Session 11: Central banks in the era of Climate Change (CC) Green Swans

- Climate Change (CC) is a new type of systemic global risk; i.e. systemic global risk or global negative externality; large shocks that affect Demand and Supply, globally and locally
- From a CB perspective; impact value of all financial assets; impact Financial Stability; impact costs of goods and services; impact price stability
- CC therefore within core mandates of all CBs

Link: [The green swan - Central banking and financial stability in the age of climate change (bis.org)]

S 11 Outline

- S 11.1. Climate change (CC) as global new systemic risk, risk taxonomy (Green Swan)
- S 11.2. Growing social awareness about Green Swans with extreme weather events
- S 11.3. Why should central banks bother? Price and financial stability mandates
- S 11.4. Analytical progress: complexity of models but still mis-pricing of these risks
- S 11.5. Institutional progress: many initiatives but need more global coordination and cooperation
- S 11.6. Policy implications (1): The urgency of Net Zero (NZ) Policy Goal, Strategies, Global, National commitments
- S 11.7. Policy implications (2): New Investments, R&D, New Technologies
- S 11.8. Policy implications (3): The financing of NZ, Green Finance, debt, taxation
- S 11.9. Policy implications (4): Role of Central Banks, guidance, inflation target, r*
- S 11.10. Policy implication (5): A New Green and Fair Bretton Woods for Net Zero

S 11.1. Climate change as global risks, risk taxonomy (Green Swan) and implications

S 11.1. Climate change as global risks, risk taxonomy (Green Swan) and implications

- Climate Change (CC) or “Green Swans”, inspired but different from Nassim Taleb’s Black Swan, not “tail of a distribution”
- All IPCC reports warnings, studies, climate scientists; Climate is new type of systemic global risk, irreversible if not addressed, global existential threat
- Urgent to act now because limited carbon budget remaining before tipping points; more frequent and extreme weather events; higher costs; threat to Price & Financial stability

Green Swan effects: large Demand and Supply shocks

	Type of shock	From gradual global warming	From extreme weather events
Demand	Investment	Uncertainty about future demand and climate risks	Uncertainty about climate risk
	Consumption	Changes in consumption patterns, eg more savings for hard times	Increased risk of flooding to residential property
	Trade	Changes in trade patterns due to changes in transport systems and economic activity	Disruption to import/export flows due to extreme weather events
Supply	Labour supply	Loss of hours due to extreme heat. Labour supply shock from migration	Loss of hours worked due to natural disasters, or mortality in extreme cases. Labour supply shock from migration
	Energy, food and other inputs	Decrease in agricultural productivity	Food and other input shortages
	Capital stock	Diversion of resources from productive investment to adaptation capital	Damage due to extreme weather
	Technology	Diversion of resources from innovation to adaptation capital	Diversion of resources from innovation to reconstruction and replacement

Source: Bolton et al. (2020), adapted from Batten (2018)

	White Swans	Black Swans	Green Swans
Predictability through	Gaussian, normal distribution	Tail risks, perhaps non-Gaussian. Surprise for historical data watchers. Ex-post rational explanation after occurrence	Highly likely or certain occurrence but uncertain timing of occurrence (when?) and materialization (how?). Too complex to fully understand (model?).
Main explanation by	Statisticians, economists	Economists, financial analysts and risk managers with some disagreement	Nature Scientists, disagreement with many economists and financial analysts
Impacts	Low or moderate	Massive and direct impact mostly material. Possible correction of damages after event (crisis).	Massive and direct impact mostly to human lives (or even civilisational). Irreversibility of damages in most cases.
Policy recommendations	Risk models are fine (can be marginally improved)	Reconceptualise approach to risk. Learn from event to design anti-fragile strategies.	Given severity of effects, even without full understanding, need for immediate action and coordination under radical uncertainty

See: https://www.bis.org/speeches/sp200514.htm

S 11.2. Growing social awareness about Green Swans with extreme weather events


FINANCIAL TIMES
Obama set to impose climate change cuts on power sector


NO MORE FOSSILS
NO MORE FOSSILS
END FOSSIL FUELS
FINANCE

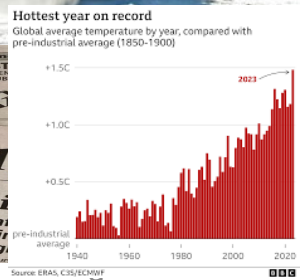

The Guardian
Global climate crisis: inevitable, unprecedented and irreversible
CODE RED FOR HUMANITY
CODE RED
PM: WAK TO RED ALERT ON CLIMATE CRISIS
NANCIAL TIMES


The Economist
Iran's dangerous game
Lessons from a Wall Street titan
Why rent controls are wrong-headed
Goddess of the Taiwan Strait
The climate issue
1850
1900
1950
2000

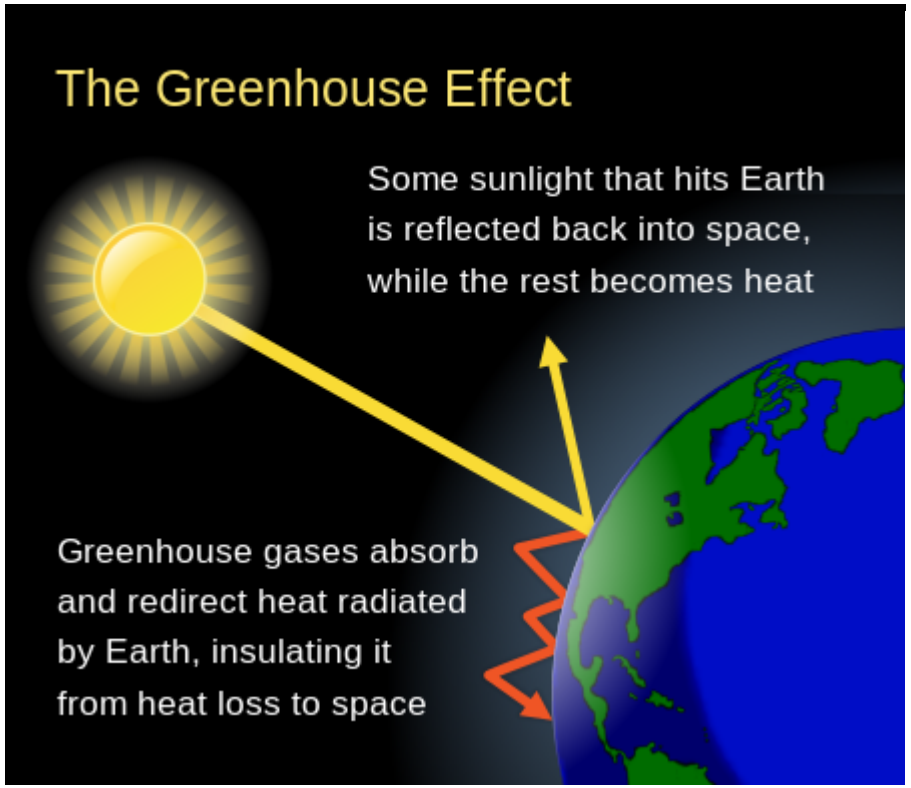

SAVE OUR PLANET SAVE OUR FUTURE!
COP26

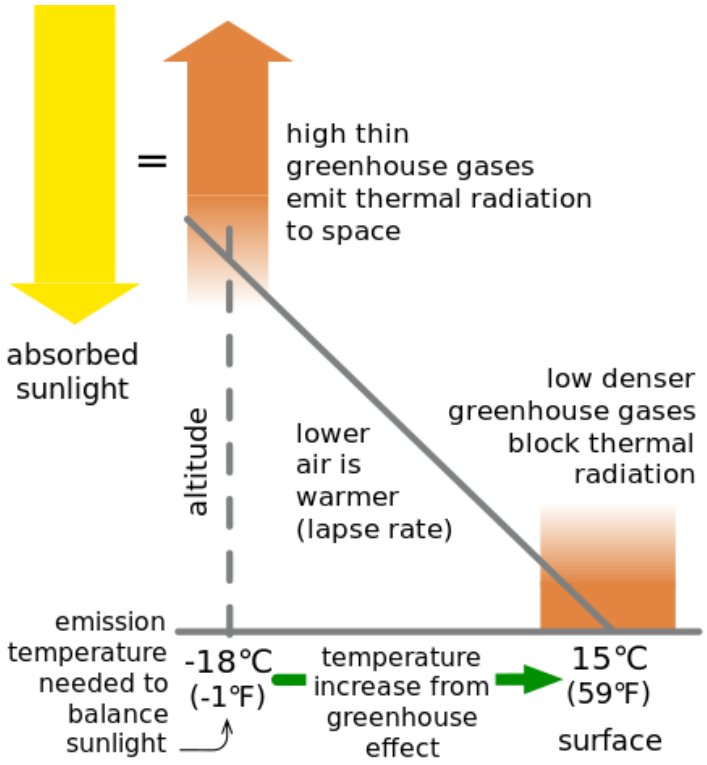

Climate records broken
BBC NEWS

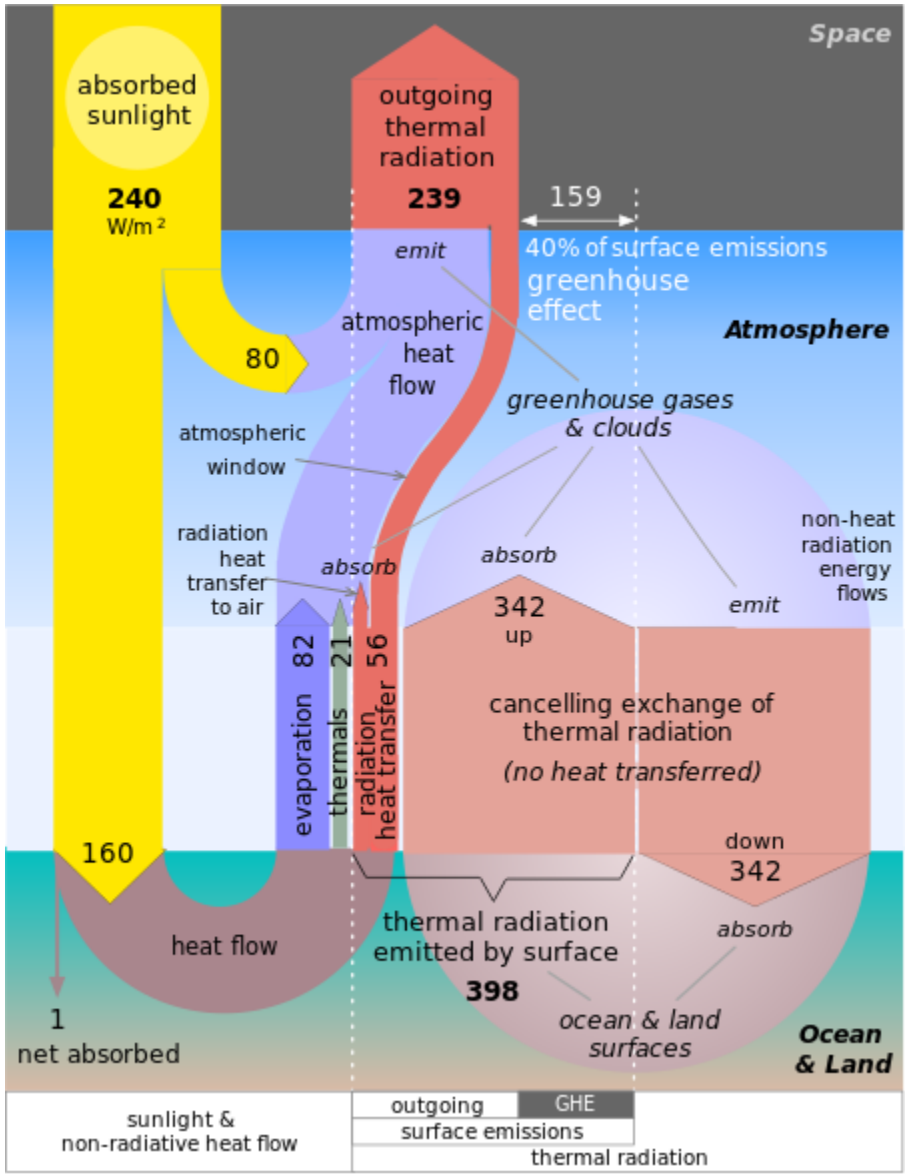

STATE
New heat options come with climate trade-offs
Sunday Gazette-Mail
Focus on the soluti
Man shot by no
Gazette
We have


Hottest year on record
Global average temperature by year, compared with pre-industrial average (1850-1900)
+1.5C
+1.0C
+0.5C
pre-industrial average
2023
1940
1960
1980
2000
2020
Source: ERA5, C3S/ECMWF
BBC

