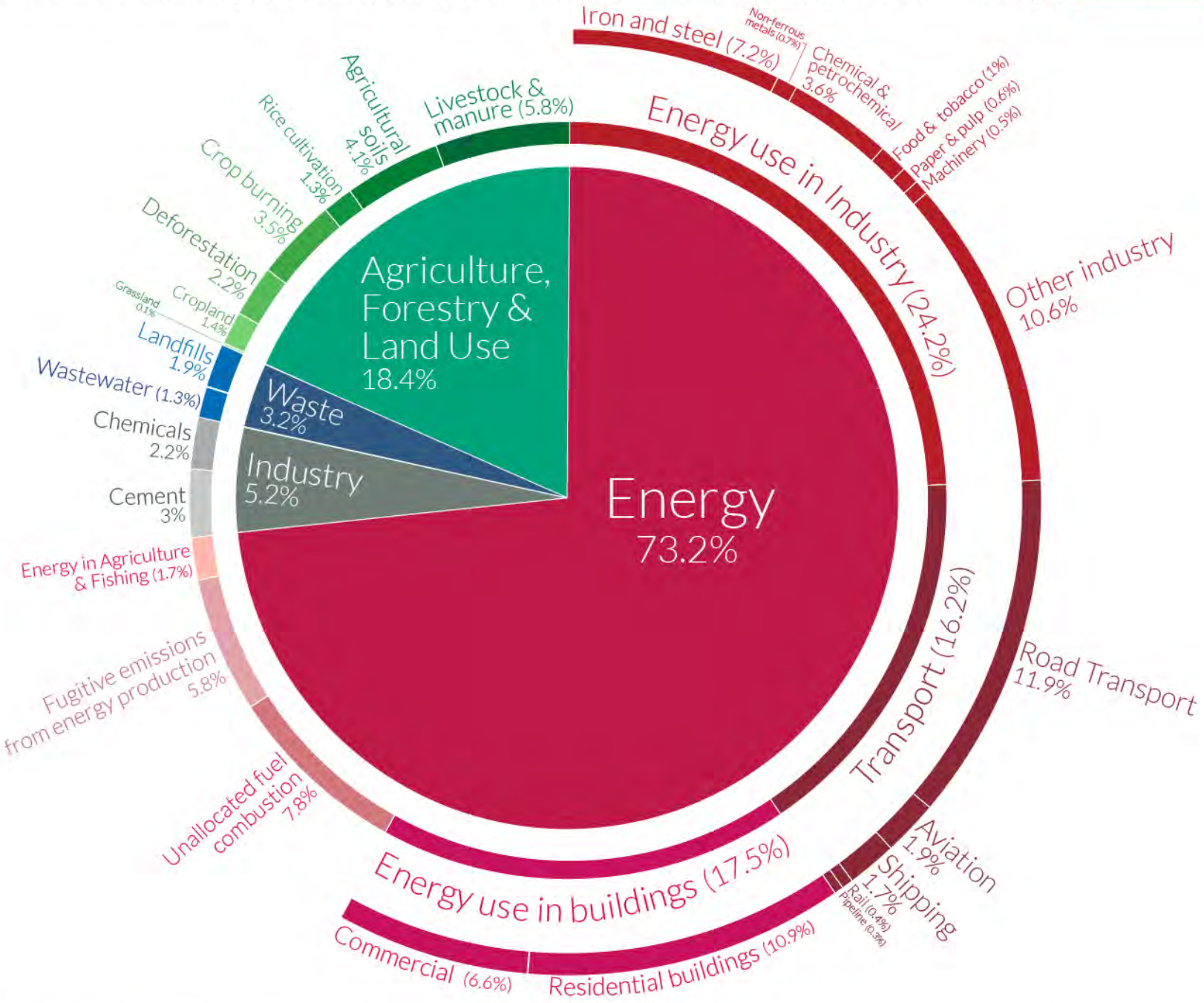


Source: Global Carbon Project; Carbon Dioxide Information Analysis Centre (CDIAC)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO_2eq.

Our World in Data



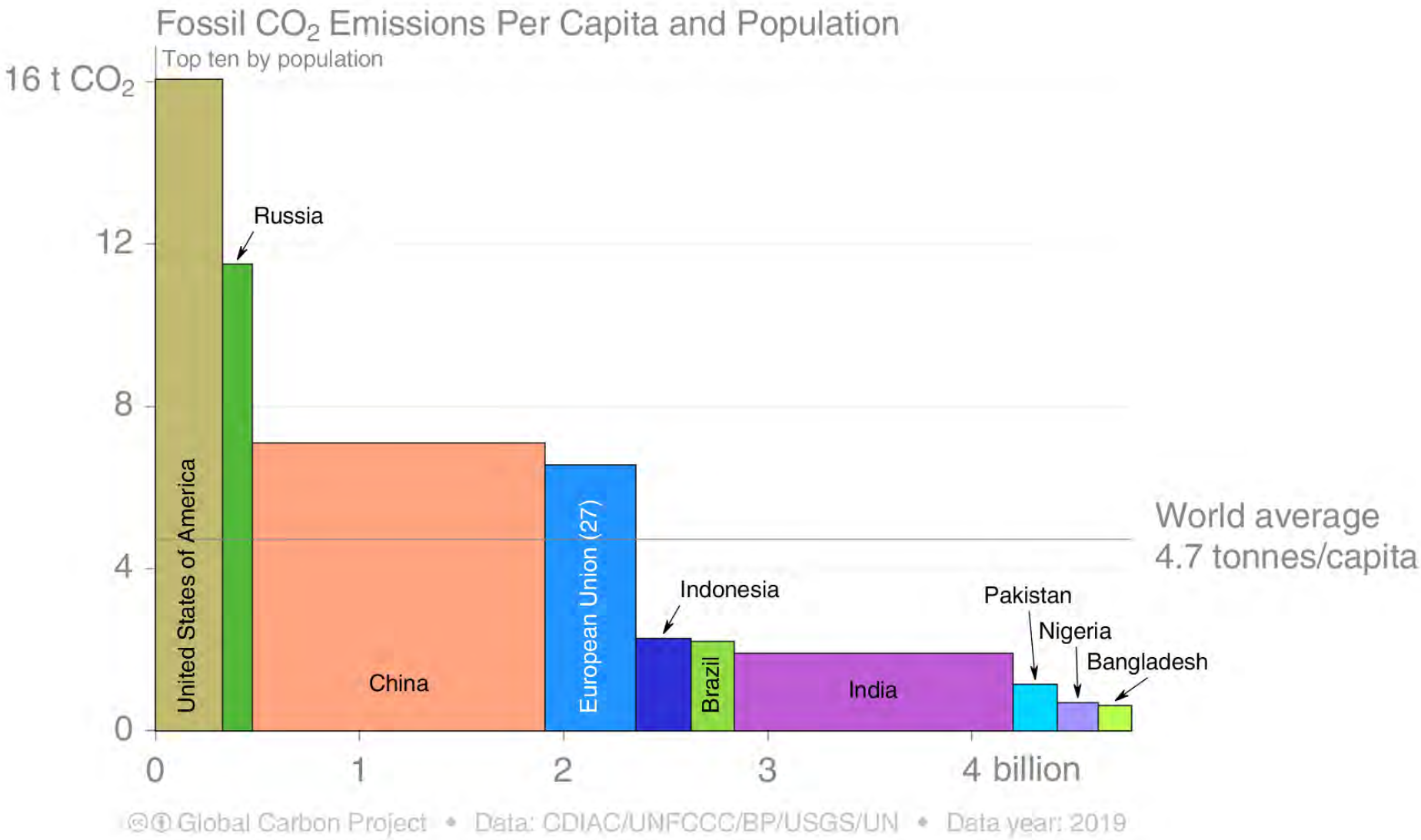
OurWorldinData.org – Research and data to make progress against the world's largest problems.

Source: Climate Watch, the World Resources Institute (2020).

Licensed under CC-BY by the author Hannah Ritchie (2020).

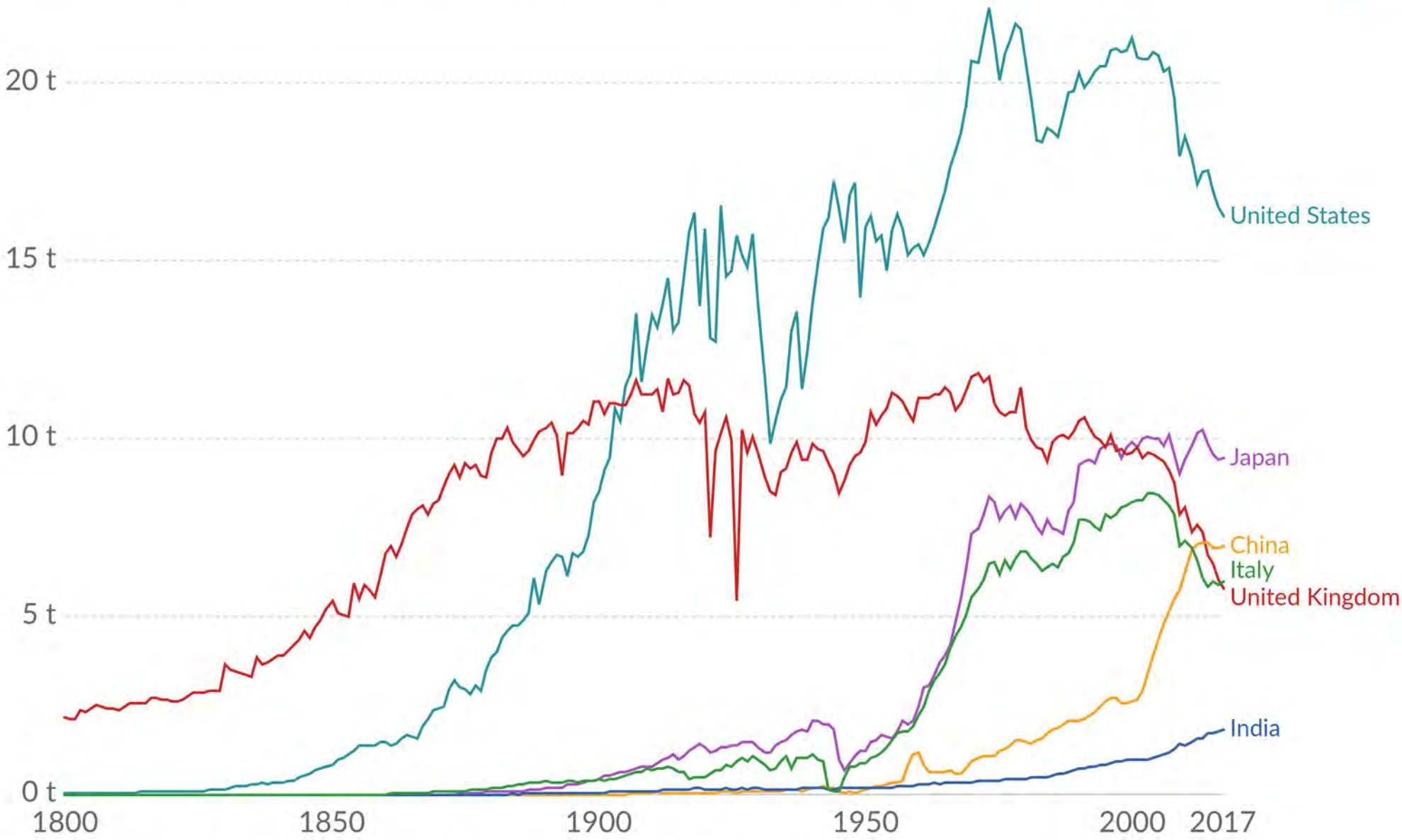
Q&A

Lei crede che il problema del riscaldamento globale possa essere risolto compatibilmente con la **crescita quasi esponenziale della popolazione mondiale**?



CO_2 emissions per capita

Average carbon dioxide (CO_2) emissions per capita measured in tonnes per year.



Source: OWID based on CDIAC; Global Carbon Project; Gapminder & UN
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

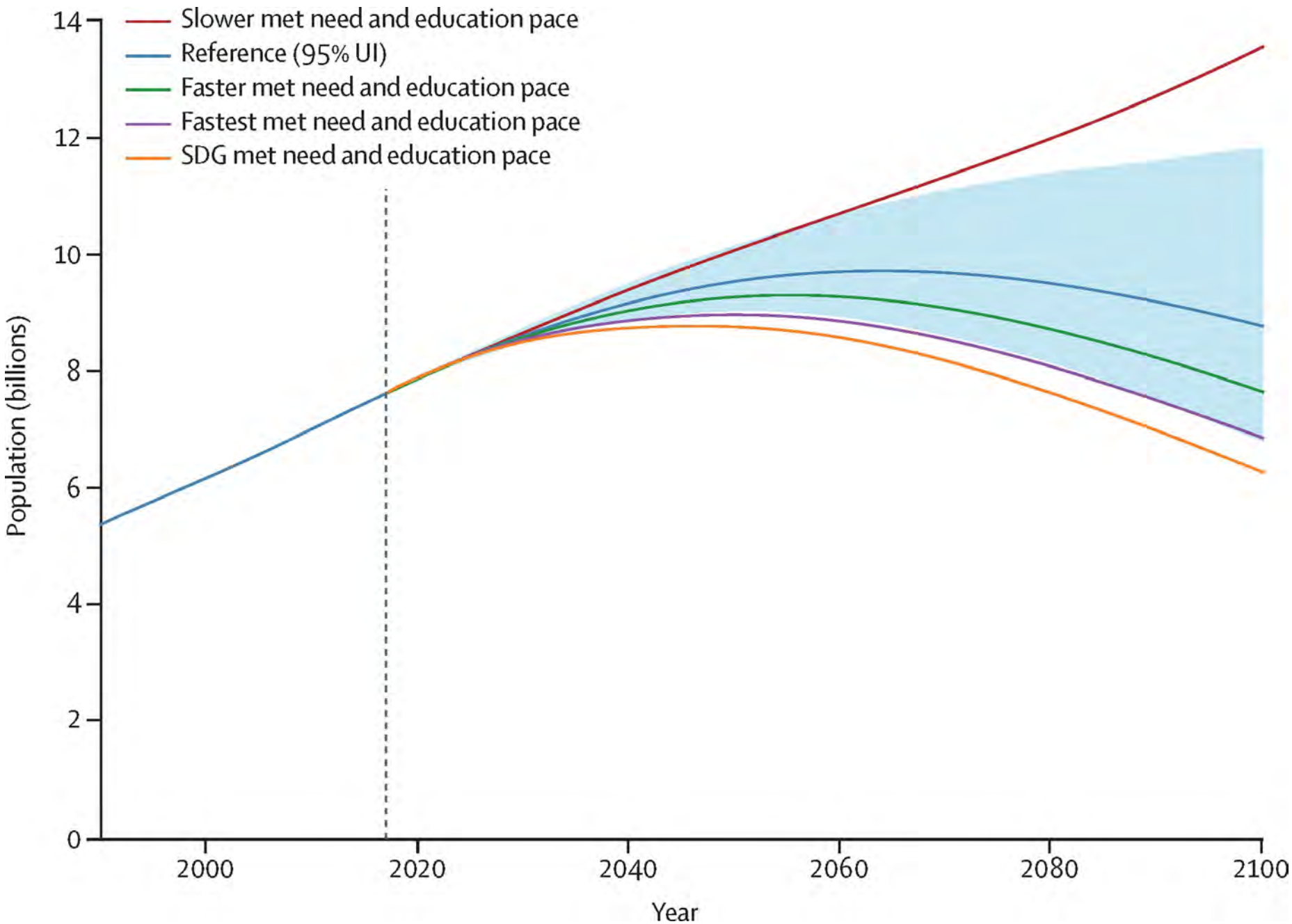
I demografi prevedono che entro la seconda metà del secolo la popolazione mondiale entrerà per la prima volta in un declino sostenuto

il pianeta raggiungerà il picco nel 2064, con 9,7 miliardi di abitanti, e poi comincerà l’inversione di tendenza che farà scendere la popolazione a 8,8 miliardi di abitanti.