“Green house effect” in physics is known since 19th century





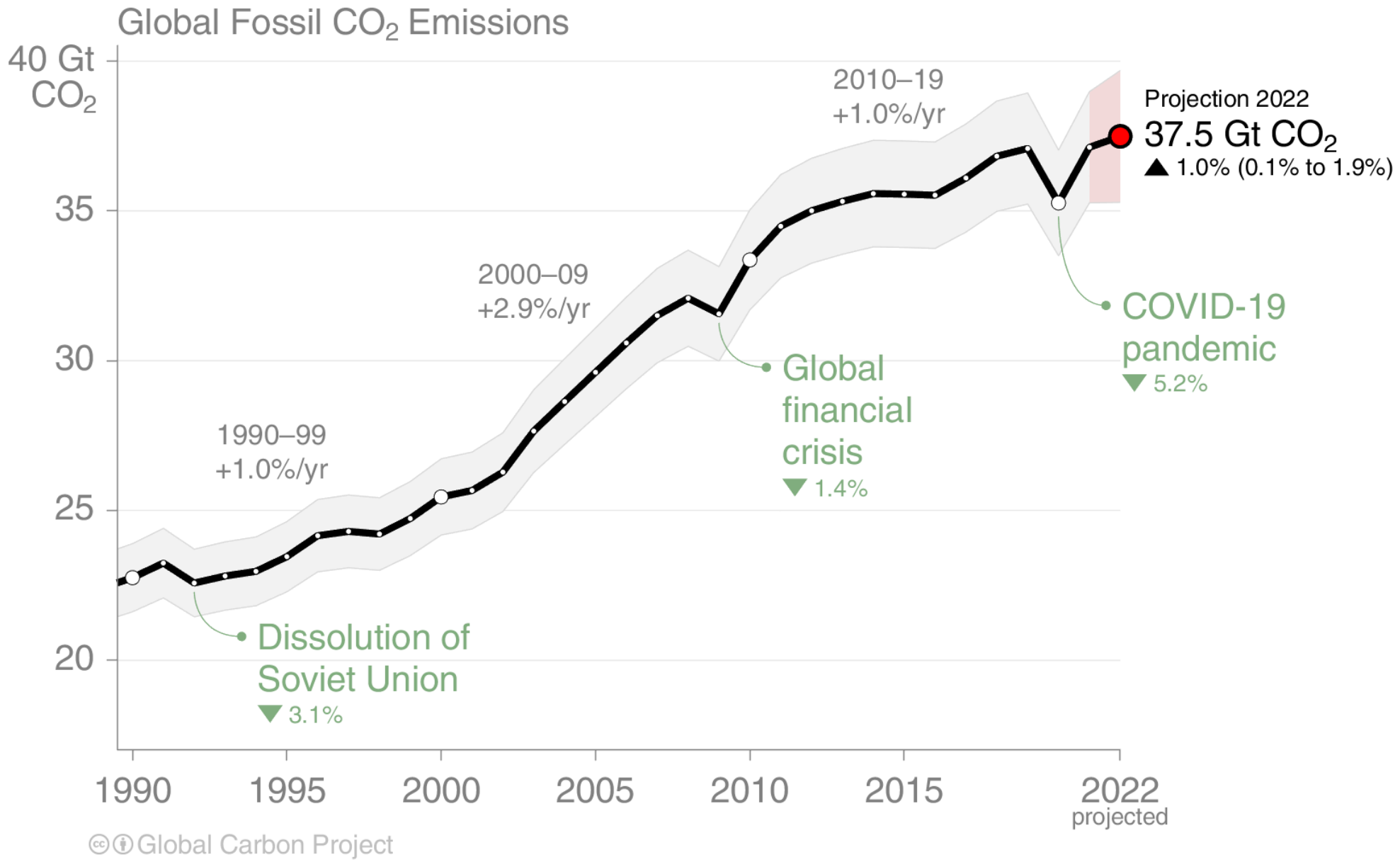


The existence of the greenhouse effect, while not named as such, was proposed as early as 1824 by Joseph Fourier

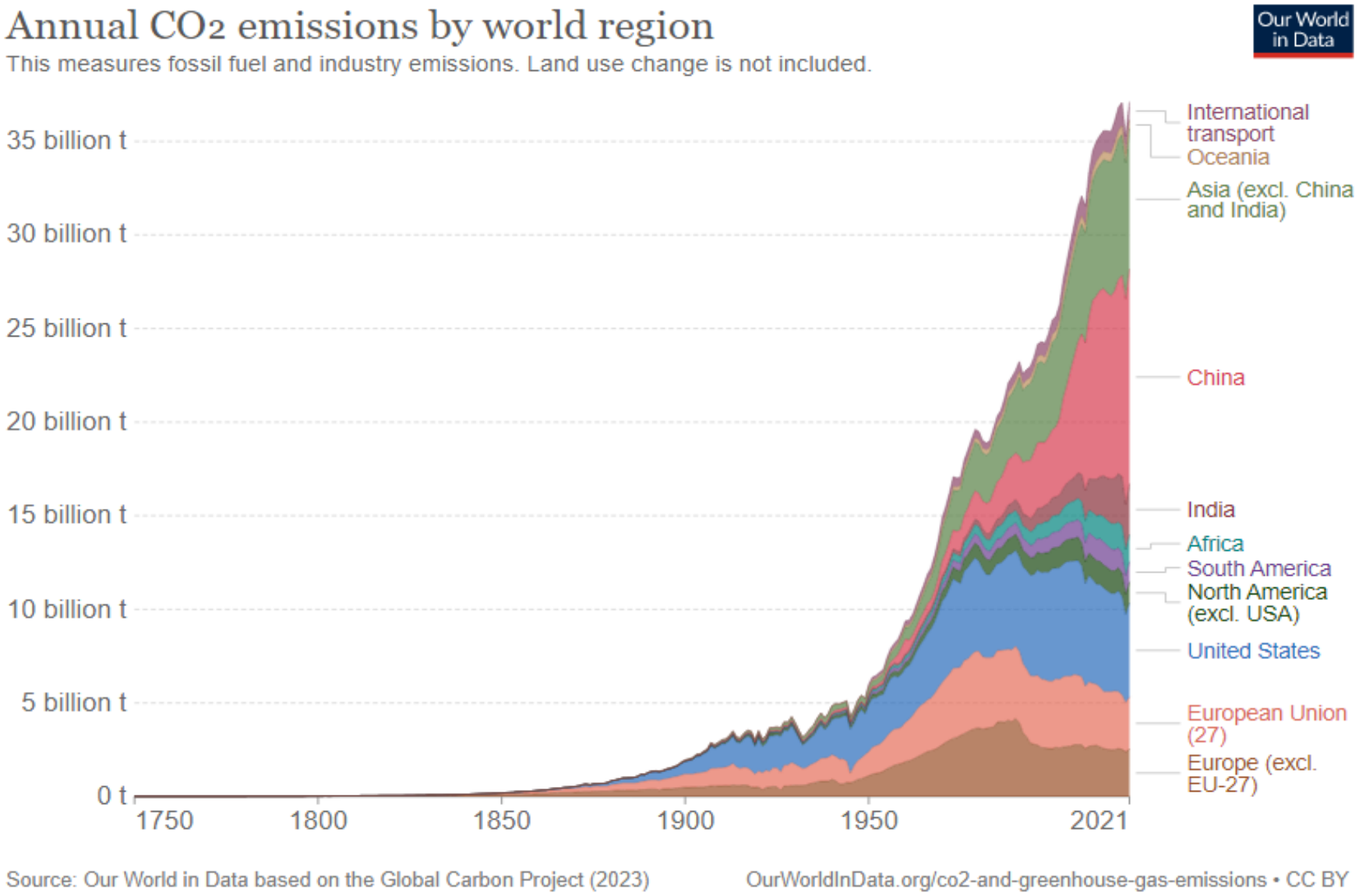
The greenhouse effect can be understood as a decrease in the efficiency of planetary cooling. The greenhouse effect is quantified as the portion of the radiation flux emitted by the surface minus that doesn't reach space, i.e., 40% or 159 W/m2. Some emitted radiation is effectively cancelled out by downwelling radiation and so does not transfer heat. Evaporation and convection partially compensate for this reduction in surface cooling. Low temperatures at high altitudes limit the rate of thermal emissions to space.

Greenhouse gases (GHGs) in dense air near the surface absorb most of the longwave radiation emitted by the warm surface. GHGs in sparse air at higher altitudes—cooler because of the environmental lapse rate—emit longwave radiation to space at a lower rate than surface emissions.

Global GHGs emissions increasing after Covid pause

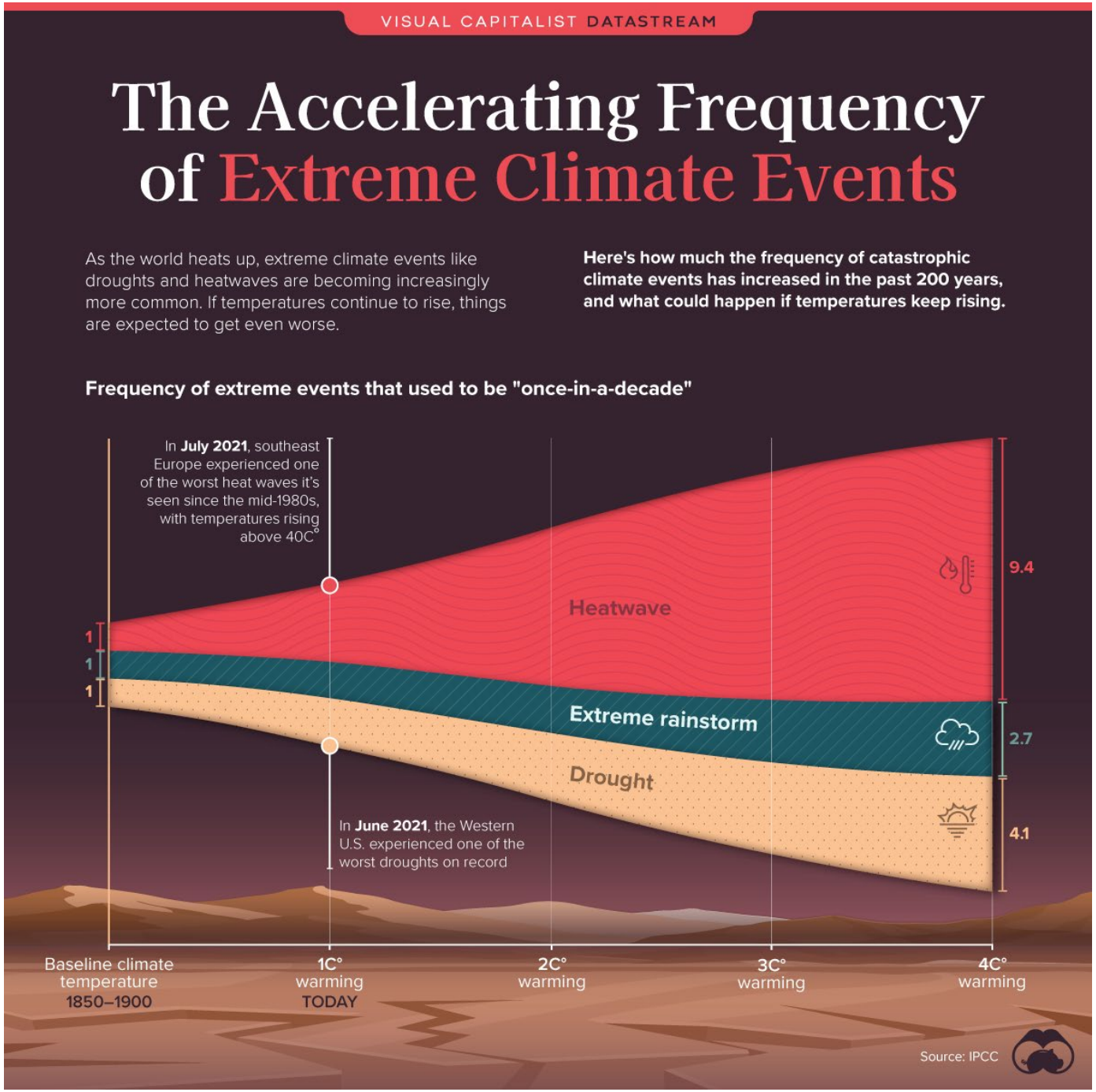


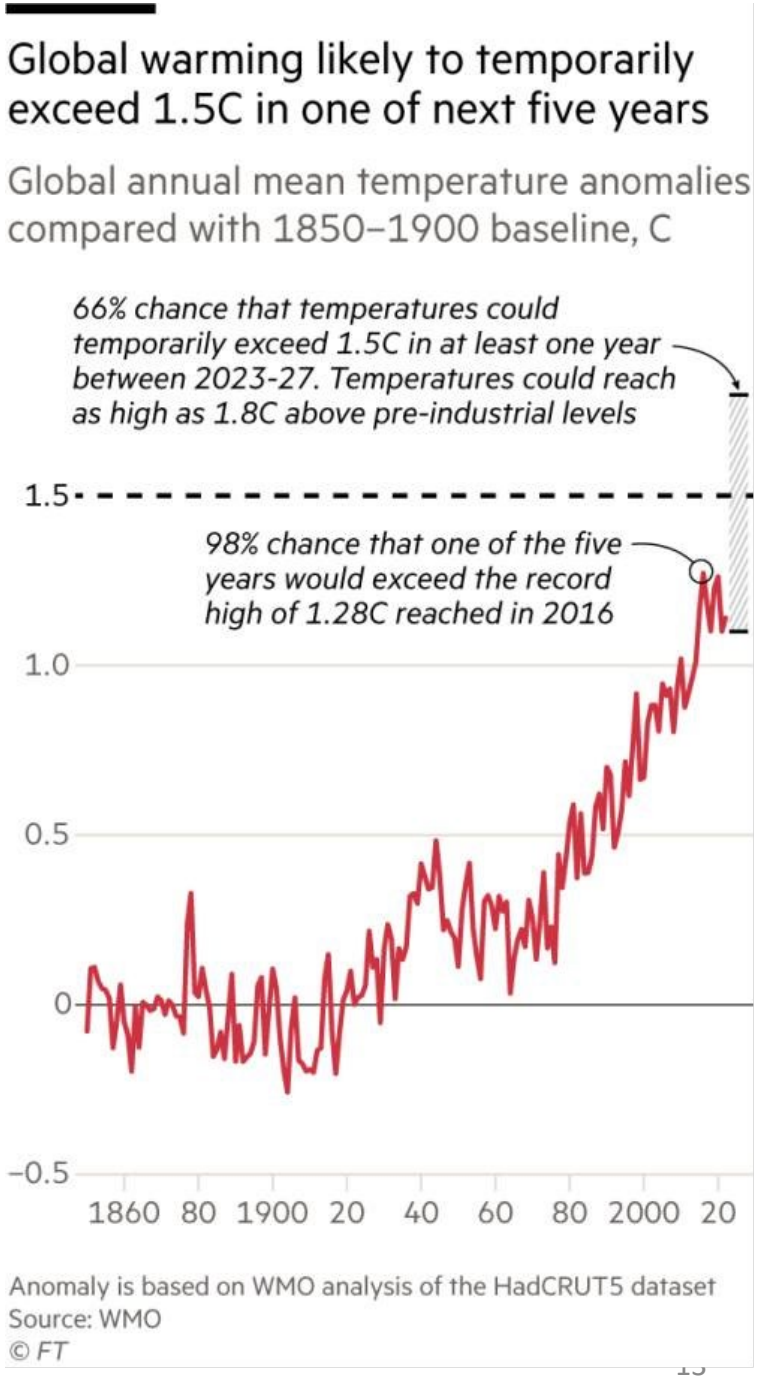
Global GHGs emissions increasing after Covid pause with different emitters



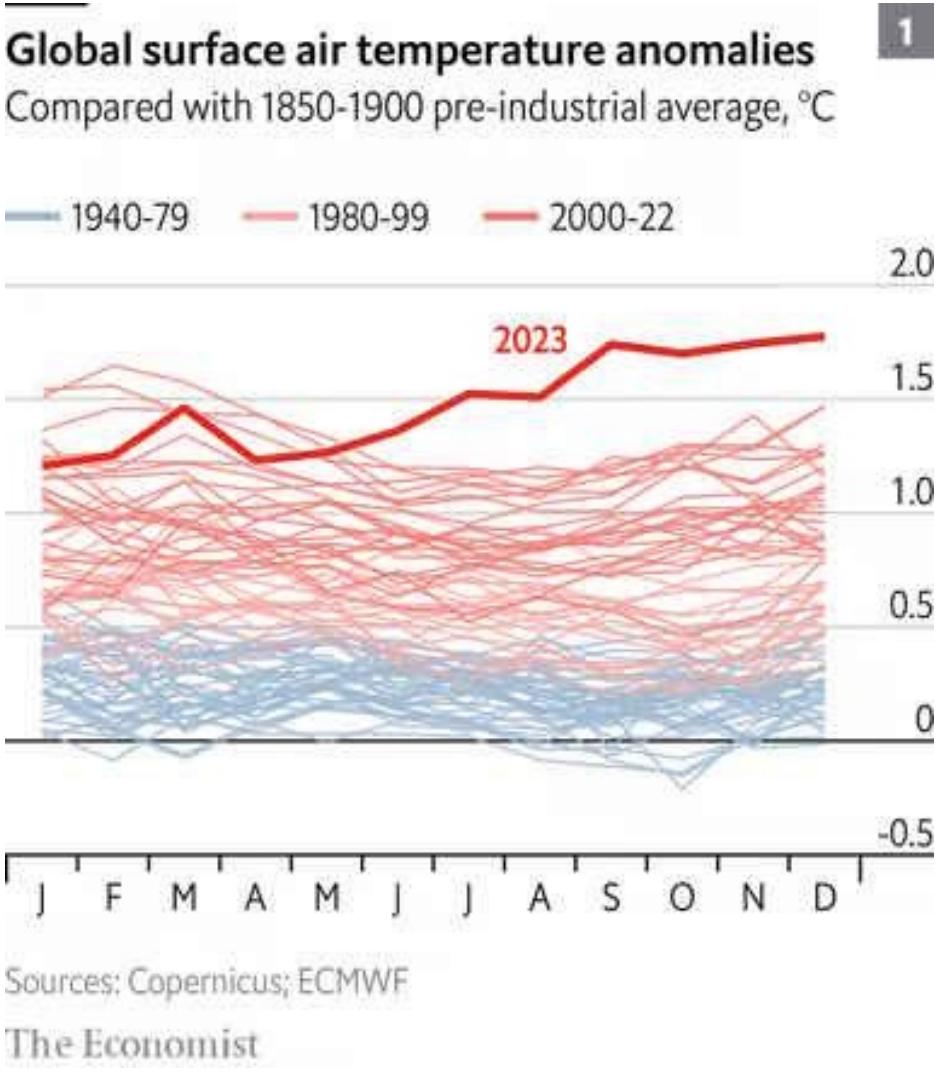
Average emission of GHG (t of CO2 per capita 2021 Source EU (EDGAR data):

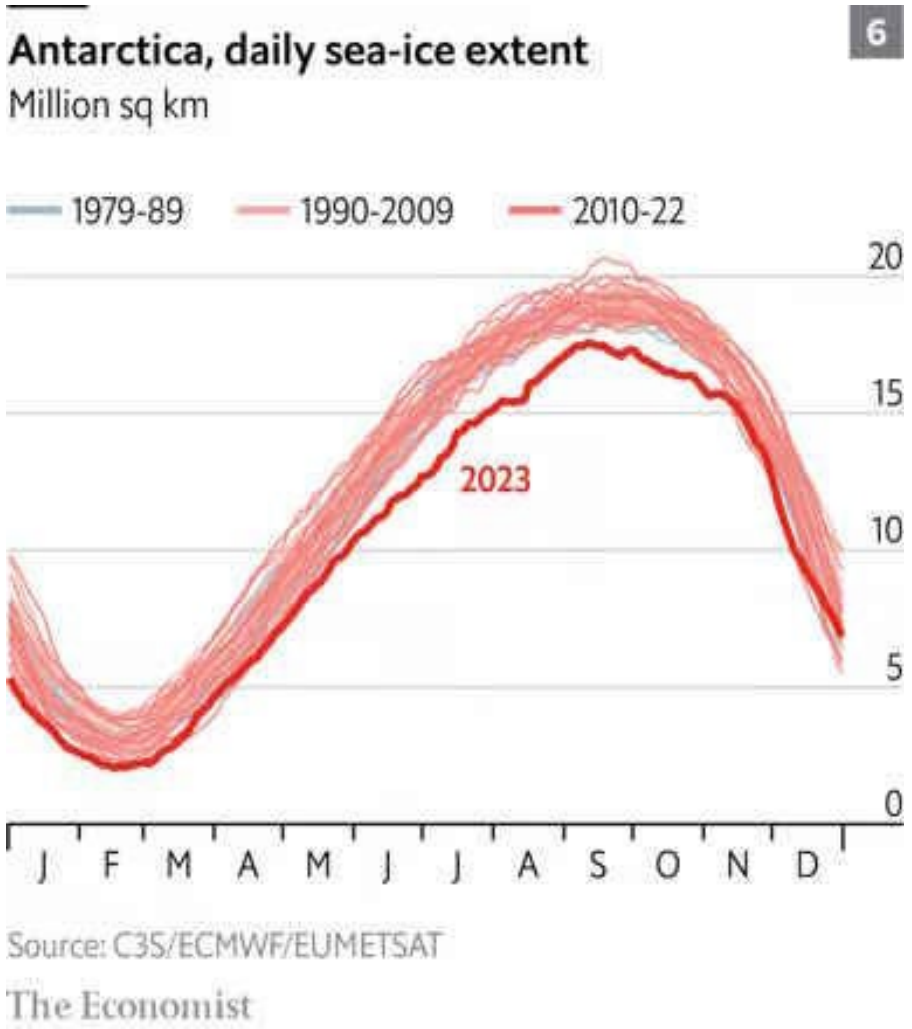
Global : 4.8
EU: 6.3
US: 14.2
China: 8.7


VISUAL CAPITALIST DATASTREAM
The Accelerating Frequency of Extreme Climate Events
As the world heats up, extreme climate events like droughts and heatwaves are becoming increasingly more common. If temperatures continue to rise, things are expected to get even worse.
Here's how much the frequency of catastrophic climate events has increased in the past 200 years, and what could happen if temperatures keep rising.
Frequency of extreme events that used to be "once-in-a-decade"
In July 2021, southeast Europe experienced one of the worst heat waves it's seen since the mid-1980s, with temperatures rising above 40C°
Heatwave
Extreme rainstorm
Drought
In June 2021, the Western U.S. experienced one of the worst droughts on record
1
1
1
9.4
2.7
4.1
Baseline climate temperature 1850–1900
1C° warming TODAY
2C° warming
3C° warming
4C° warming
Source: IPCC


Global warming likely to temporarily exceed 1.5C in one of next five years
Global annual mean temperature anomalies compared with 1850–1900 baseline, C
66% chance that temperatures could temporarily exceed 1.5C in at least one year between 2023-27. Temperatures could reach as high as 1.8C above pre-industrial levels
98% chance that one of the five years would exceed the record high of 1.28C reached in 2016
1.5
1.0
0.5
0
−0.5
1860 80 1900 20 40 60 80 2000 20
Anomaly is based on WMO analysis of the HadCRUT5 dataset
Source: WMO
© FT

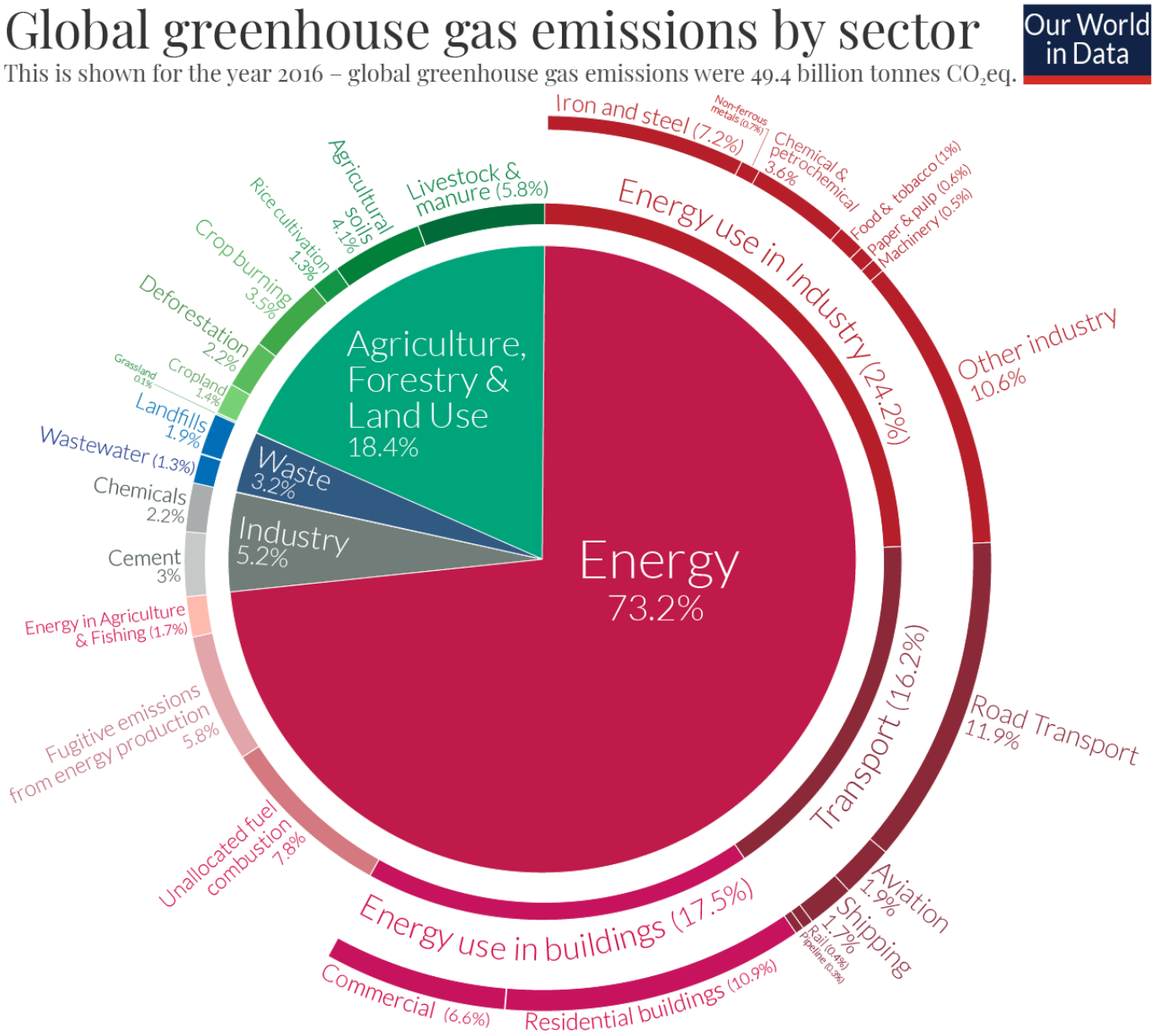
Climate Change (CC): evidence is growing that we might be already above 1.5C