Per 23 paesi, tra cui l’Italia, la riduzione sarà superiore al 50 per cento.
Intanto la popolazione dell’Africa subsahariana triplicherà.

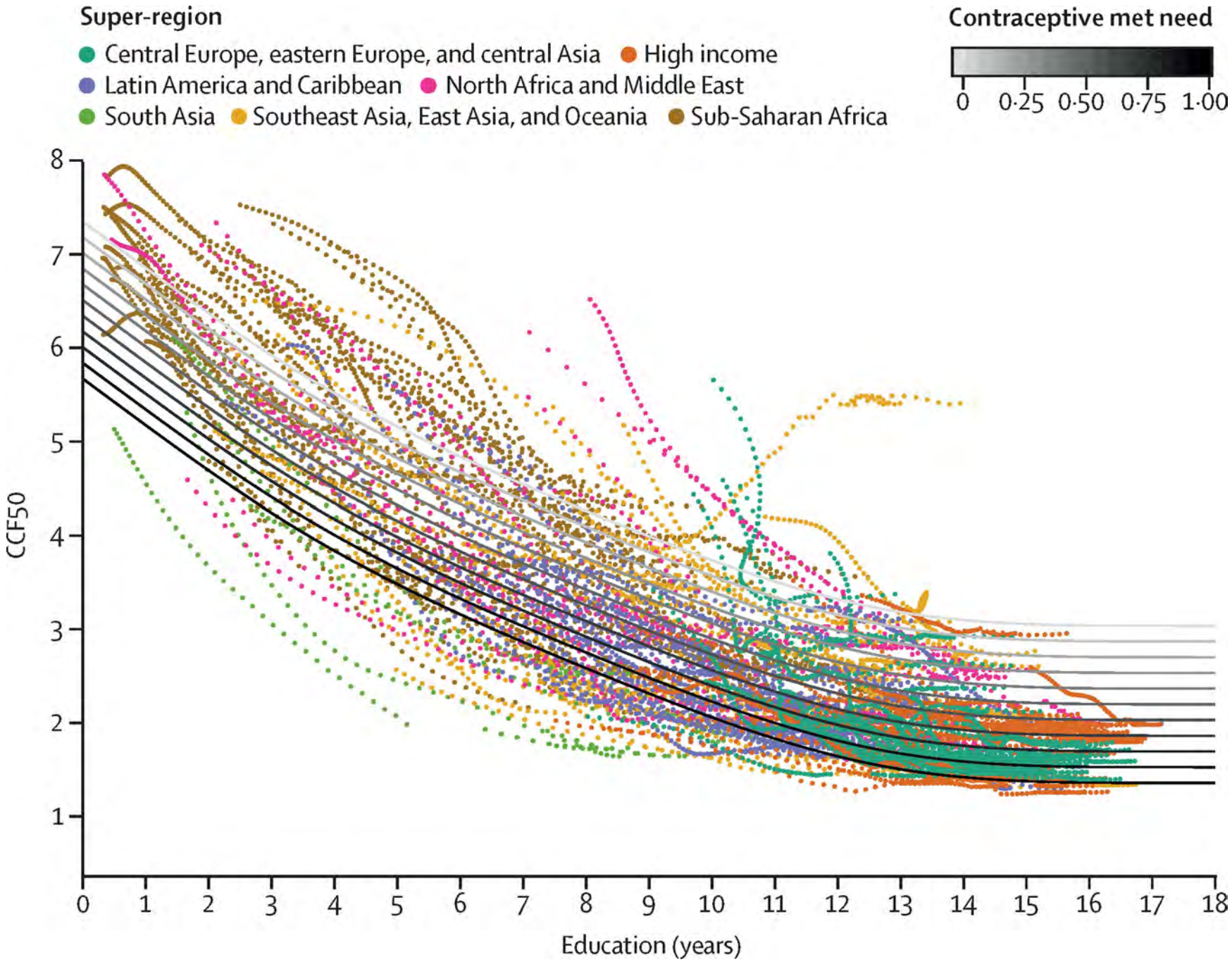
Vollset et al. 2020 The Lancet https://doi.org/10.1016/S0140-6736(20)30677-2

Proiezioni popolazione mondiale (https://vizhub.healthdata.org/population-forecast/)

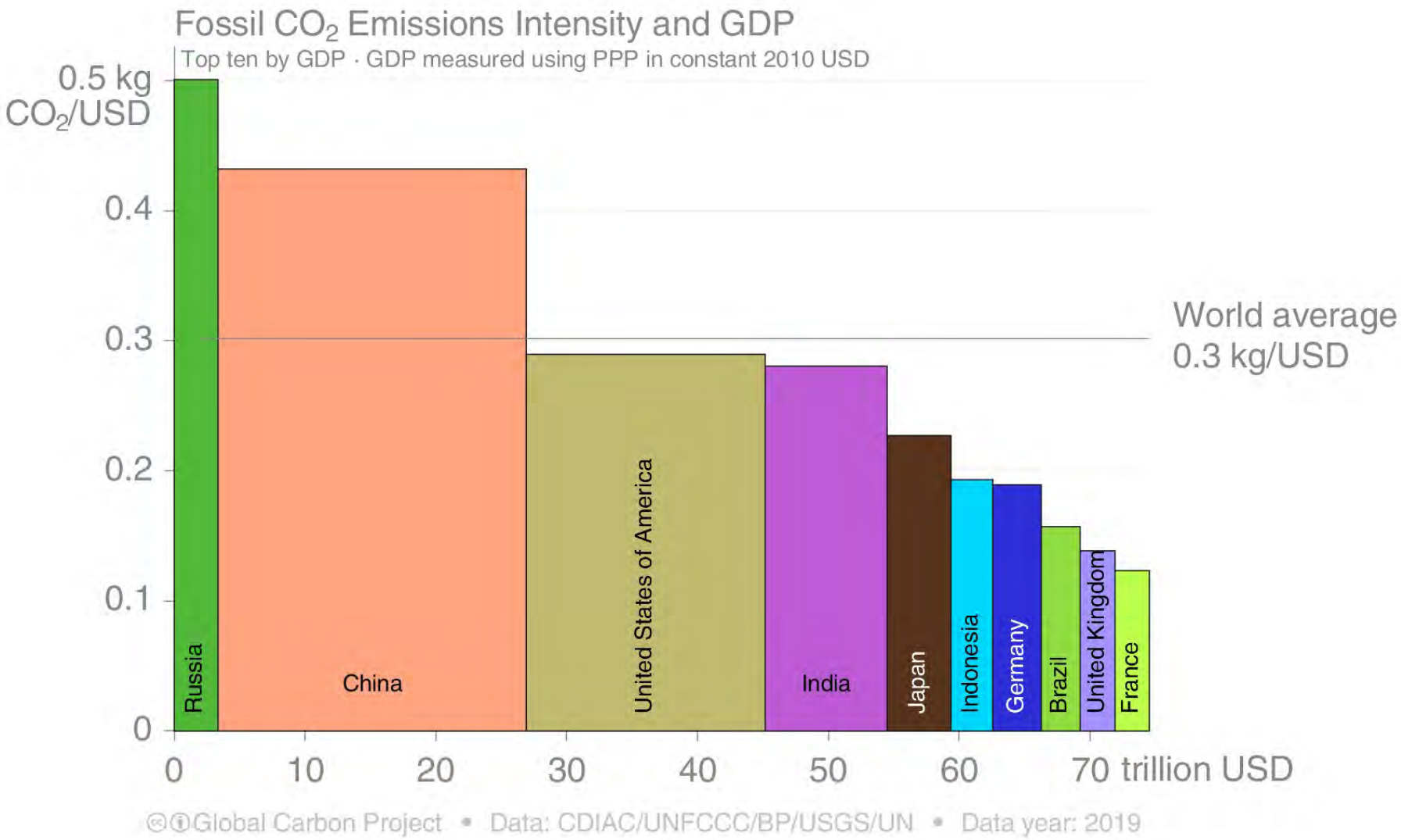


Vollset et al. 2020 The Lancet https://doi.org/10.1016/S0140-6736(20)30677-2

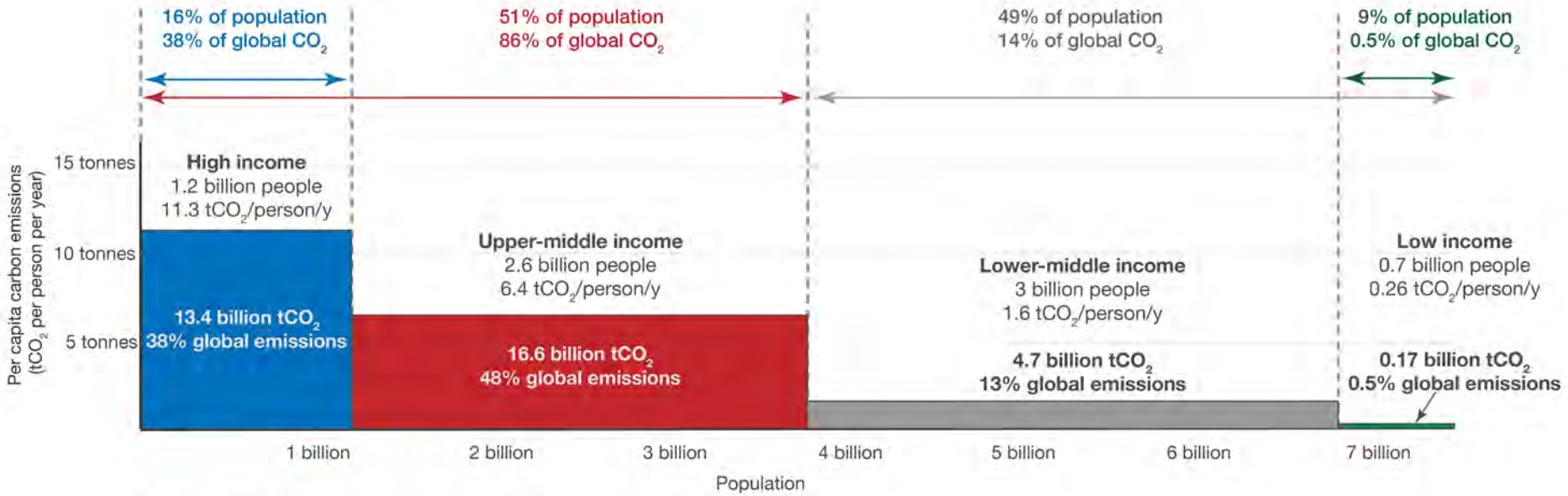
Tassi di fertilità



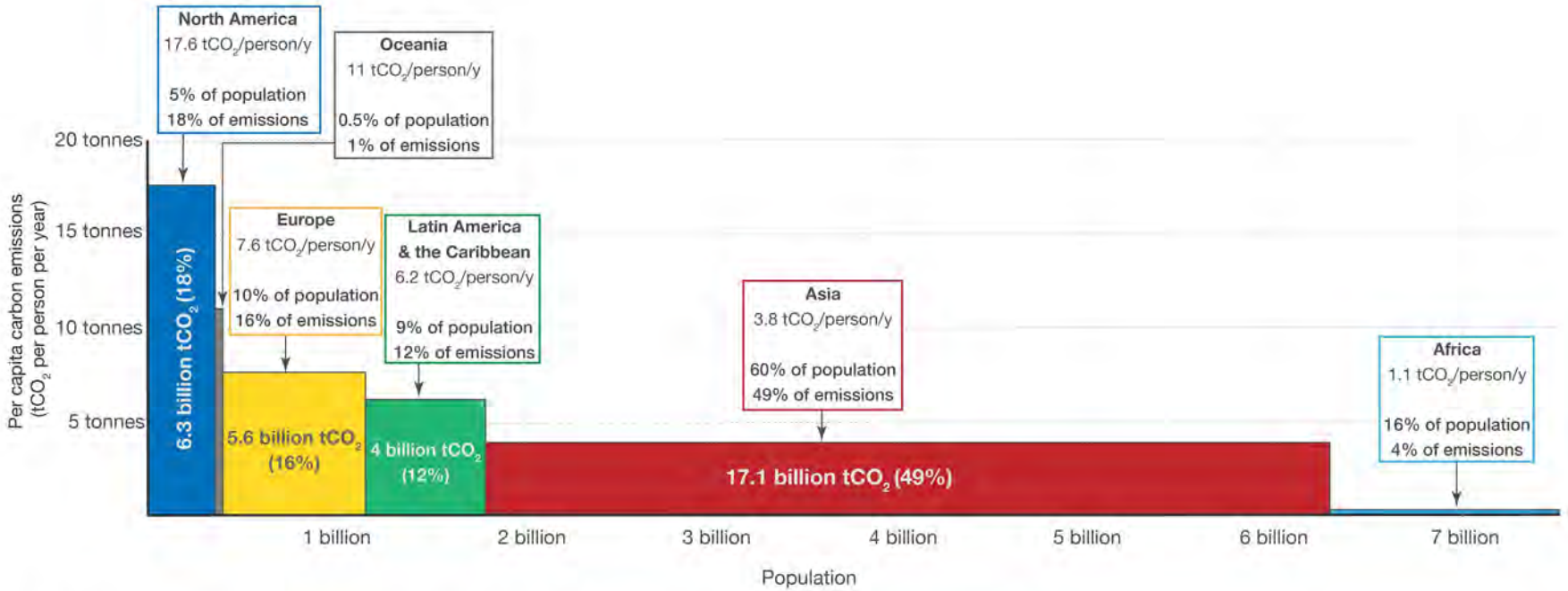
Il futuro sviluppo delle **economie emergenti** porterà ad una desensibilizzazione di questi ultimi in merito alle tematiche ambientali mettendo in primo piano lo sviluppo stesso?