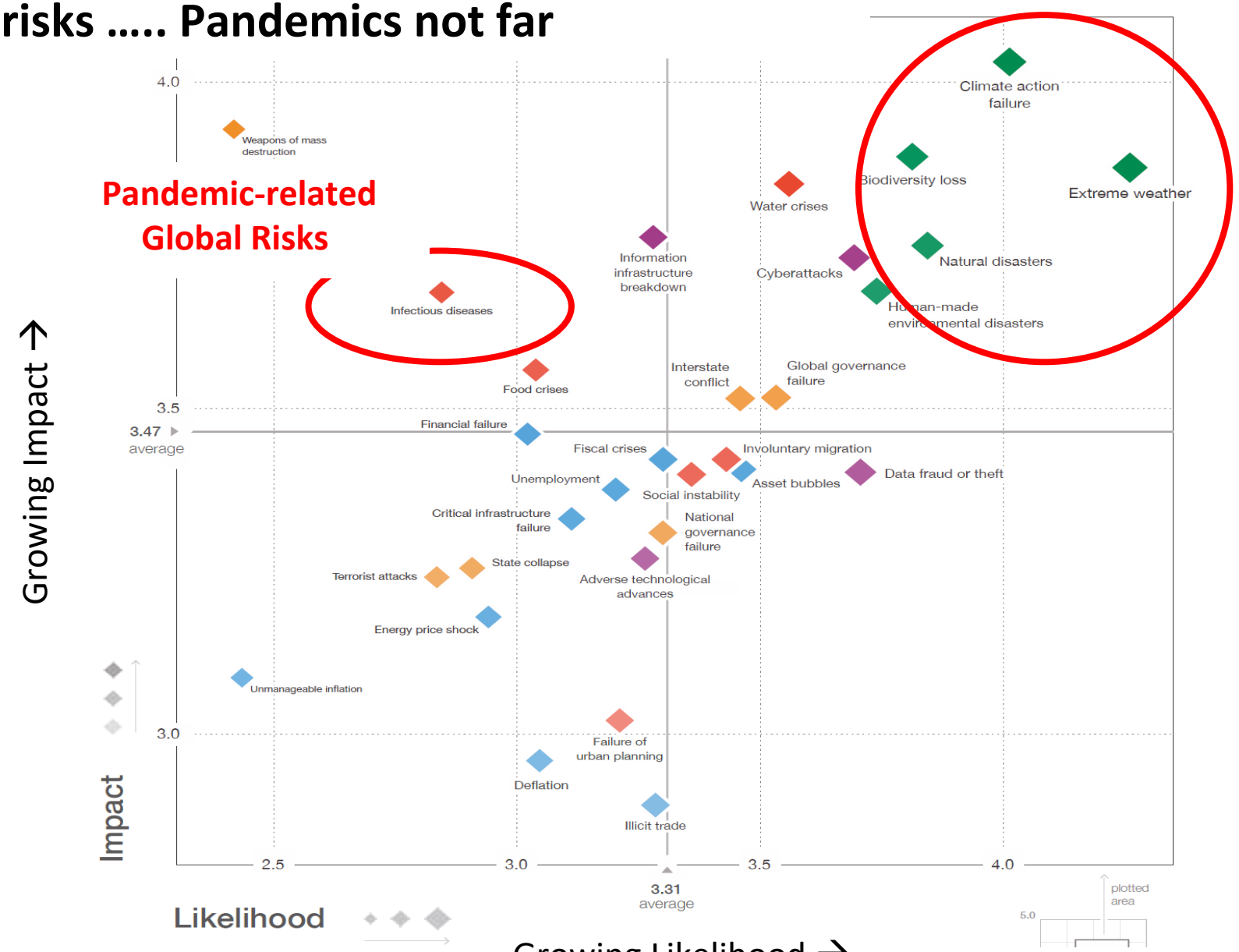


Sources of GHG emissions

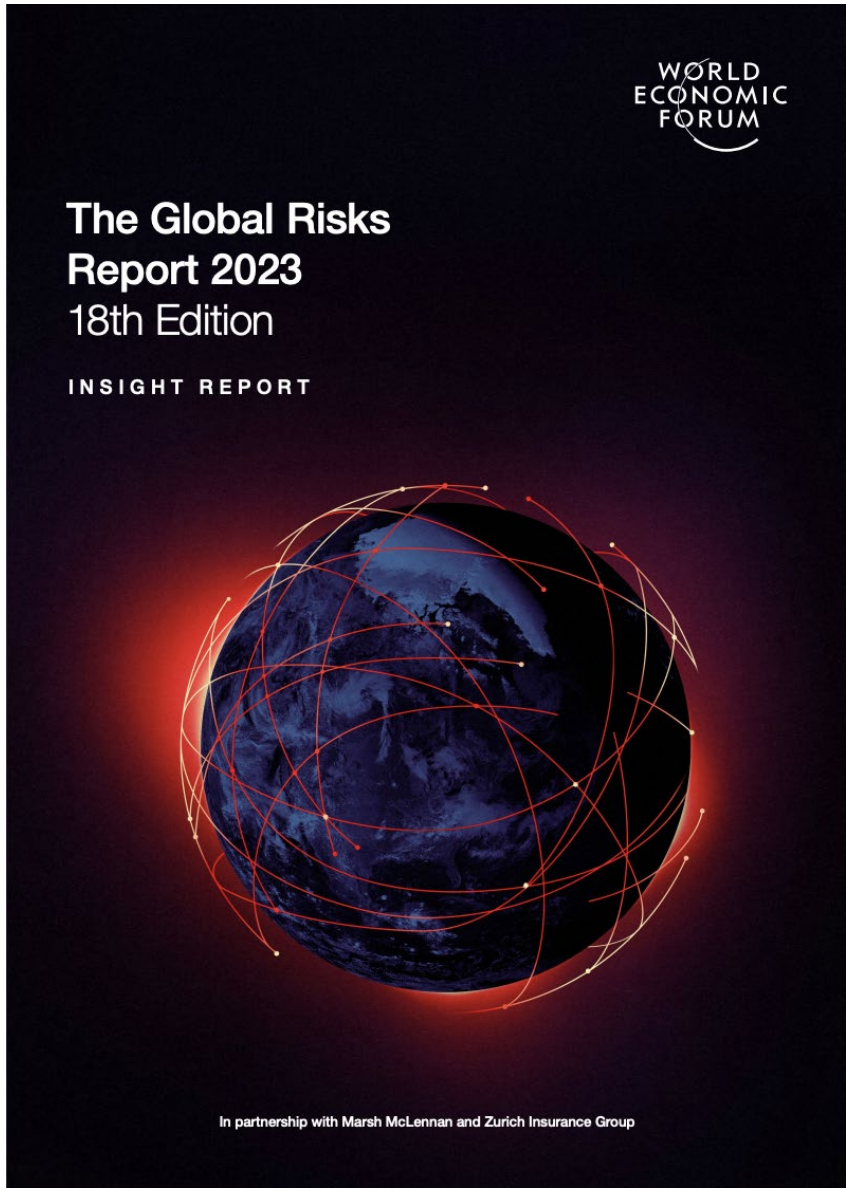
- Energy in industry: 24%
- Energy in buildings: 18%
- Energy in Transportation: 16%
- Agriculture, land use, forestry: 18%
- Industry: 5%



Global Business recognition that CC-related events are biggest risks ….. Pandemics not far

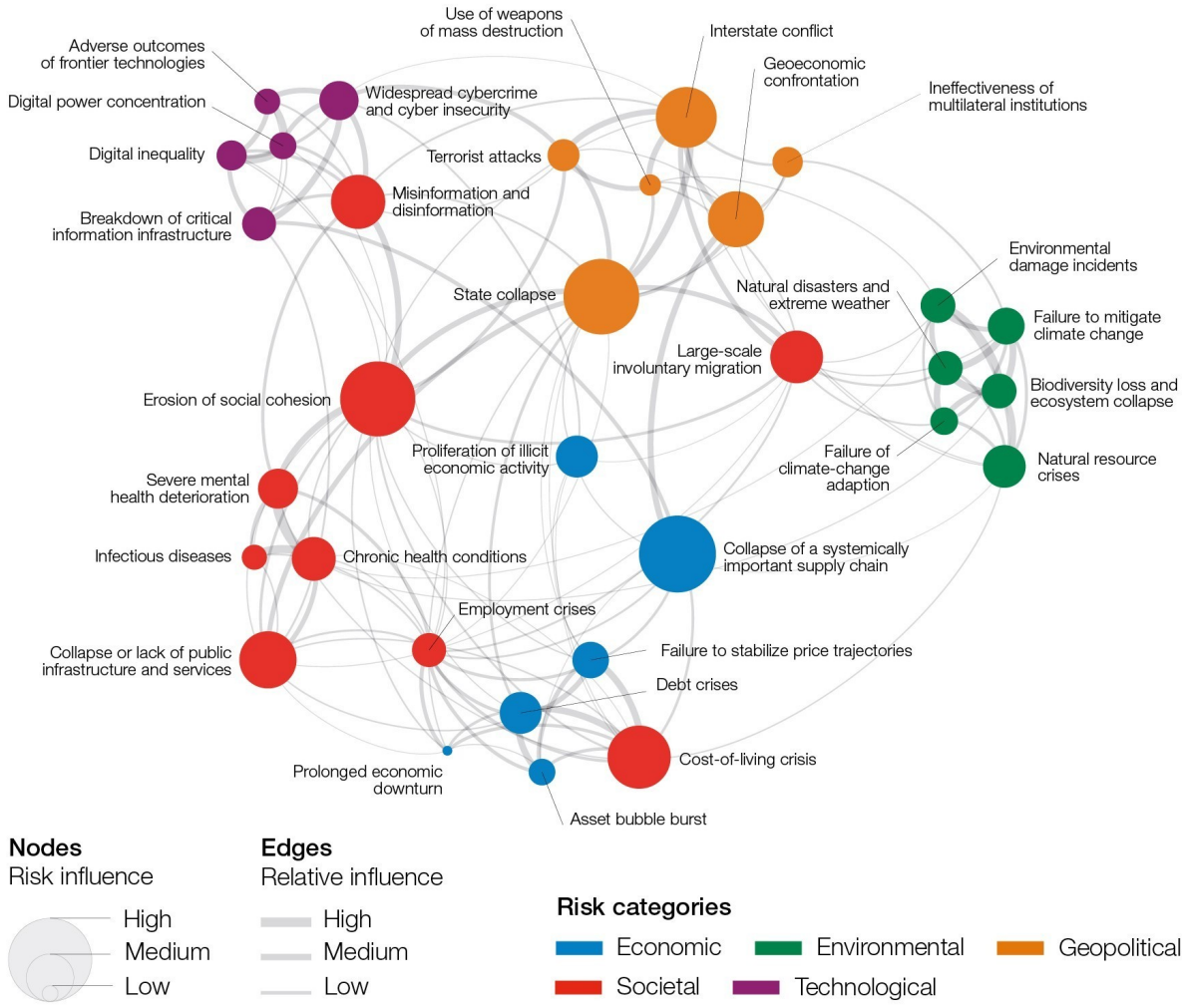


Source: World Economic Forum, « The Global Risks Report 2020 »