By Income Group



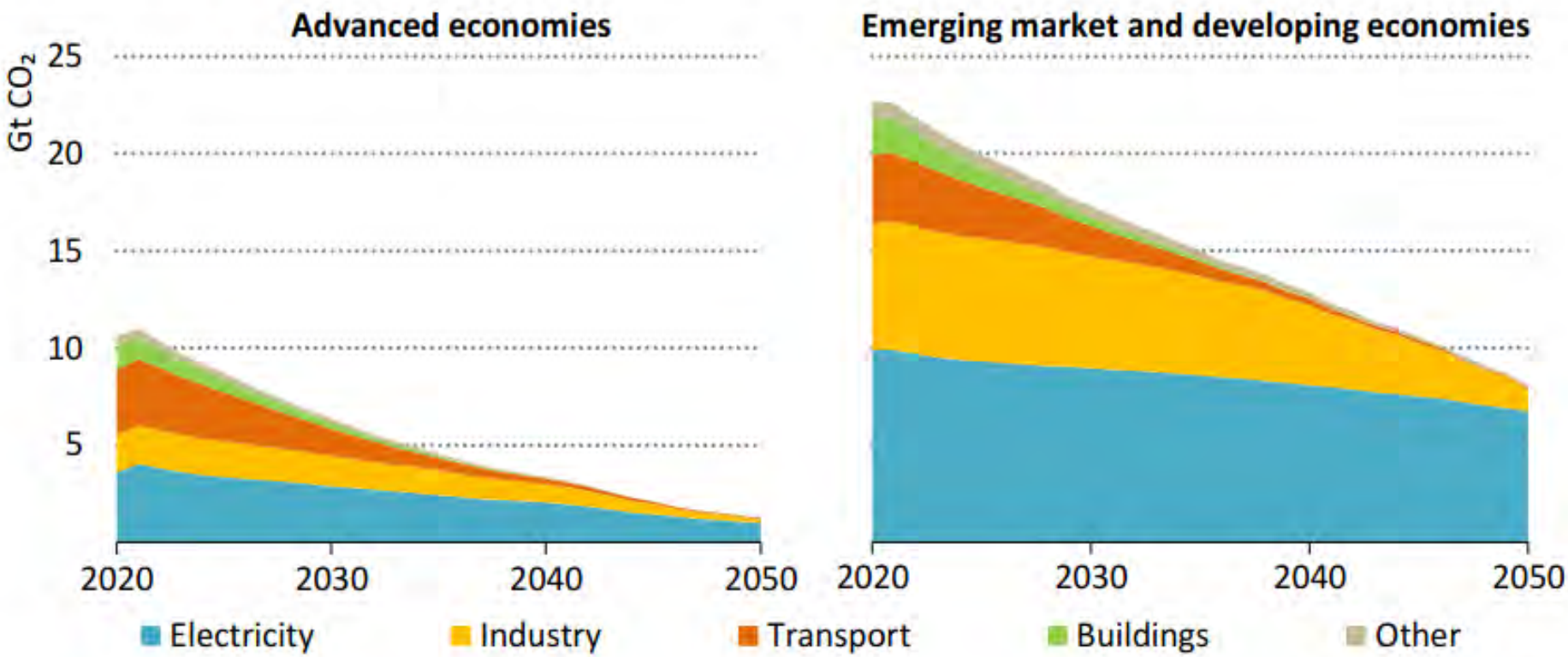
By Region



Source: Our World in Data based on data from the Global Carbon Project, UN Population Division (2018) & World Bank income groups.
This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.

Licensed under CC-BY-SA by the authors Hannah Ritchie and Max Roser.

Figure 1.9 ▷ Emissions from existing infrastructure by sector and region



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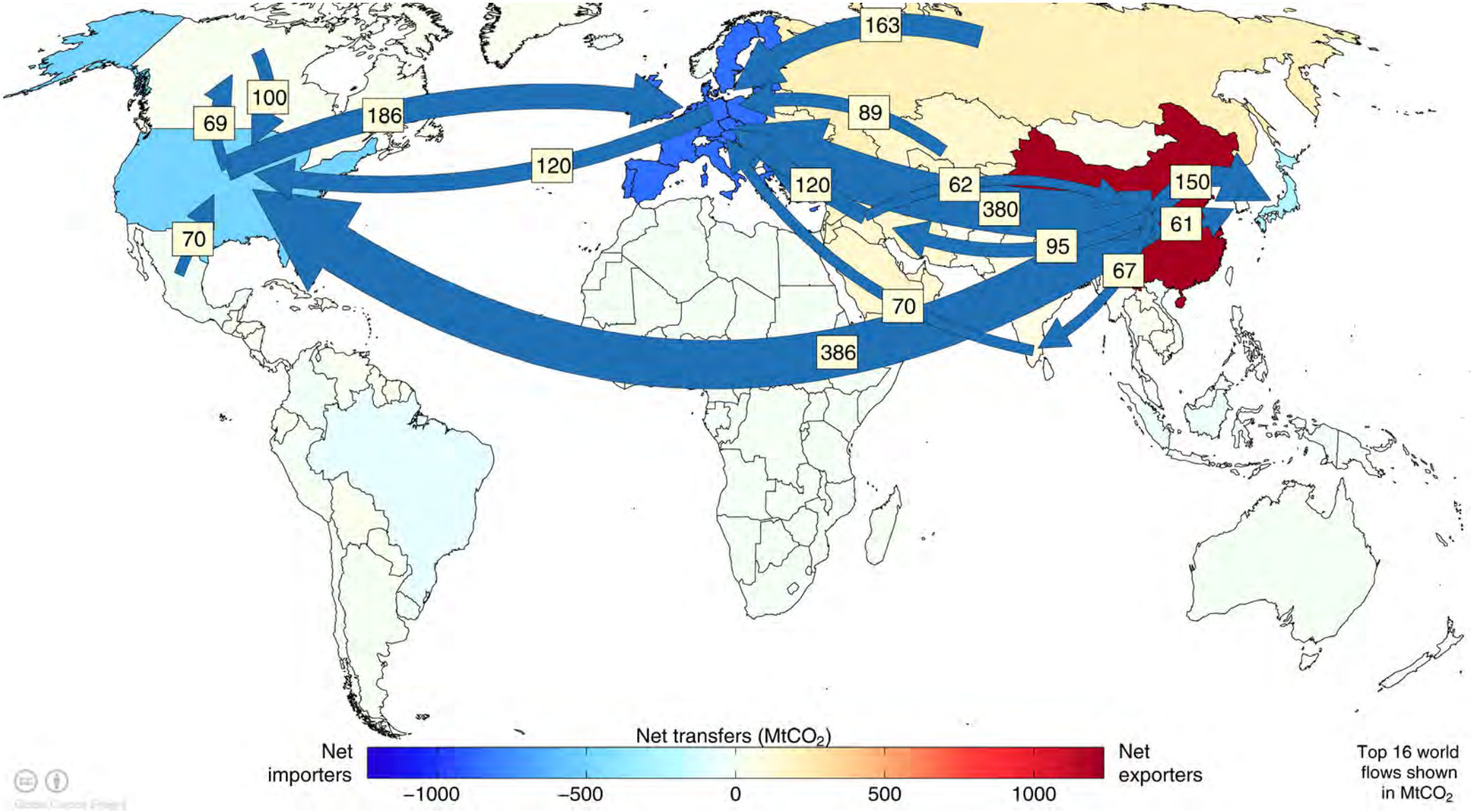
Emerging market and developing economies account for three-quarters of cumulative emissions from existing infrastructure through to 2050

Delocalizzazione delle emissioni

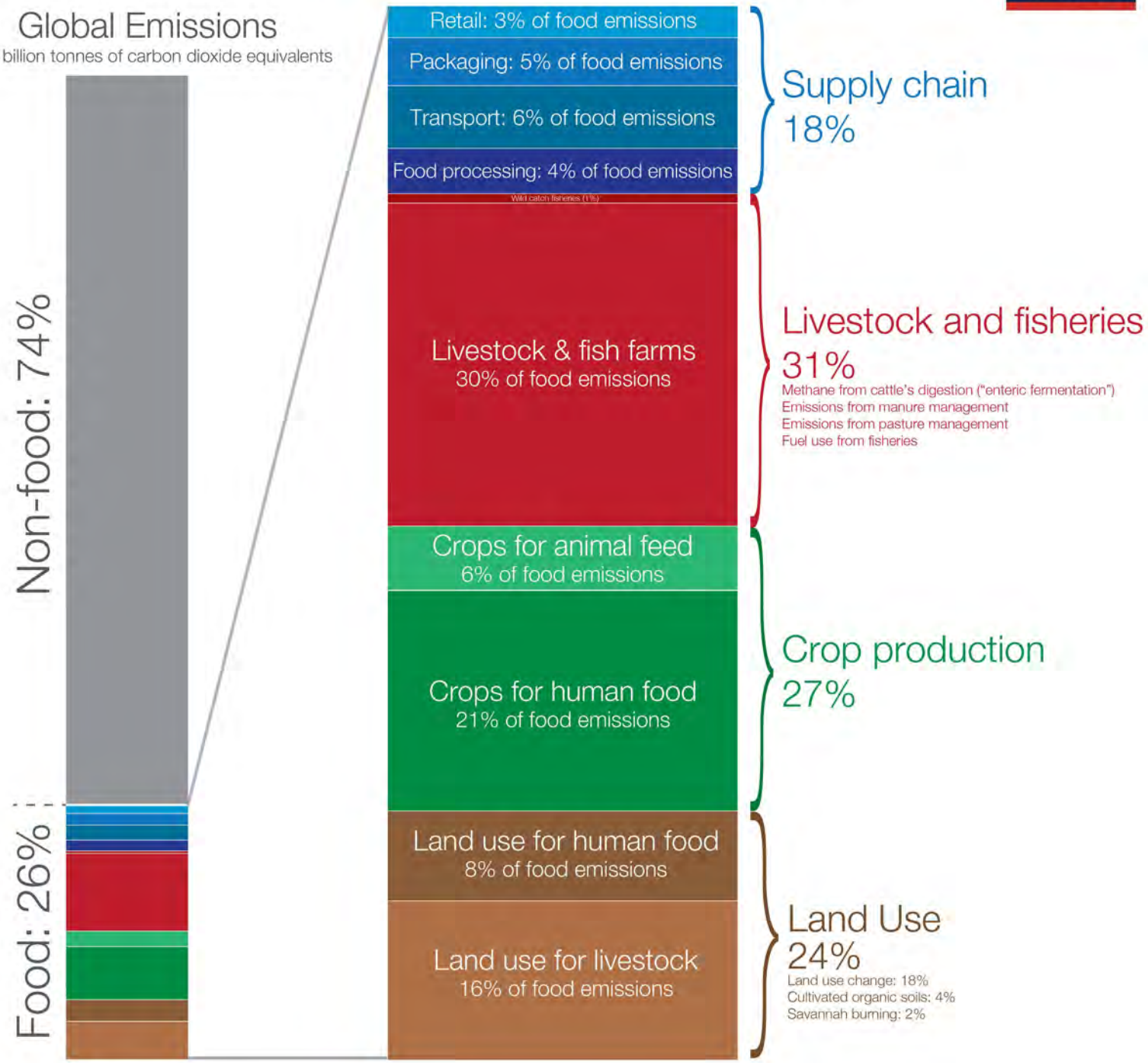


Può una diminuzione dei **prodotti animali** attenuare il fenomeno del riscaldamento globale?

Tra i diversi metodi di **smaltimento dei rifiuti** presenti, qual è il più ecosostenibile? C’è qualche nuova idea o progetto che sarà più efficiente?

Global greenhouse gas emissions from food production

Our World in Data



Data source: Joseph Poore & Thomas Nemecek (2018). Reducing food's environmental impacts through producers and consumers. Published in *Science*.

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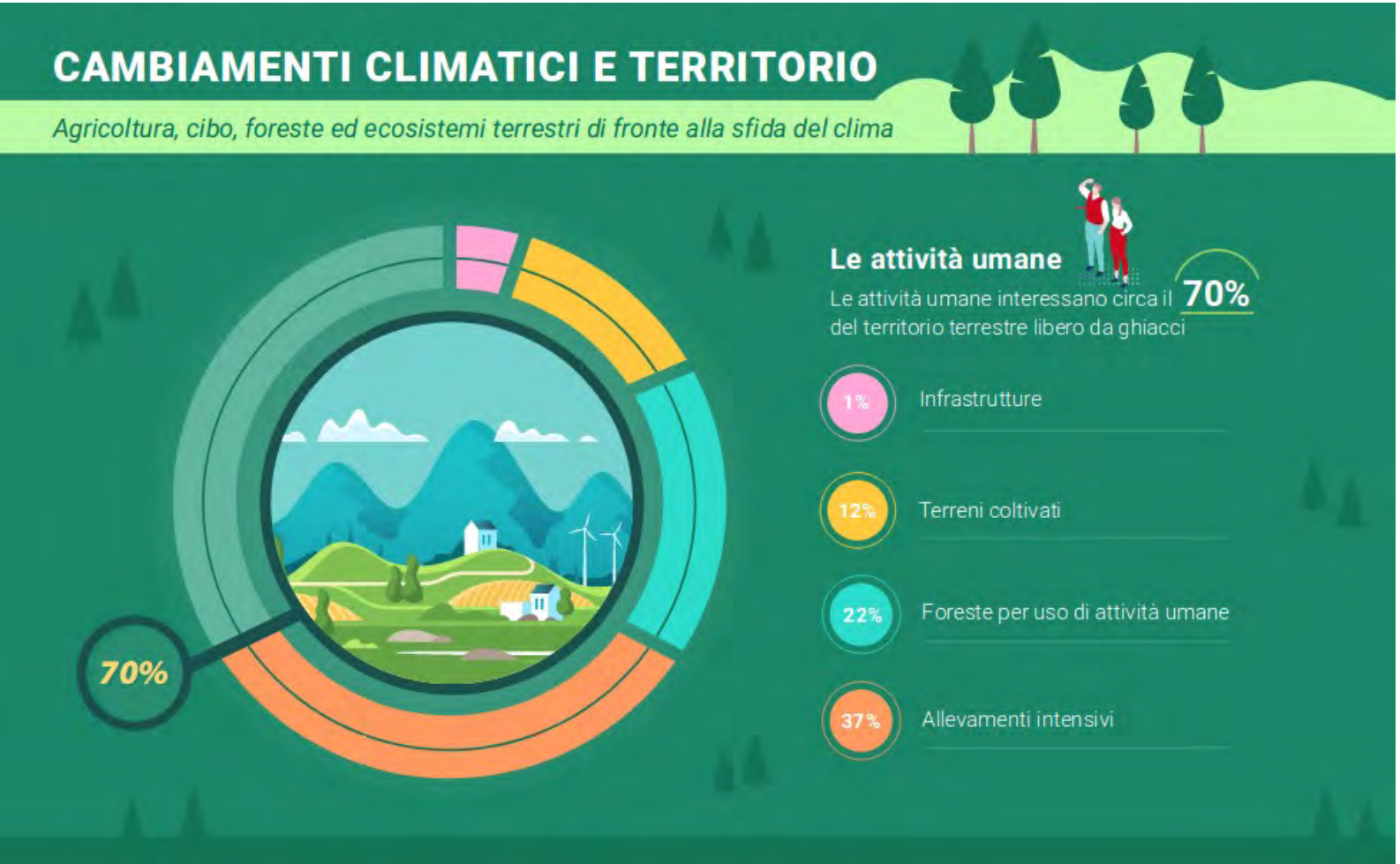
Climate Change and Land
REPORT
An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems
DOWNLOAD REPORT