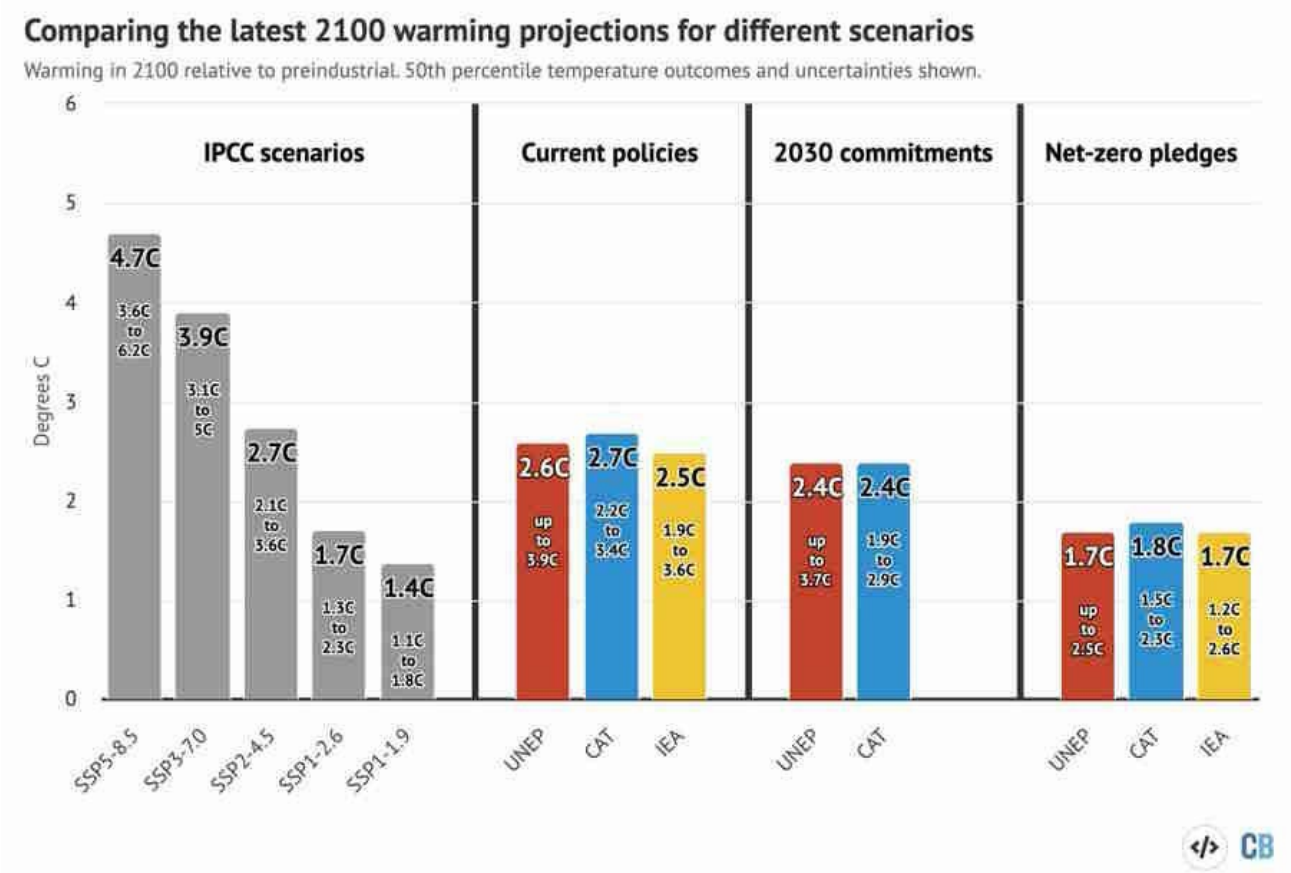
Global risks landscape: an interconnections map

WORLD ECONOMIC FORUM



Source: World Economic Forum, Global Risks Perception Survey 2022-2023

Projected average temperatures with scenarios on Climate Change (CC)



Source: [Zeke Hausfather]

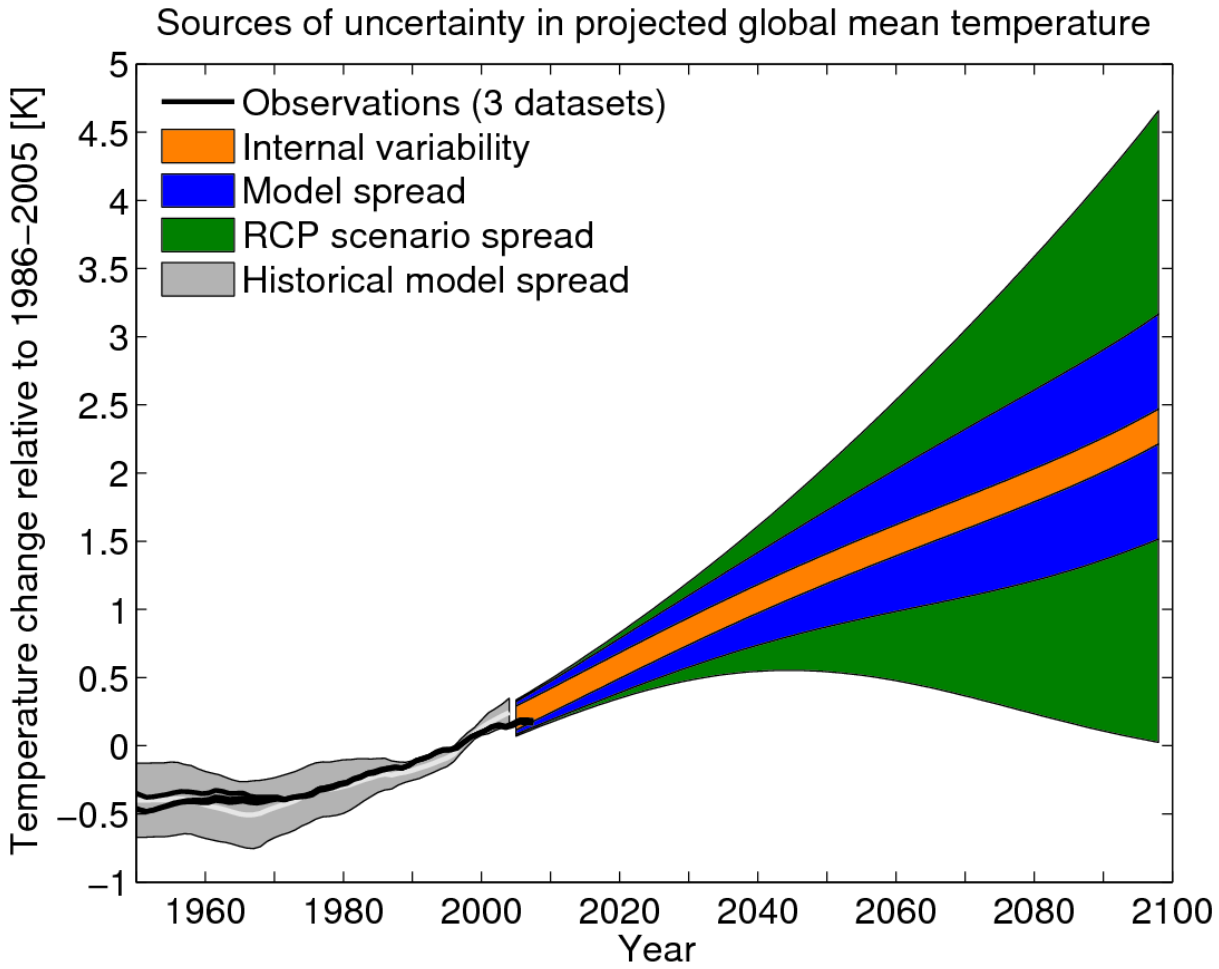
CMIP stands for Coupled Model Intercomparison Project. It is a collaborative effort coordinated by the World Climate Research Programme (WCRP). The data and findings from CMIP are widely used in climate research, including the assessment reports by the Intergovernmental Panel on Climate Change (IPCC).

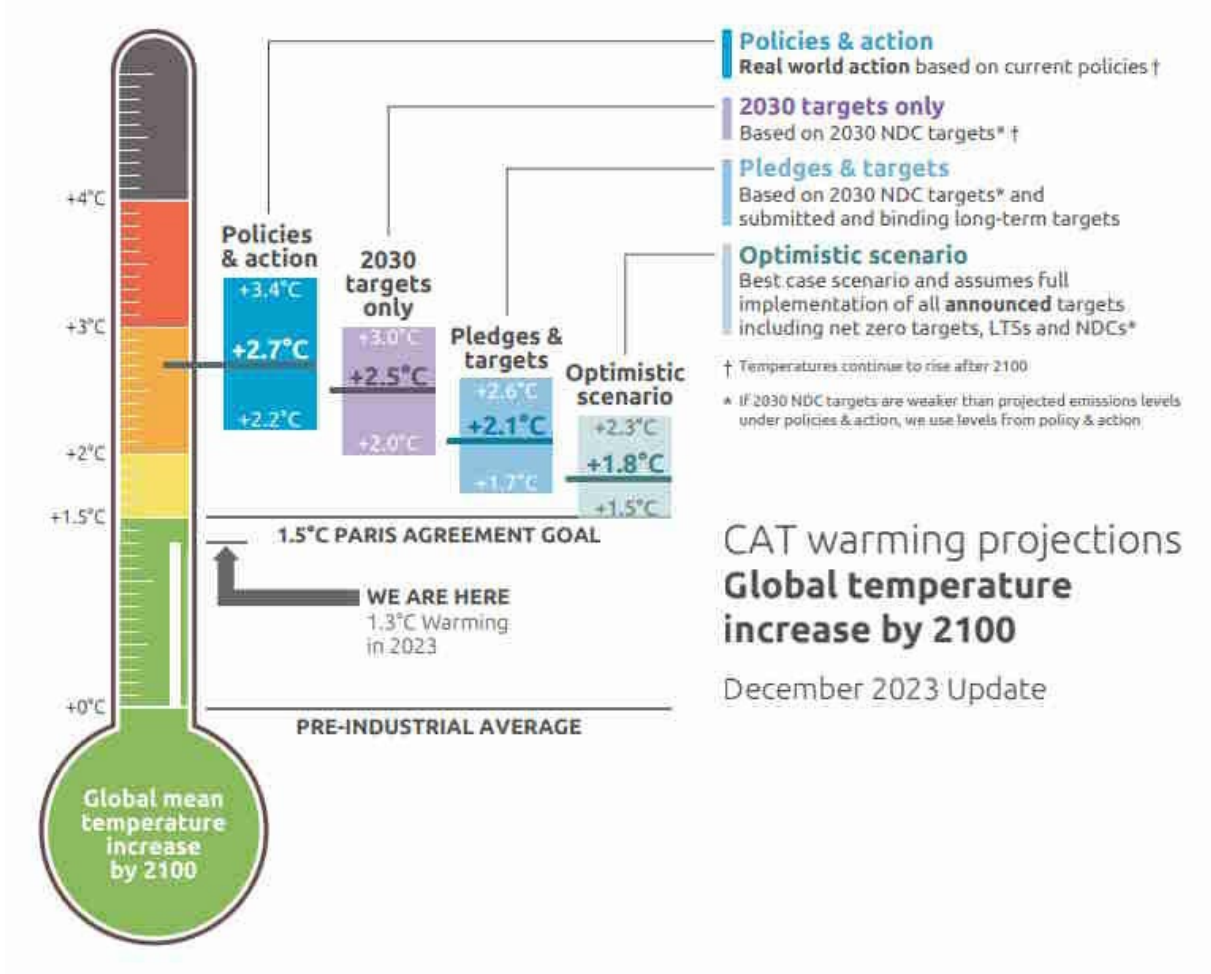
RCP stands for Representative Concentration Pathway. RCPs are scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases, aerosols, and chemically active gases, as well as land use/land cover.