CAMBIAMENTI CLIMATICI E TERRITORIO
Agricoltura, cibo, foreste ed ecosistemi terrestri di fronte alla sfida del clima
70%
Le attività umane
Le attività umane interessano circa il 70% del territorio terrestre libero da ghiacci
1% Infrastrutture
12% Terreni coltivati
22% Foreste per uso di attività umane
37% Allevamenti intensivi

Spreco e perdita alimentare
Lo spreco alimentare è il cibo che viene acquistato e non viene consumato ma viene buttato
+40%
Lo spreco alimentare pro capite è aumentato dal 1960
25-30%
del cibo prodotto
8 -10%
delle emissioni del sistema alimentare

6% of global greenhouse gas emissions come from food losses and waste
Our World in Data
Emissions from food that is never eaten accounts for 6% of total emissions
Lost in supply chains
Consumer waste
Food eaten
Food production is responsible for 26% of global greenhouse gas emissions
Note: One-quarter of food emissions comes from food that is never eaten: 15% of food emissions from food lost in supply chains; and 9% from consumer waste.
Data source: Joseph Poore & Thomas Nemecek (2018). Reducing food's environmental impacts through producers and consumers. Science.
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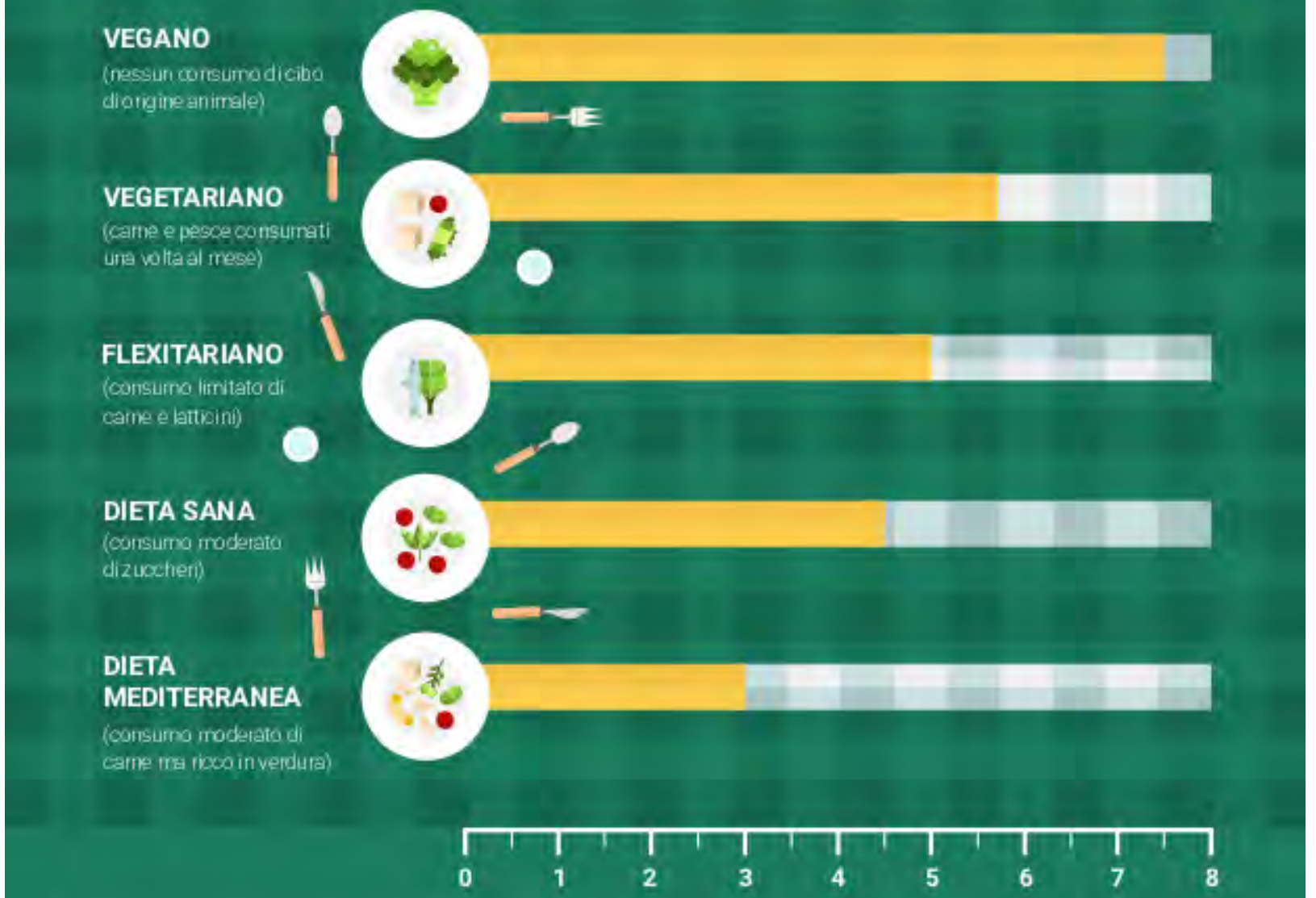
Diete e abitudini alimentari

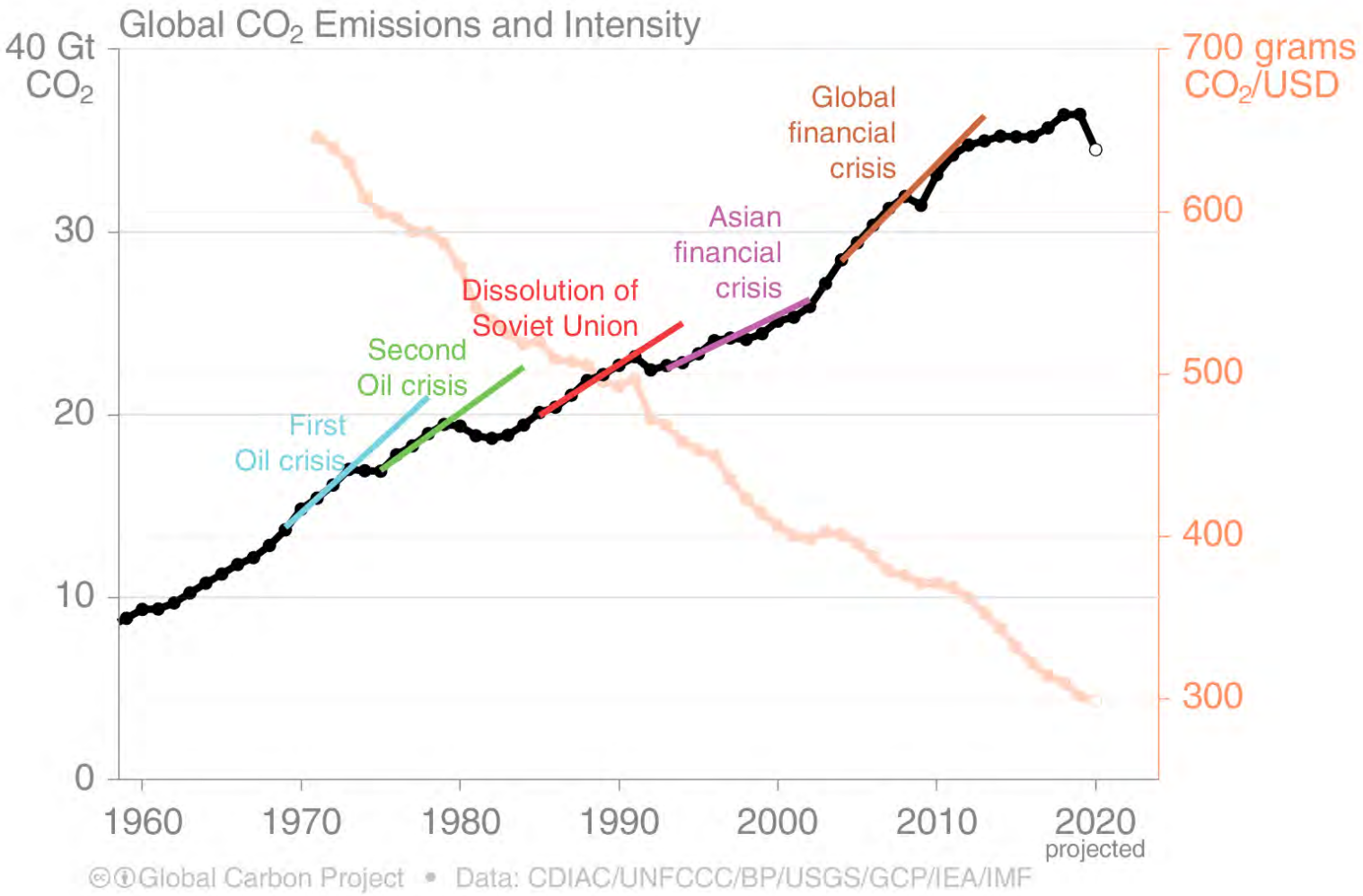
contribuiscono alla riduzione delle emissioni di gas serra.
Una transizione diffusa a diete più sane
potrebbe liberare un'area di **4-25 milioni di Km² al 2050** e avrebbe un potenziale di riduzione pari a **0.7-0.8 Gt CO_2 eq all'anno** al **2050.**



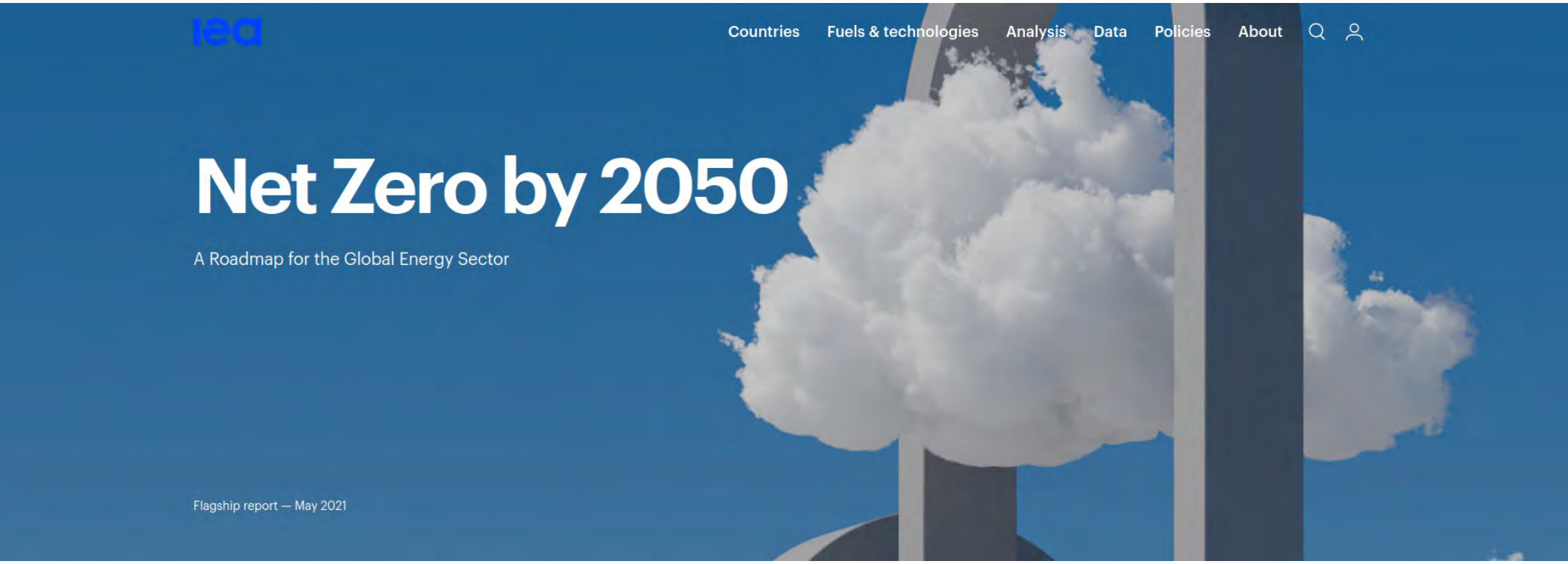
*Quantità di riduzione di emissioni per ogni tipo di dieta a livello globale in **Gt CO_2eq/anno***

*La **CO_2 equivalente** (**CO_2 eq**) è una misura che valuta l'impatto di una tonnellata di gas serra rispetto alla stessa quantità di **CO_2***

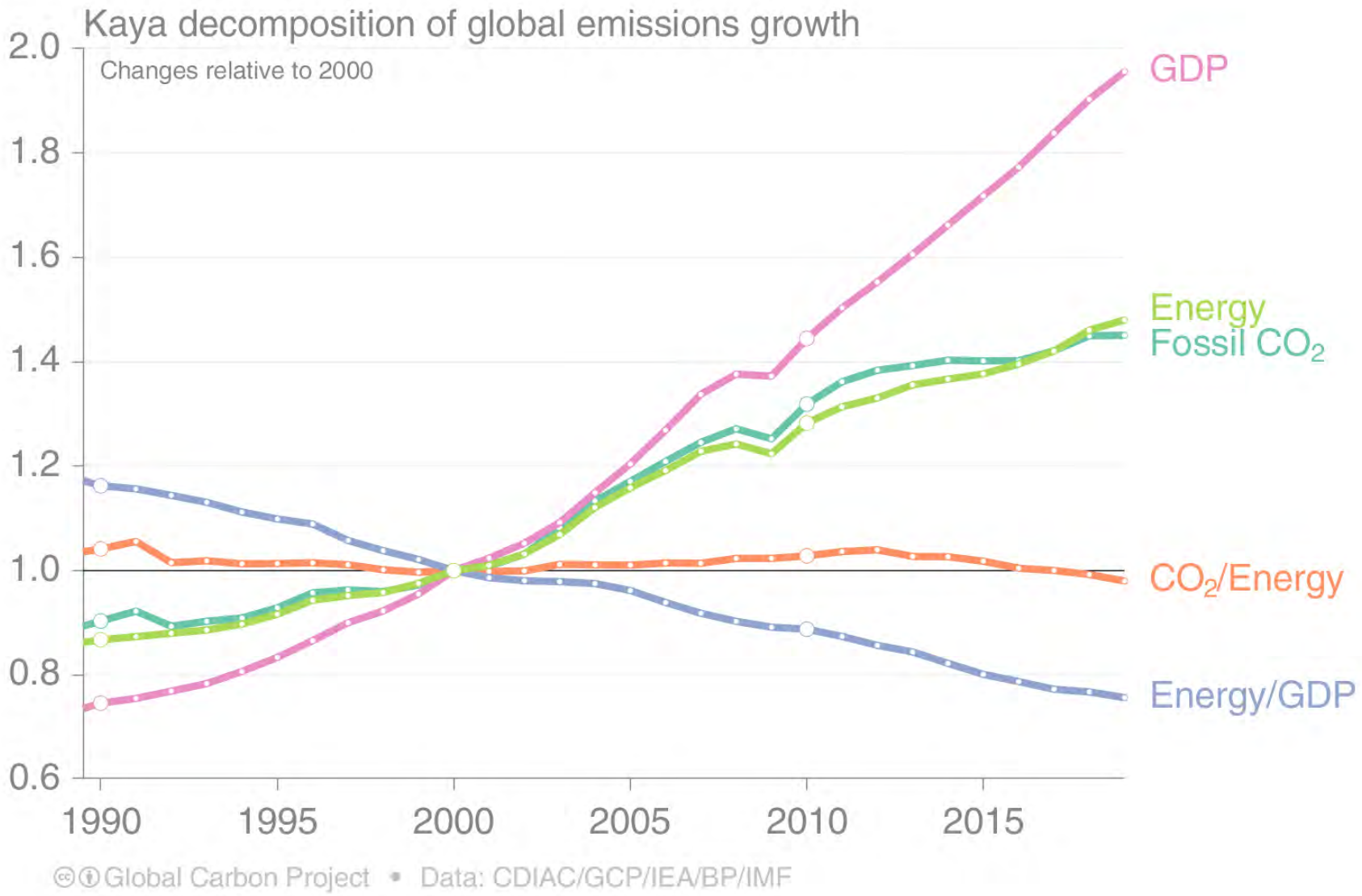
Quali sono le soluzioni proposte a livello globale che sono già state messe in campo o che potranno essere attuate **compatibilmente con lo sviluppo economico?**

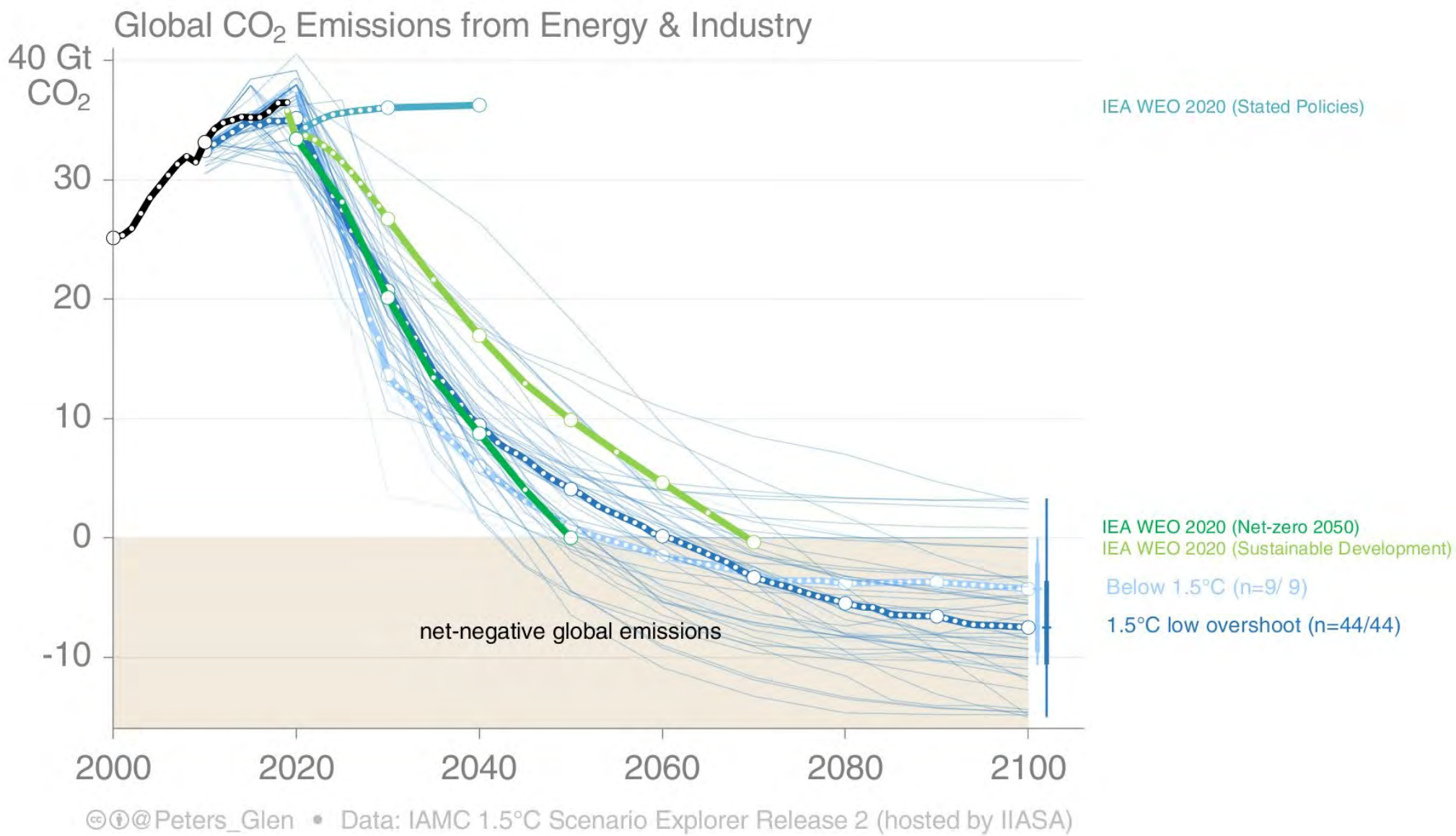


Quali sono le soluzioni proposte a livello globale che sono già state messe in campo o che potranno essere attuate **compatibilmente con lo sviluppo economico?**

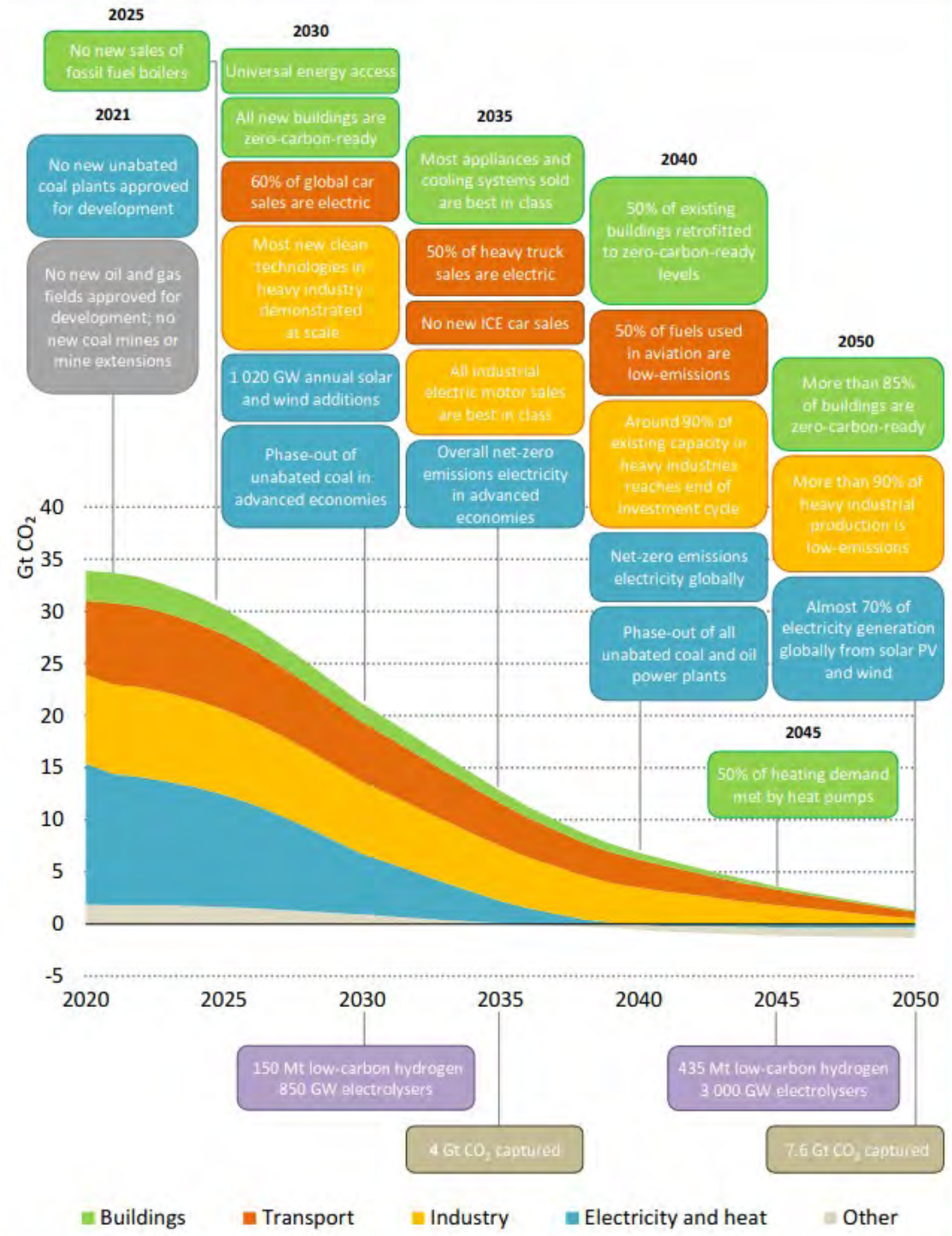


IEA (2021), Net Zero by 2050, IEA, Paris
https://www.iea.org/reports/net-zero-by-2050

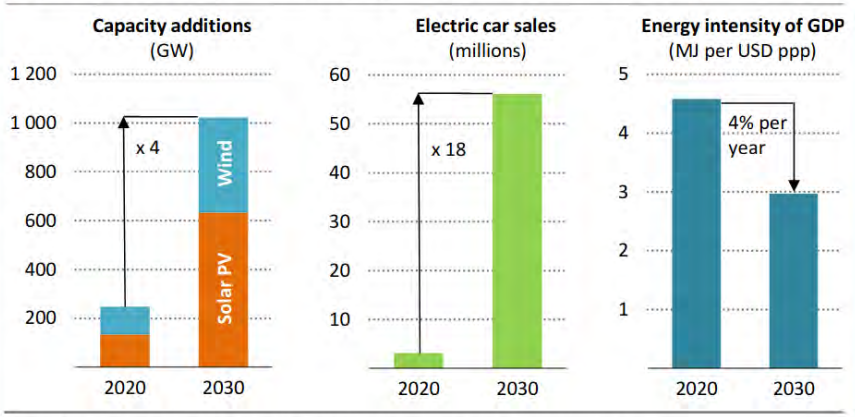

Kaya decomposition of global emissions growth
Changes relative to 2000
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
1990
1995
2000
2005
2010
2015
GDP
Energy
Fossil CO_2
CO_2/Energy
Energy/GDP
Global Carbon Project • Data: CDIAC/GCP/IEA/BP/IMF


Global CO_2 Emissions from Energy & Industry
40 Gt CO_2
30
20
10
0
-10
2000
2020
2040
2060
2080
2100
IEA WEO 2020 (Stated Policies)
IEA WEO 2020 (Net-zero 2050)
IEA WEO 2020 (Sustainable Development)
Below 1.5°C (n=9/ 9)
1.5°C low overshoot (n=44/44)
net-negative global emissions
@Peters_Glen • Data: IAMC 1.5°C Scenario Explorer Release 2 (hosted by IIASA)