SSP stands for Shared Socioeconomic Pathway. SSPs are scenarios to describe possible future changes in societal development and their impacts on the environment. There are five primary SSPs:

SSP1: Sustainability (Taking the Green Road)
SSP2: Middle of the Road
SSP3: Regional Rivalry (A Rocky Road)
SSP4: Inequality (A Road Divided)
SSP5: Fossil-fueled Development (Taking the Highway)

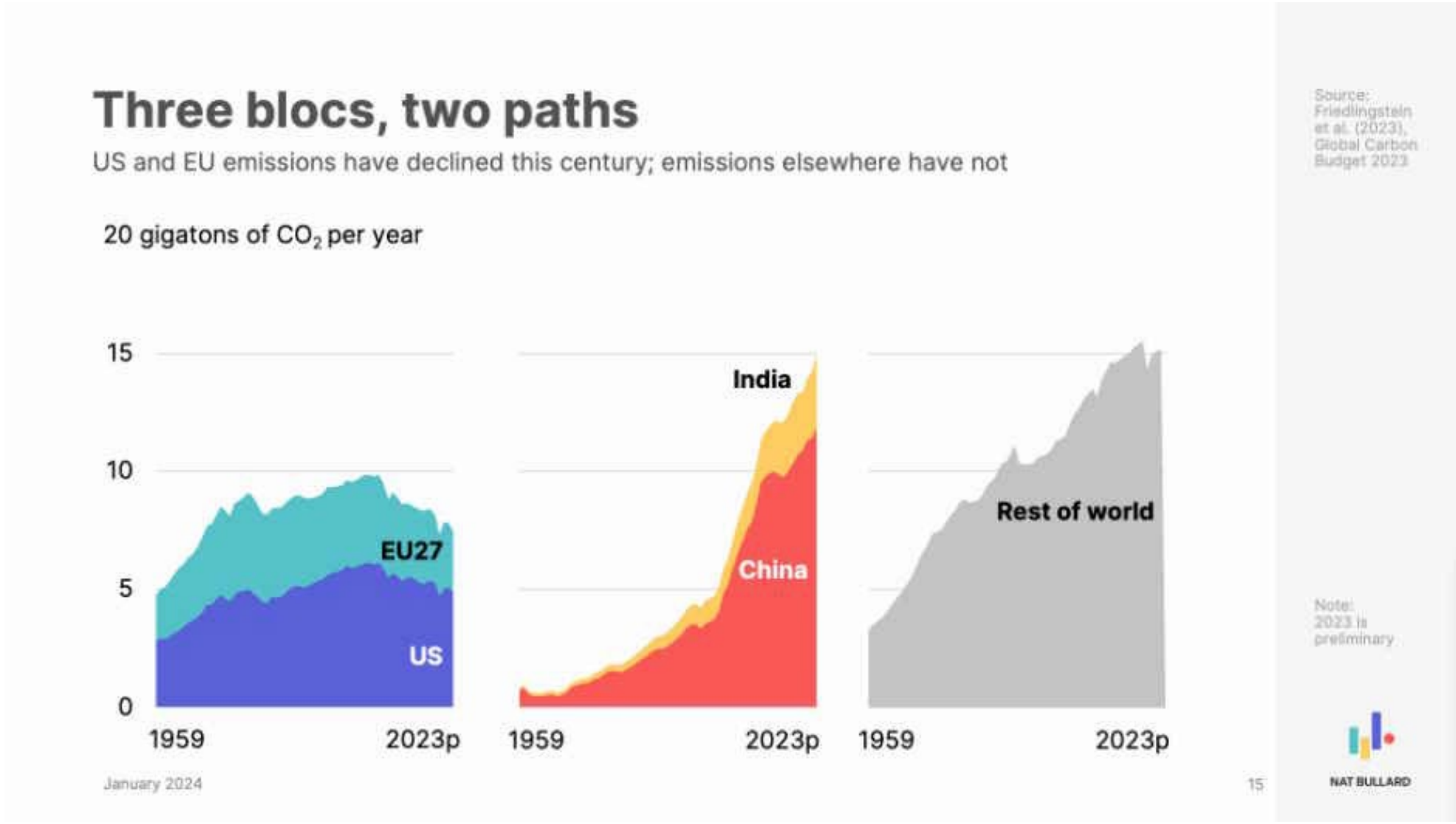
Average temperature increases comes with great variance (0.5C to 4C) and risks





Source: [Climate Action Tracker]

Climate Change: shift in major emitters of GHGs



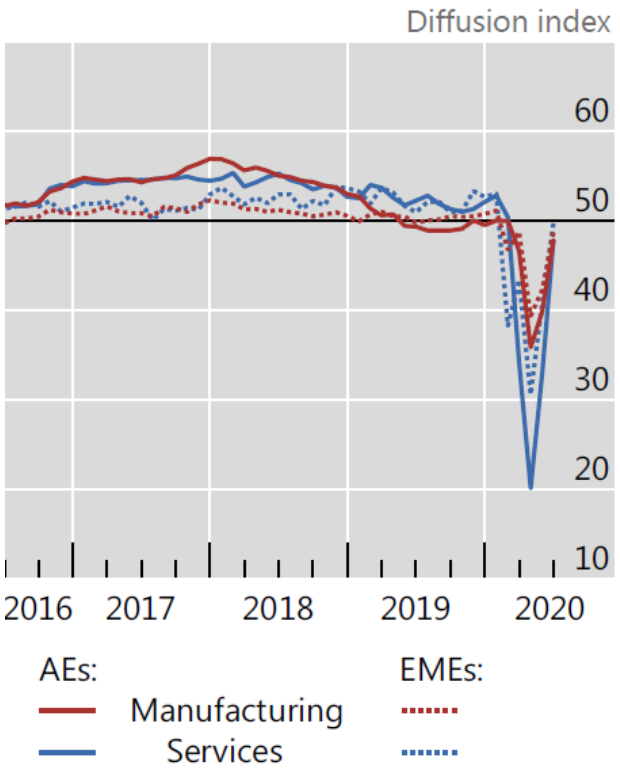
Source: Nat Bullard

S 11.2. Growing social awareness about Green Swans with extreme weather events

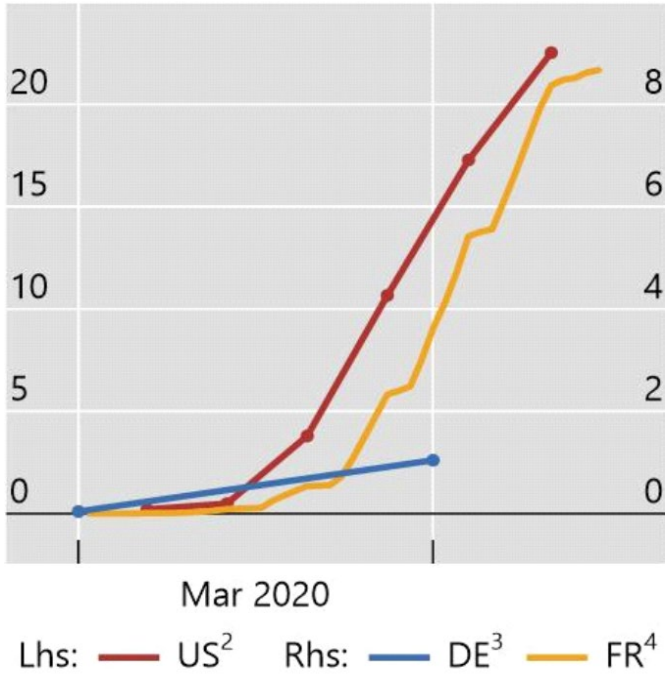
- Growing awareness among central bankers, financial supervisors and regulators that climate change brings systemic risks that will impact financial stability:
- Mark Carney (2015): "*once climate change becomes a defining issue for financial stability, it may already be too late*"
- Creation of the NGFS (Network for Greening the Financial System) in 2017: "*Climate-related risks are a source of financial risk. It is therefore within the mandates of central banks and supervisors to ensure the financial system is resilient to these risks*" (NGFS 2018)

Growing social awareness, illustrated by Covid-19, vivid, "accelerated" image of "global sudden stop" & huge cost

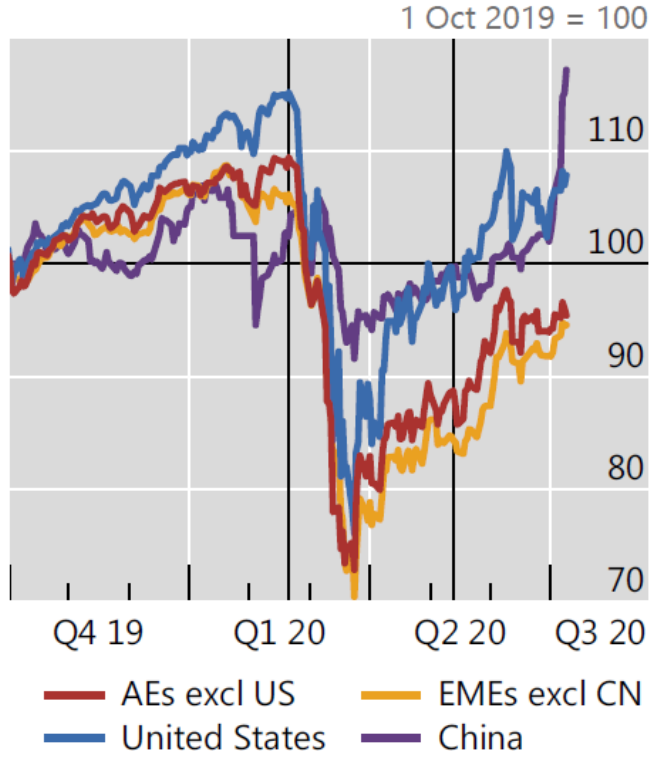
Headline PMIs



Surge in jobless, short-time workers



Global stocks



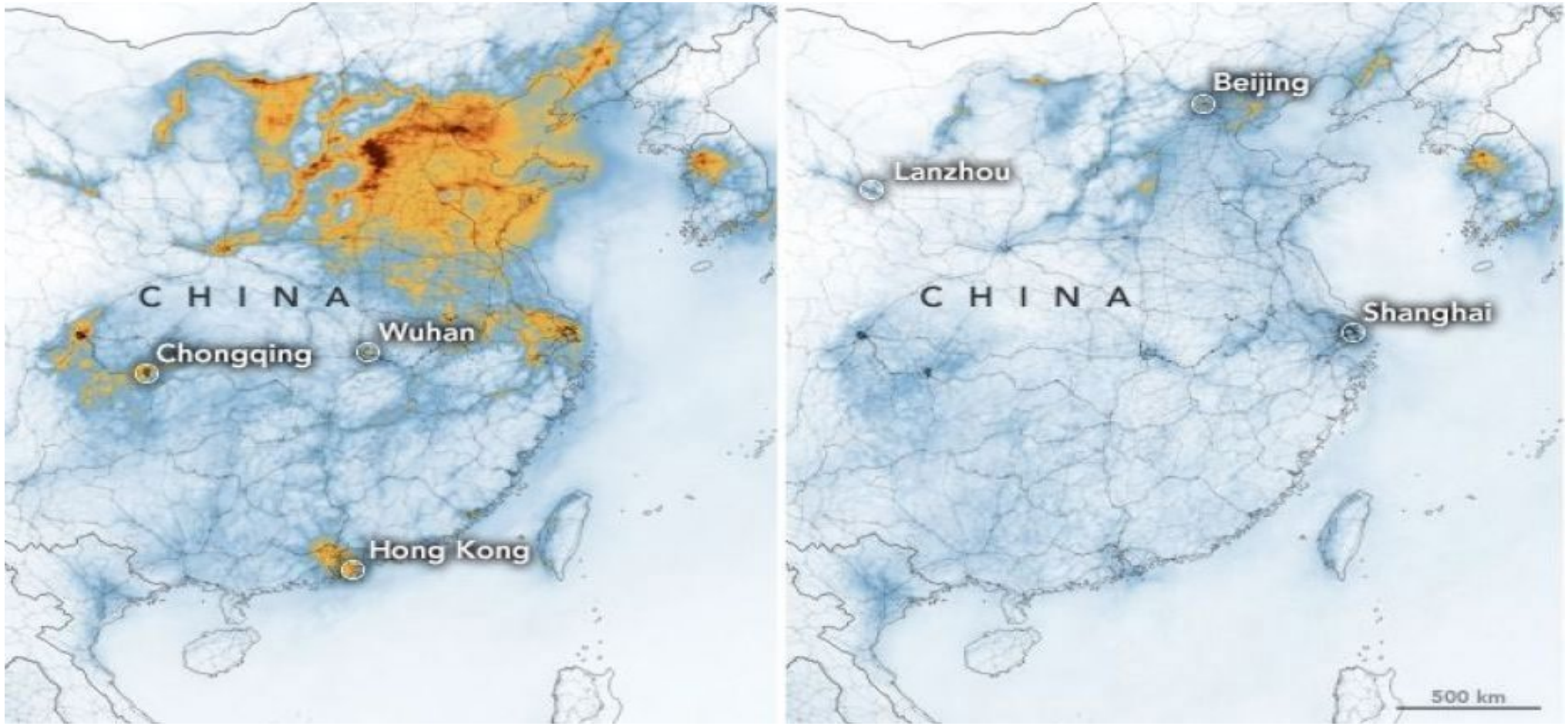
Sources: Consensus Economics; Datastream; IHS Markit; national data; BIS calculations.

Was the Covid-19 pandemic a “prelude” or “accelerated image” of a Green Swan?