Key milestones in the pathway to net zero

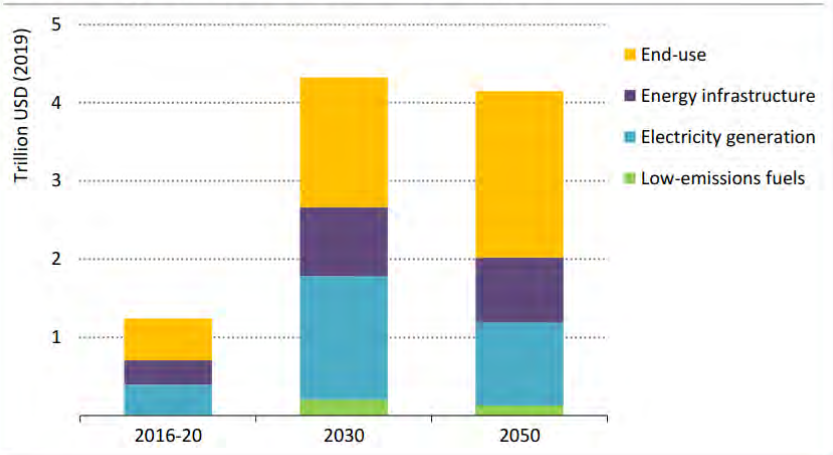


Key clean technologies ramp up by 2030 in the net zero pathway

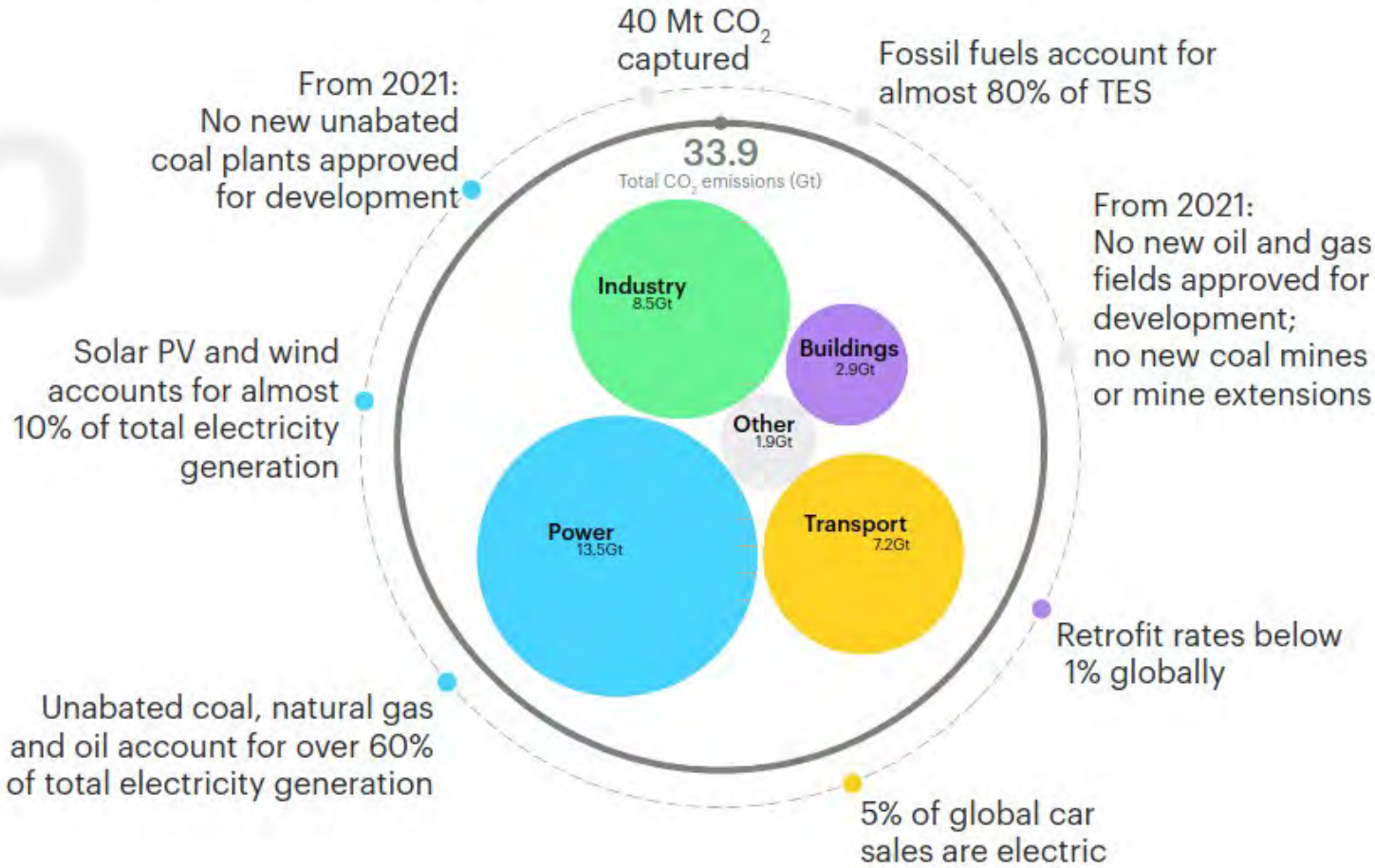


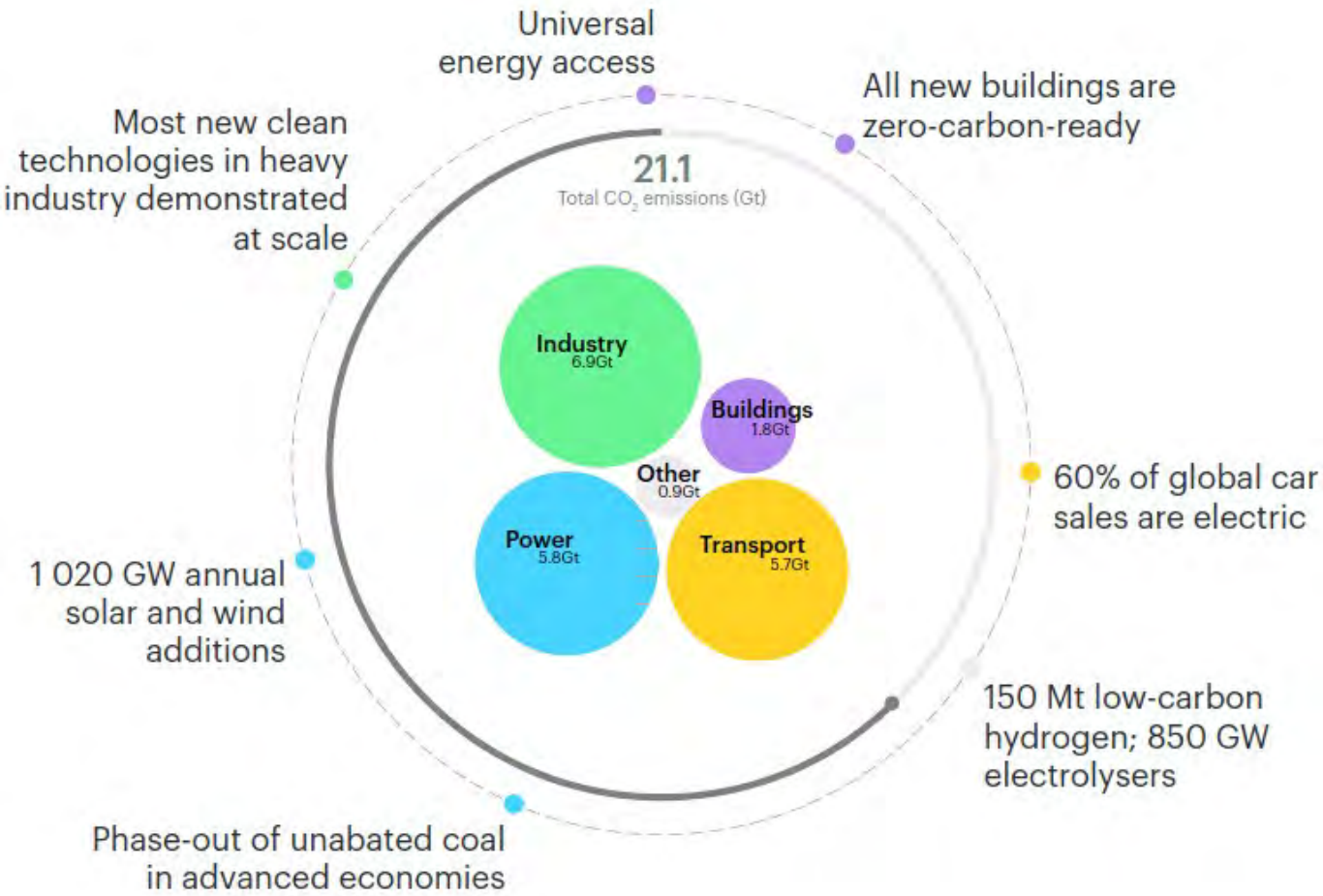
Note: MJ = megajoules; GDP = gross domestic product in purchasing power parity.

Clean energy investment in the net zero pathway



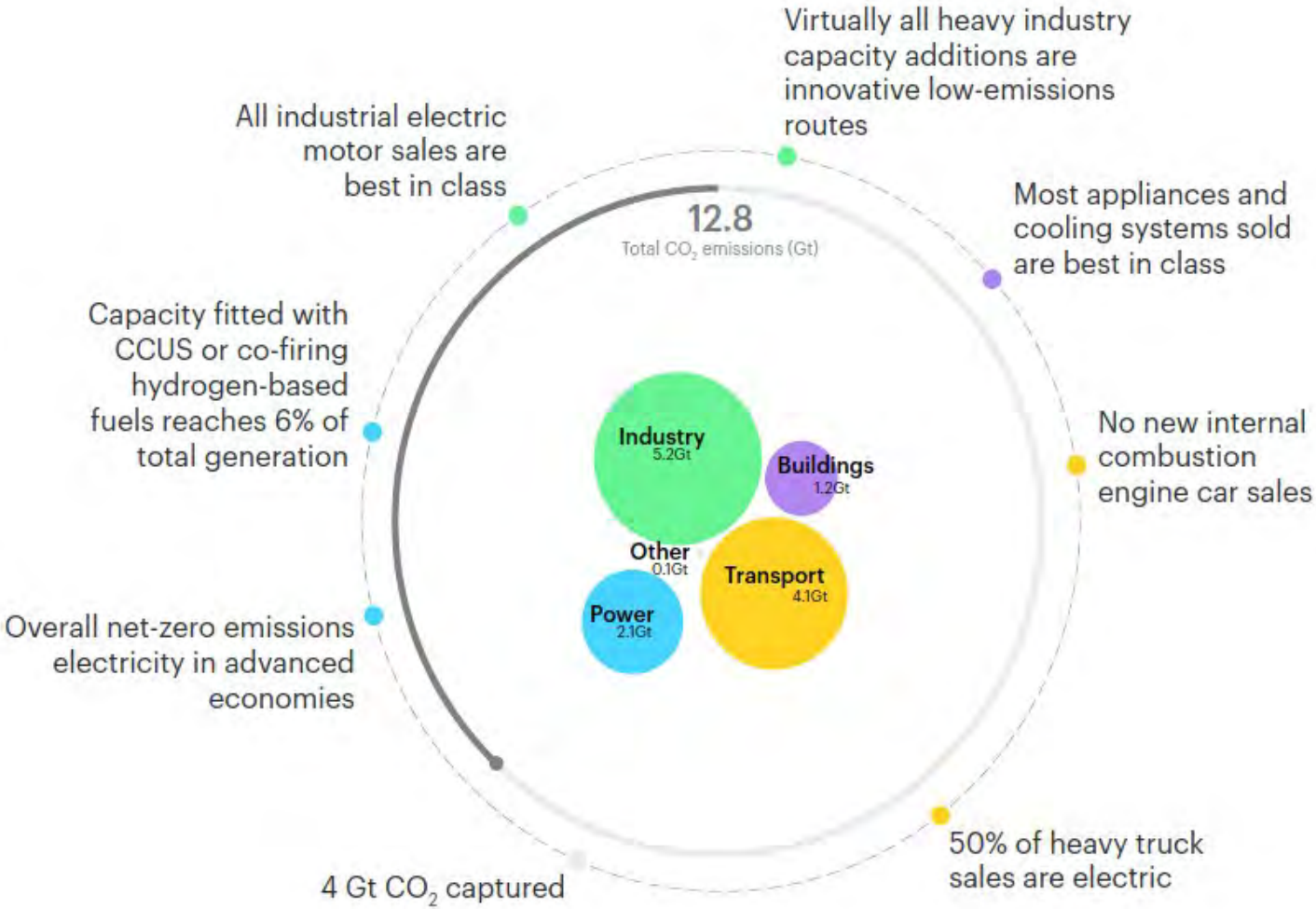
Net Zero Emissions by 2050 Interactive iea.li/nzeroadmap

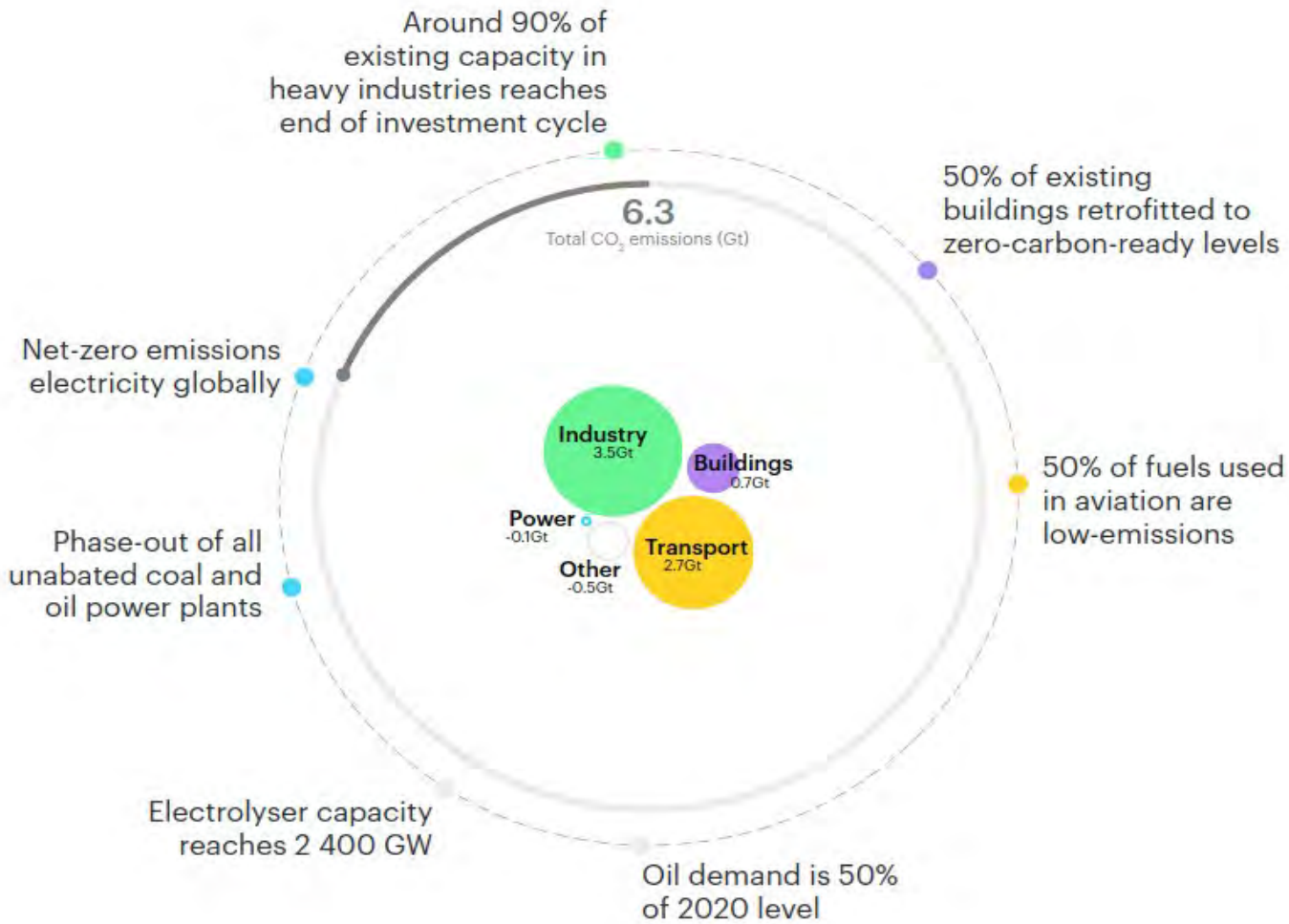



Universal energy access
All new buildings are zero-carbon-ready
Most new clean technologies in heavy industry demonstrated at scale
21.1
Total CO_2 emissions (Gt)
Industry 6.9Gt
Buildings 1.8Gt
Other 0.9Gt
Power 5.8Gt
Transport 5.7Gt
60% of global car sales are electric
1 020 GW annual solar and wind additions
150 Mt low-carbon hydrogen; 850 GW electrolysers
Phase-out of unabated coal in advanced economies