- Tick all the boxes (above) for a « Green Swan ». Global massive negative effects on humans (and global sudden-stop), warnings by scientists of quasi-certainty for occurrence (SARS, H1N1, Ebola), prompted need to act immediately even without fully understanding transmission (massive unprecedented MP+FP responses)
- The destruction of our natural habitat by CC behind pandemics as Green Swans. Scientists suggest biodiversity acts as “natural health barrier” for humans; losing it is less “resilience” for life in general;
- Huge losses of biodiversity due to urbanisation and transport, industrialization of agriculture and deforestation;
- Human activities get closer contact to known vectors of viral diseases (eg., bats especially robust, only mammals capable of true and sustained flight). Environmental and health crises can therefore be understood jointly and as potentially reinforcing each other.
- More speculative debates about ways in CC may relate to pandemics. Beyond 2°C of global warming, the chances of reaching tipping points (such as a melting of the Arctic permafrost) become more likely (eg., IPCC Special Report on Global Warming of 1.5°C, 2018). This might unearth ancient viruses now frozen in the permafrost to which we could be as vulnerable as to Covid-19 (happened with outbreak of Anthrax spores in Siberia).

…. Another example of growing social awareness, increased by Covid-19

Global (China) sudden-stop and concentration of nitrogen dioxide levels over China (during 1–20 January 2020, before the quarantine, and 10–25 February 2020, during the quarantine)



Source and photo credit: NASA Earth Observatory images by Joshua Stevens.

Before vs after Covid-19 casual observations increased social awareness

New Delhi

Beijing

Why the urgency? The “Carbon Budget”

Estimation of remaining carbon budgets from early 2020 in Gt of CO2 equivalent: How much additional G tonnes of CO2 can we emit in total before tipping-point (since 2015 we emit ~30-40Gt of CO2 per year): “do the math”

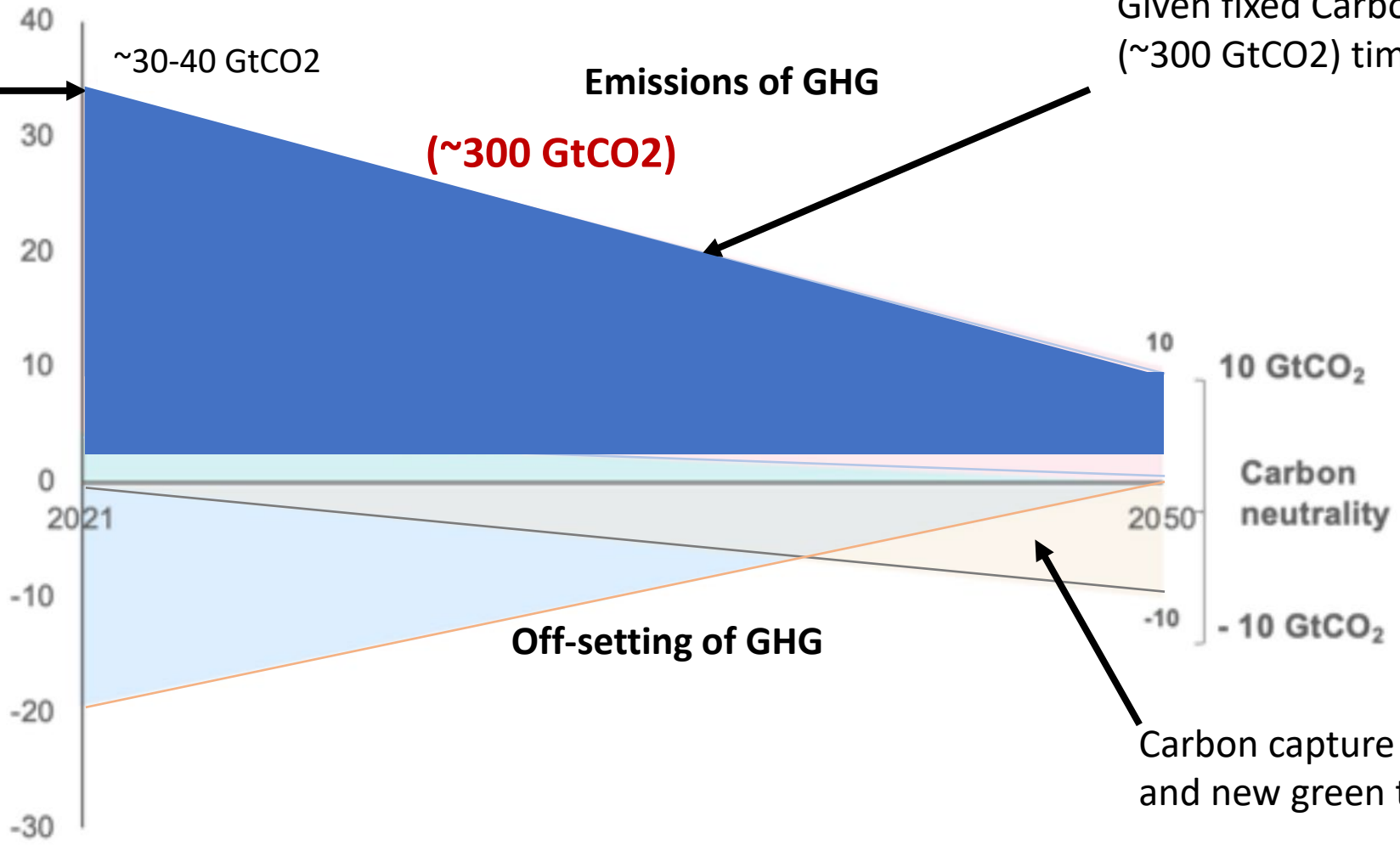
	(2) … with a probability of …				
	17%	33%	50%	67%	83%
(1) to limit warming to…	**(3) there remains an available carbon budget of (in GtCO2):**				
+ 1.5 °C	900	650	500	400	**300**
+ 1.7 °C	1450	1050	850	700	550
+ 2.0 °C	2300	1700	1350	1150	900

Source: Boissinot J, "La Finance Verte" (Dunod, 2002) based from data in GIEC, AR6, WG1 report (SPM).

How to implement trajectory to net zero emissions for remaining carbon budget: Need to reduce emissions AND finance off-setting new green technologies

Given fixed Carbon Budget to keep 1.5C, (~300 GtCO2) time is of the essence

Current annual Emission of GHG



Carbon capture (avoid deforestation) and new green technologies

Source: IPCC, Carbone4, Bolton et al

S 11.3. Why should central banks bother? Price and financial stability mandates

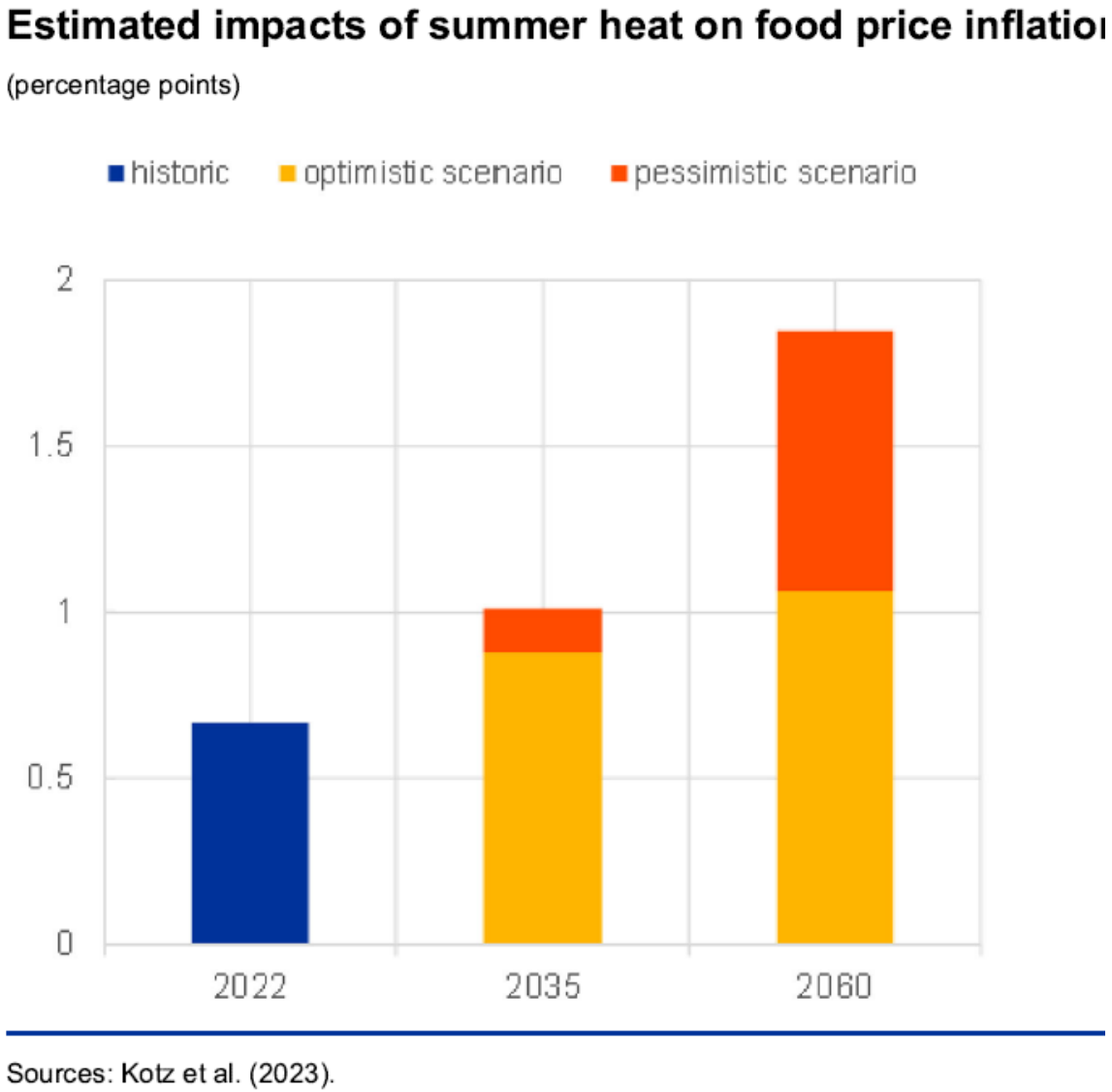
- S 11.3.1. Price stability effects of CC
- S 11.3.2. Financial stability effects of CC

S 11.3.1. Price stability effects of CC

Estimated with a global panel regression approach, using monthly prices and high-resolution climate data. Cumulative deviation of food inflation from baseline after 12 months due to extreme June/July/August temperatures are shown.

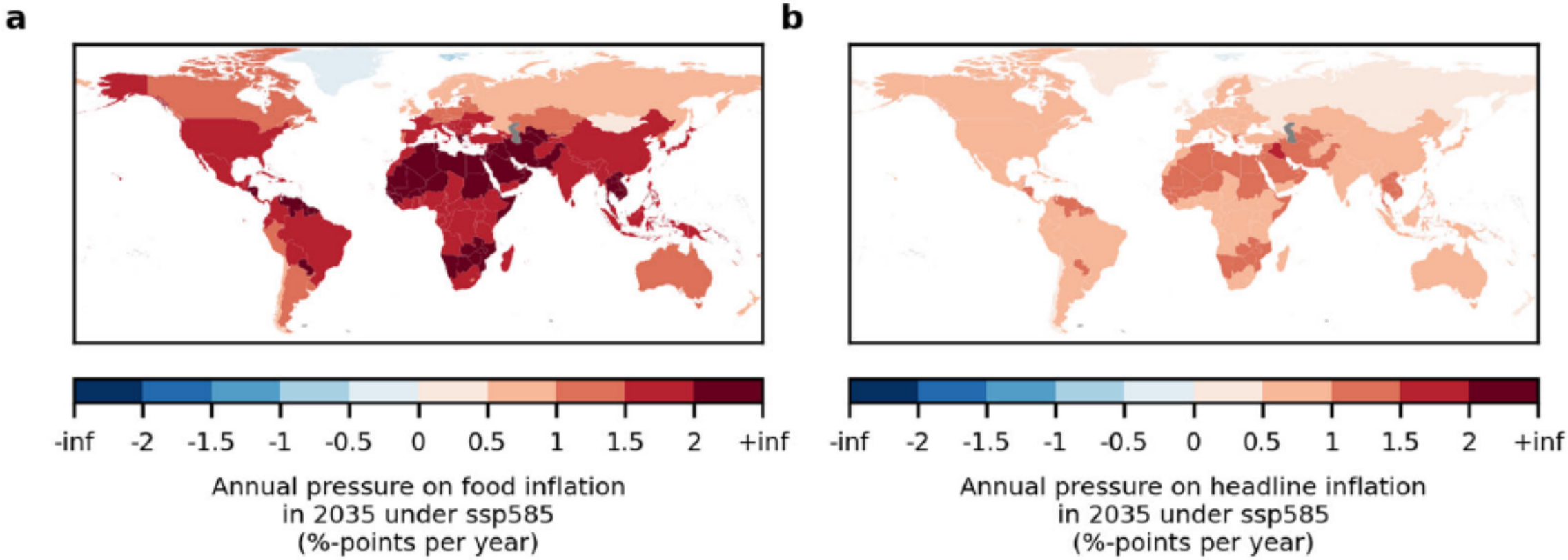
The chart is based on combining elasticities of a 1°C increase in temperatures with results from 21 global climate models.