2030

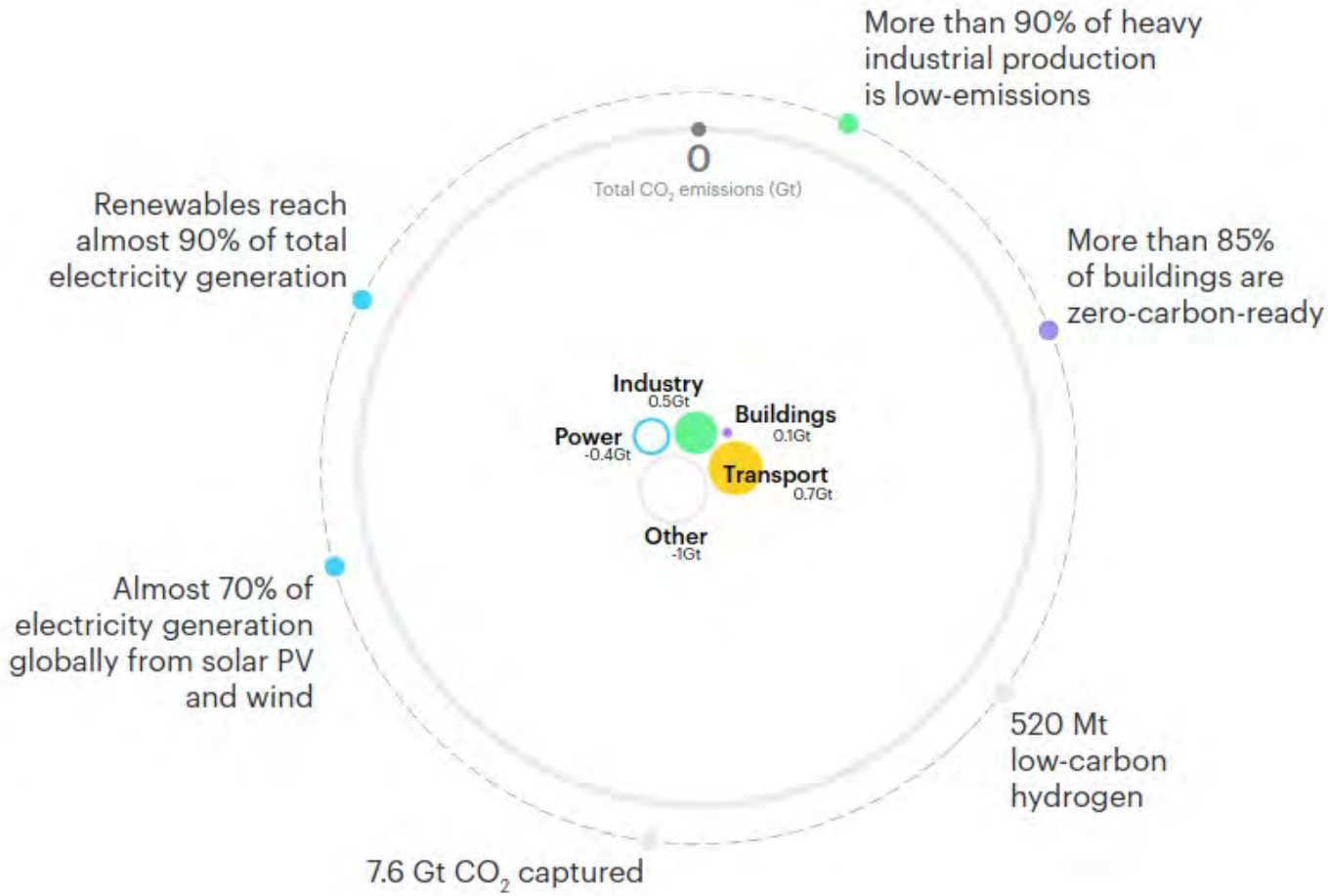
2035


Virtually all heavy industry capacity additions are innovative low-emissions routes
All industrial electric motor sales are best in class
Most appliances and cooling systems sold are best in class
12.8
Total CO_2 emissions (Gt)
Capacity fitted with CCUS or co-firing hydrogen-based fuels reaches 6% of total generation
Industry 5.2Gt
Buildings 1.2Gt
No new internal combustion engine car sales
Other 0.1Gt
Transport 4.1Gt
Power 2.1Gt
Overall net-zero emissions electricity in advanced economies
50% of heavy truck sales are electric
4 Gt CO_2 captured


Around 90% of existing capacity in heavy industries reaches end of investment cycle
6.3
Total CO_2 emissions (Gt)
50% of existing buildings retrofitted to zero-carbon-ready levels
Net-zero emissions electricity globally
Industry
3.5Gt
Buildings
0.7Gt
Power
-0.1Gt
Other
-0.5Gt
Transport
2.7Gt
50% of fuels used in aviation are low-emissions
Phase-out of all unabated coal and oil power plants
Electrolyser capacity reaches 2 400 GW
Oil demand is 50% of 2020 level

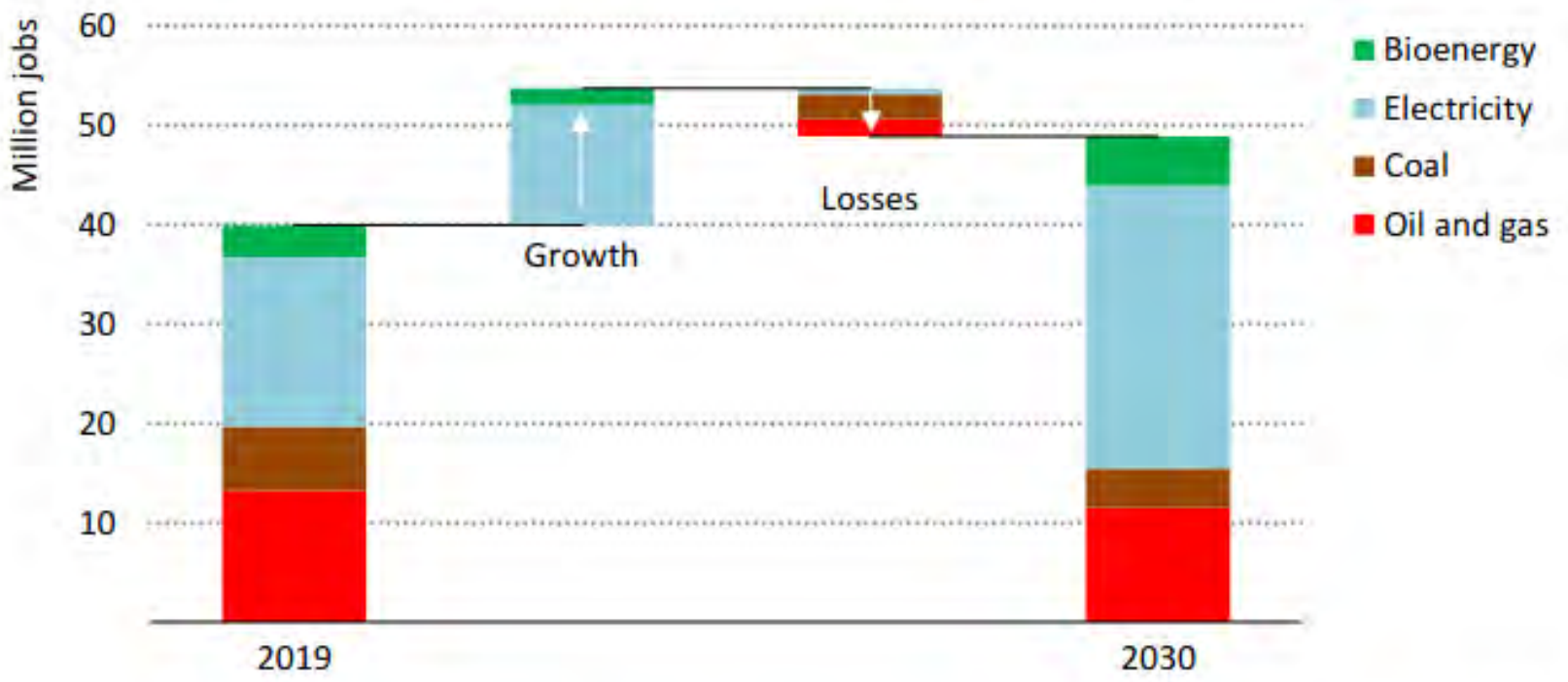
2040

2050


More than 90% of heavy industrial production is low-emissions
0
Total CO_2 emissions (Gt)
Renewables reach almost 90% of total electricity generation
More than 85% of buildings are zero-carbon-ready
Industry
0.5Gt
Buildings
0.1Gt
Power
-0.4Gt
Transport
0.7Gt
Other
-1Gt
Almost 70% of electricity generation globally from solar PV and wind
520 Mt low-carbon hydrogen
7.6 Gt CO_2 captured

jobs

Figure 4.5 ▷ Global energy sector employment in the NZE, 2019-2030



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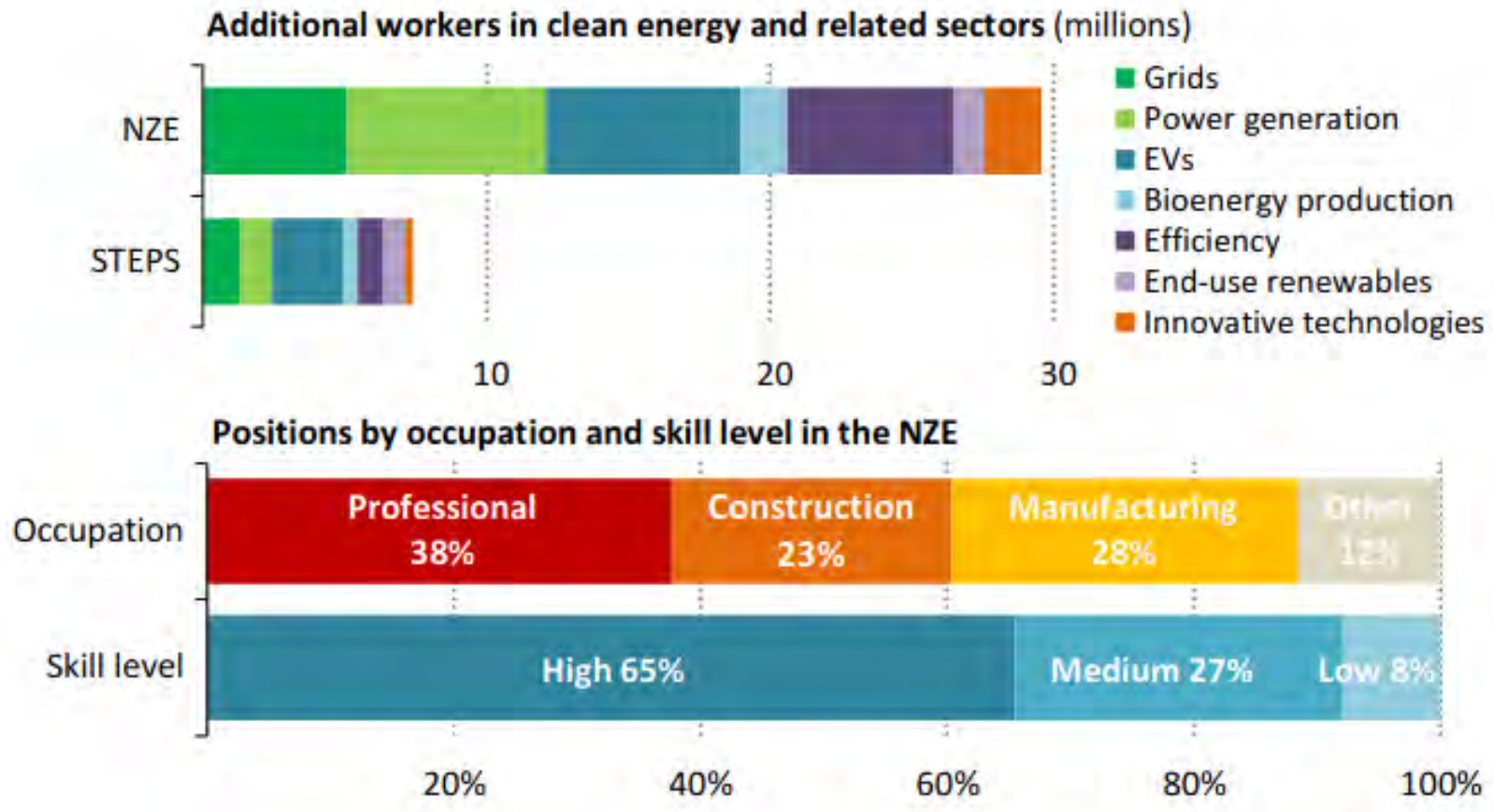
Overall employment in the energy sector increases by almost 9 million to 2030 as jobs created in clean energy sectors outpace losses in fossil fuels

The transition to net zero brings substantial **new opportunities for employment, with 14 million jobs created by 2030** in our pathway thanks to **new activities and investment** in clean energy … Spending on more efficient appliances, electric and fuel cell vehicles, and building retrofits and energy-efficient construction would require a further **16 million workers**. But these opportunities are often in different locations, skill sets and sectors than the jobs that will be lost as fossil fuels decline. In our pathway, **around 5 million jobs are lost. Most of those jobs are located close to fossil fuel resources, and many are well paid, meaning structural changes can cause shocks for communities with impacts that persist over time. This requires careful policy attention to address the employment**

jobs

Figure 4.6 ▷ New workers in clean energy and related sectors and shares by skill level and occupation in the NZE and the STEPS in 2030



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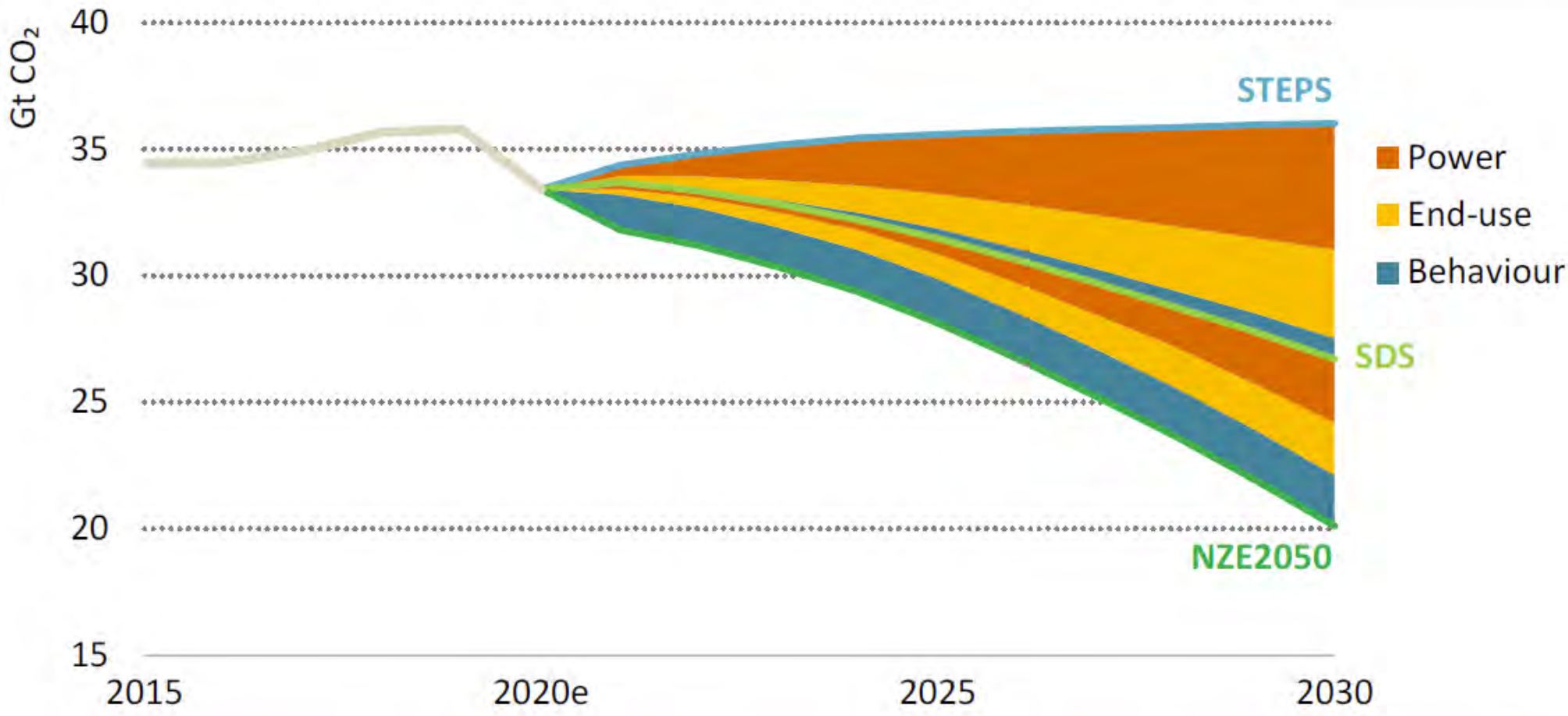
About 30 million new workers are needed by 2030 to meet increased demand for clean energy, efficiency, and low-emissions technologies; over half are highly skilled positions

Behaviour changes



An unparalleled transformation of the energy sector and major behaviour changes in the next ten years would be needed to achieve global net-zero emissions by 2050

Behaviour changes

Table 2.10 ▷ Key behavioural changes in the NZE

	Policy options	Related policy-goals	Cost-effectiveness	Timeliness	Social acceptability	CO_2 emissions impact
Low-car cities • Phase out ICE cars from large cities. • Rideshare all urban car trips.	• Low-emissions zones. • Access restrictions. • Parking restrictions. • Registration caps. • Parking pricing. • Congestion charges. • Investment in cycling lanes and public transportation.	• Air pollution mitigation. • Public health. • Reduced congestion. • Urban space. • Beautification and liveability.	🟡	🟡	🟡	🟢
Fuel-efficient driving • Reduce motorway speeds to less than 100 km/h. • Eco-driving. • Raise air conditioning temperature in cars by 3 °C.	• Speed limits. • Real-time fuel efficiency displays. • Awareness campaigns.	• Road safety. • Reduced noise pollution.	🟢	🟢	🟡	🟢
Reduce regional flights • Replace all flights <1h where high-speed rail is a feasible alternative.	• High-speed rail investment. • Subsidies for high-speed rail travel. • Price premiums.	• Lower air pollution. • Lower noise pollution.	🔴	🔴	🟡	🟡
Reduce international flights • Keep air travel for business purposes at 2019 levels. • Keep long-haul flights for leisure at 2019 levels.	• Awareness campaigns. • Price premiums. • Corporate targets. • Frequent-flyer levies.	• Lower air pollution. • Lower noise pollution.	🟢	🟢	🟡	🟢
Space heating • Target average set-point temperatures of 19-20 °C.	• Awareness campaigns. • Consumption feedback. • Corporate targets.	• Public health. • Energy affordability.	🟢	🟢	🟢	🟢
Space cooling • Target average set-point temperatures of 24-25 °C.	• Awareness campaigns. • Consumption feedback. • Corporate targets.	• Public health. • Energy affordability.	🟢	🟢	🟢	🔴

🔴 = poor match 🟡 = neutral match 🟢 = good match

	Behaviour change	Emissions savings (Mt CO_2) 2021	2025	2030	Cumulative savings (Mt CO_2) 2021-30	Share in 2030
Space heating	Reduce space heating temperature by 3 °C.	460 33%	400 23%	300 15%	4 340 23%	11% of residential emissions. % of total savings.
Space cooling	Raise air conditioning temperature by 3 °C.	95 7%	95 5%	45 2%	860 5%	2% of residential emissions. % of total savings.
Line-drying	Line-drying instead of tumble-drying during summer months.	65 5%	55 3%	30 1%	550 3%	1% of residential emissions. % of total savings.
Laundry temperature	Wash on average 10 °C colder.	30 2%	25 1%	15 1%	270 1%	1% of residential emissions. % of total savings.
Driving more slowly	Reduce driving speed by 7 km/h.	420 30%	400 23%	340 17%	4 280 23%	7% of road transport emissions. % of total savings.
Eco-driving	Avoid sudden acceleration, stops or idling; early upshifting.	30 2%	160 9%	290 14%	1 670 9%	6% of road transport emissions. % of total savings.
Ride-sharing	Share all urban car trips.	20 2%	100 6%	190 10%	1 100 6%	9% of passenger car emissions. % of total savings.
Cycling and walking	Cycle or walk all car trips that would take less than ten minutes to cycle.	15 1%	75 4%	140 7%	820 4%	7% of passenger car emissions. % of total savings.
Mobile air conditioning	Raise air conditioning temperature in cars by 3 °C.	120 9%	110 6%	90 4%	1 160 6%	4% of passenger car emissions. % of total savings.
Working from home	20% of global workforce works from home 3 days of the week.[7]	80 6%	75 4%	55 3%	800 4%	3% of passenger car emissions. % of total savings.
Passenger aviation	Total passenger aviation.	50 4%	260 15%	520 26%	2 850 15%	60% of aviation emissions. % of total savings.
	Replace all flights less than 1 hour.	10	50	100	550	11% of aviation emissions.
	Replace three-quarters of all business flights.	25	120	240	1 340	28% of aviation emissions.
	Replace three-quarters of long-haul flights.	35	170	350	1 910	40% of aviation emissions.
Total		1 390	1 750	2 010	18 700	

Qual’è quella **domanda** che nessuno si fa riguardo al cambiamento climatico ma che bisognerebbe porsi?

1) Energy transition: le buone notizie

- Elettrificare l'economia: **produzione di energia elettrica da fonti rinnovabili deve aumentare di circa 4/5 volte**: da ~ 22 kTWh/anno a 80-110 kTWh/anno in funzione di quanto riduciamo parallelamente l'energy demand

- Il **costo** della produzione di 1 Mwh da solare fotovoltaico o eolico è crollato **-60/80 % in 5-6 anni** – incentivi pubblici a R&D e installazione quando NON era economicamente vantaggioso (EU) + investimenti (Cina)

- Il costo di produzione da fonti rinnovabili è adesso inferiore ai combustibili fossili: NESSUNO ERA STATO IN GRADO DI PREVEDERLO 10 ANNI FA

- I costi delle riduzioni future delle emissioni non si conoscono a priori (in termini economici si definiscono costi endogeni) → se decidiamo di investire in qualcosa i costi scenderanno (learning curves tecnologiche e economie di scale)

- La stessa cosa sta succedendo alle **batterie** (-80% tra 2010-2018)

- Batterie fondamentali per gestire **l'intermittenza** (giornaliera e stagionale) della produzione delle rinnovabili. + altre soluzioni tecnologiche (es thermal gas plant con carbon capture and storage, hydrogen, demand management)

- Dove mettiamo impianti fotovoltaici e eolici? E' sufficiente ~ **1% della superficie terrestre** globale (0.3% land+ocean) → achievable at global level attenzione a livello di specifici paesi (es Cina vs Bangladesh → importanza degli accordi internazionali)

Politiche necessarie

1. obiettivi a lungo termine ambiziosi e non negoziabili: emissioni nette zero al 2050

2. “mission” globale e nazionale di maggior elettrificazione da fonti rinnovabili (x4/5)

3. incentivi iniziali per tecnologie chiave (come fatto per PV, wind, batteries, ..)

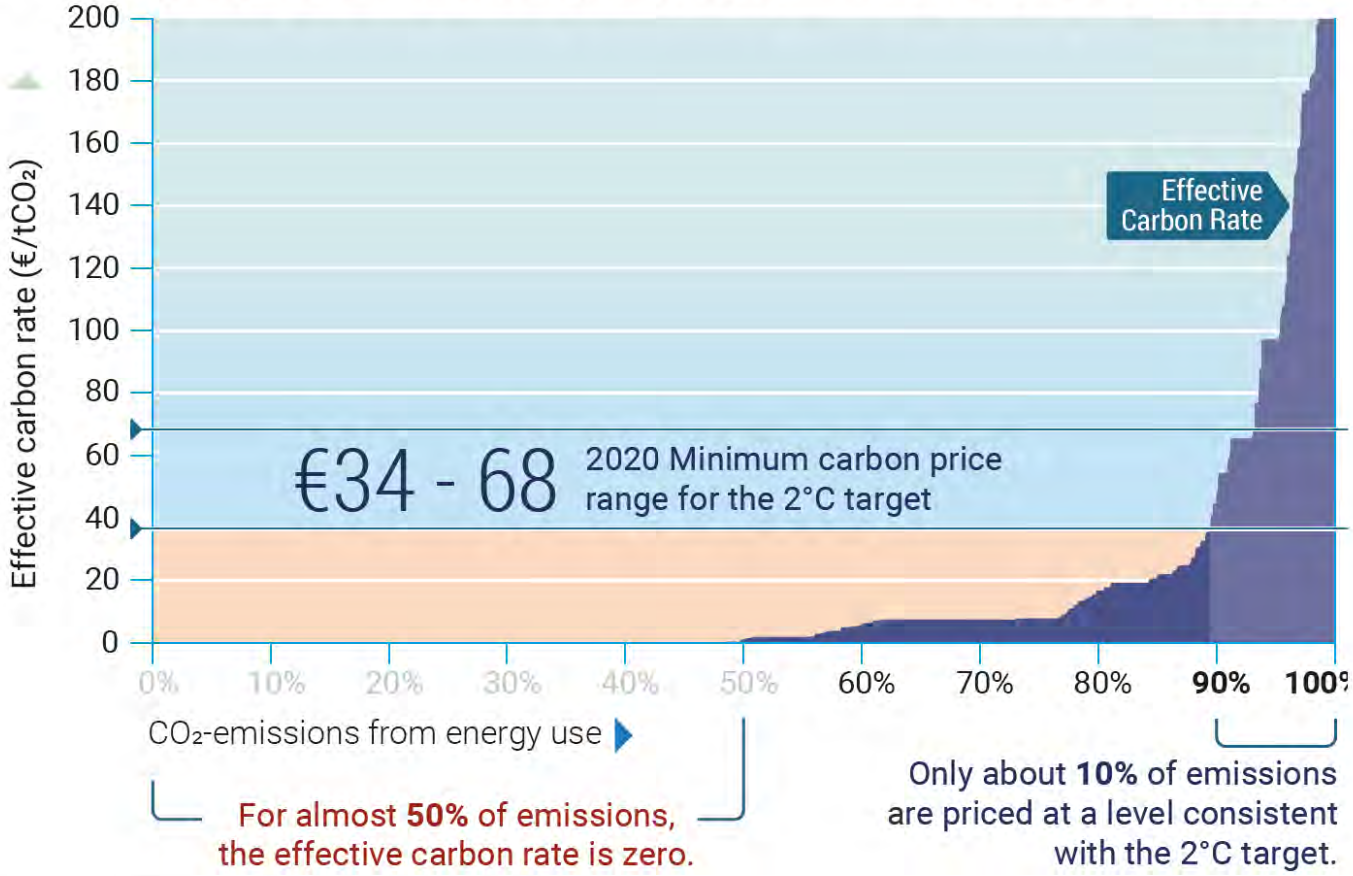
4. carbon prices
non solo su consumatore (es diesel e benzina) ma anche su produttori
border carbon taxes (dazi per paesi che non impongono lo stesso carbon price)
carbon dividendi per rendere attractive la carbon taxation (redistribuzione ed equità)

Carbon pricing non applicato ad un livello sufficiente

50% delle emissioni da combustibili fossili non sono tassate e solo il 10% è tassato al prezzo necessario per limitare il riscaldamento a 2°C

Eliminare i sussidi pubblici ai combustibili fossili

Effective carbon rates on energy use across 42 OECD and G20 countries (estimate for 2018) and the minimum carbon price range needed in 2020 for the 2°C target



Source: UNEP Emissions Gap Report

Politiche necessarie

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border carbon taxes (dazi per paesi che non impongono lo stesso carbon price)
carbon dividendi per rendere attractive la carbon taxation (redistribuzione ed equità)

5. regolamentazioni in alcuni settori (es case lampadine LED) … a volte il mercato da solo non basta

6. R&D per le nuove tecnologie (miglioramento fotovoltaico, idrogeno, pompe di calore, batterie, …) → opportunità enormi in presenza di regolamentazione e target

Ruolo dei sindacati:

governare e gestire le transizioni
(winners and loosers)

vs.

ostacolare il cambiamento