Projected temperatures of a 2022-like summer (i.e., in the upper tail of the temperature distribution) in future climates are retrieved from climate model results under an optimistic ("below 2C by 2100", RCP2.6) and a pessimistic ("hot house world", RCB8.5) emissions scenario.



Source: Kuik Friderike, Christiane Nickel, Miles Parker and Wolfgang Modery" The price of inaction: what a hotter climate means for monetary policy" ECB Blog, 18 December 2023

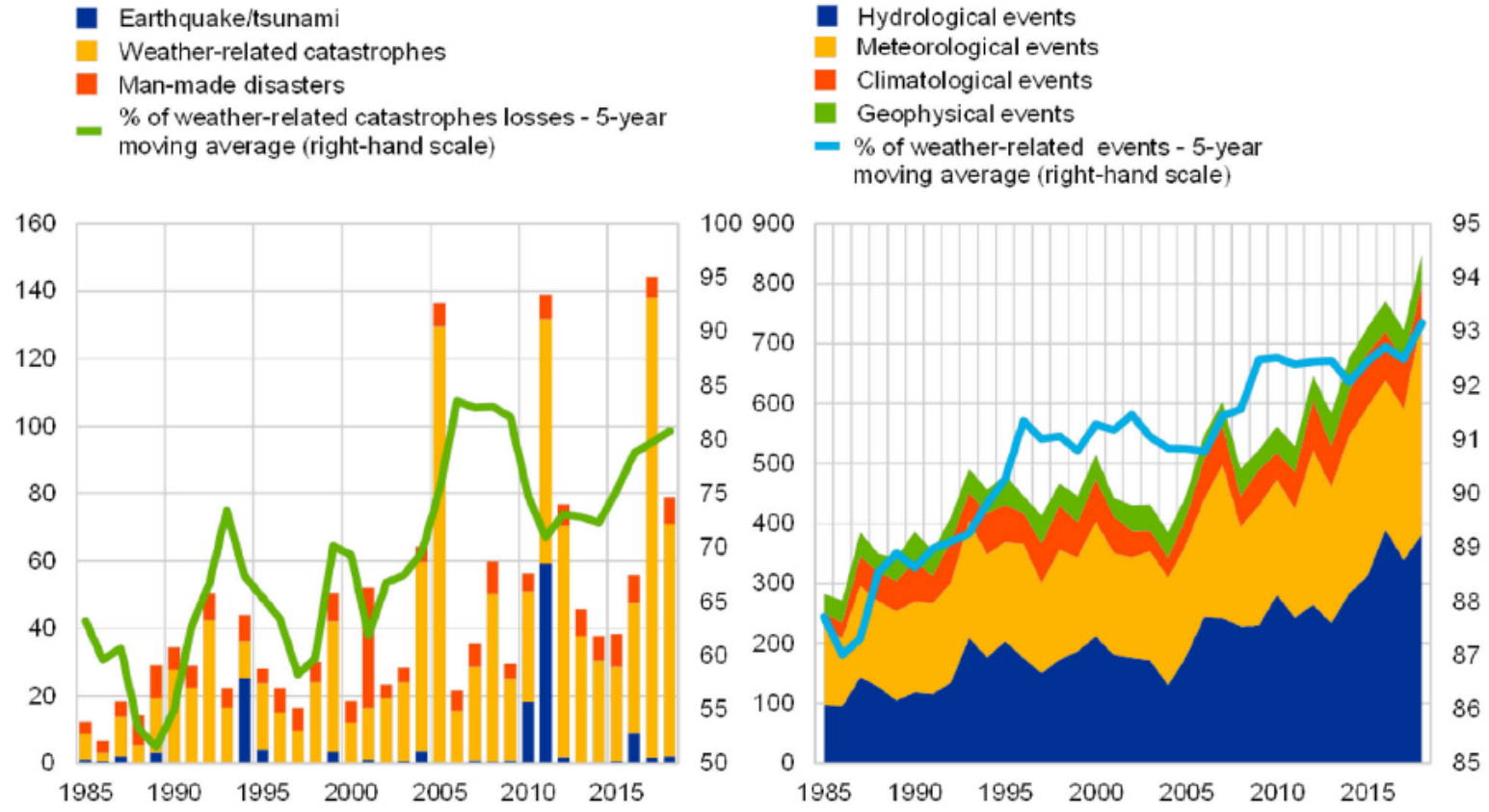
S 11.3.1. Price stability effects of CC



S 11.3.2. Financial stability effects of CC (Physical Risks)

Global insured catastrophe losses (left panel) and number of relevant natural loss events worldwide (right panel)

(1985-2018; left panel: left-hand scale: USD billions; right-hand scale: percentages; right panel: left-hand scale: number of events; right-hand scale: percentages)

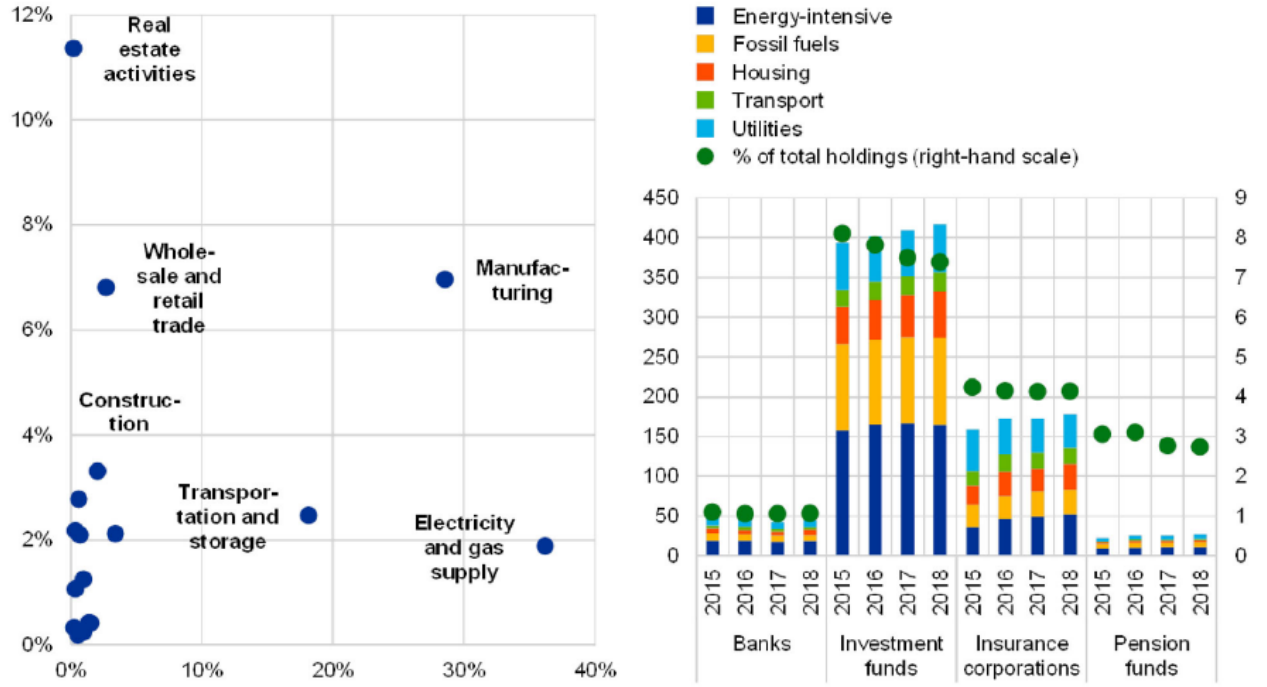


Sources: Swiss Re Institute, Munich Re NatCatService and ECB calculations.

S 11.3.2. Financial stability effects of CC (Transition Risks)

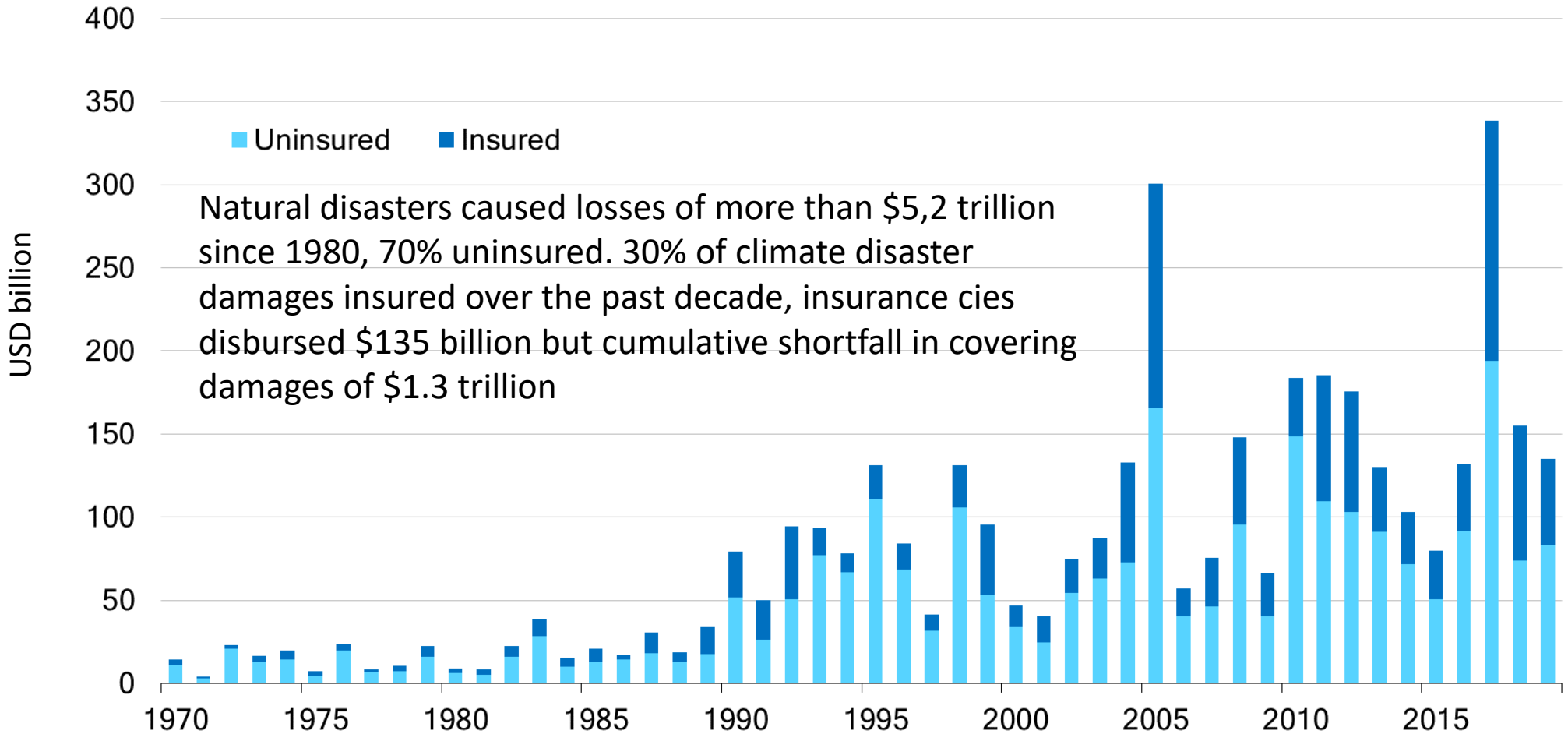
Euro area banks' exposures and sectoral contributions to carbon emissions (left panel); evolution of investment exposures to climate-sensitive sectors (by issuer sector) (right panel)

(left panel: percentages; x-axis: sectoral contributions to total carbon emissions; y-axis: bank exposures (as a share of total exposures); right panel: Dec. 2015-Dec. 2018; left-hand scale: € billions; right-hand scale: percentage of total holdings)



Sources: ECB supervisory statistics, European Commission EDGAR dataset, Eurostat, ECB SHSS, ECB CSDB and ECB calculations.Notes: Left panel: the share of carbon emissions is calculated from Eurostat data on air emissions accounts by NACE activity, which cover the EU28, Turkey and Serbia. Electricity and gas supply also includes steam and air conditioning supply. Right panel: the classification of climate-sensitive assets follows the approach of Battiston et al. (2017). Sectoral holdings are classified according to the NACE categorisation in the ECB's Centralised Securities Database (CSDB).

Risks: Climate change linked to large and growing losses & cost (uninsured weather related disasters), insurance industry says

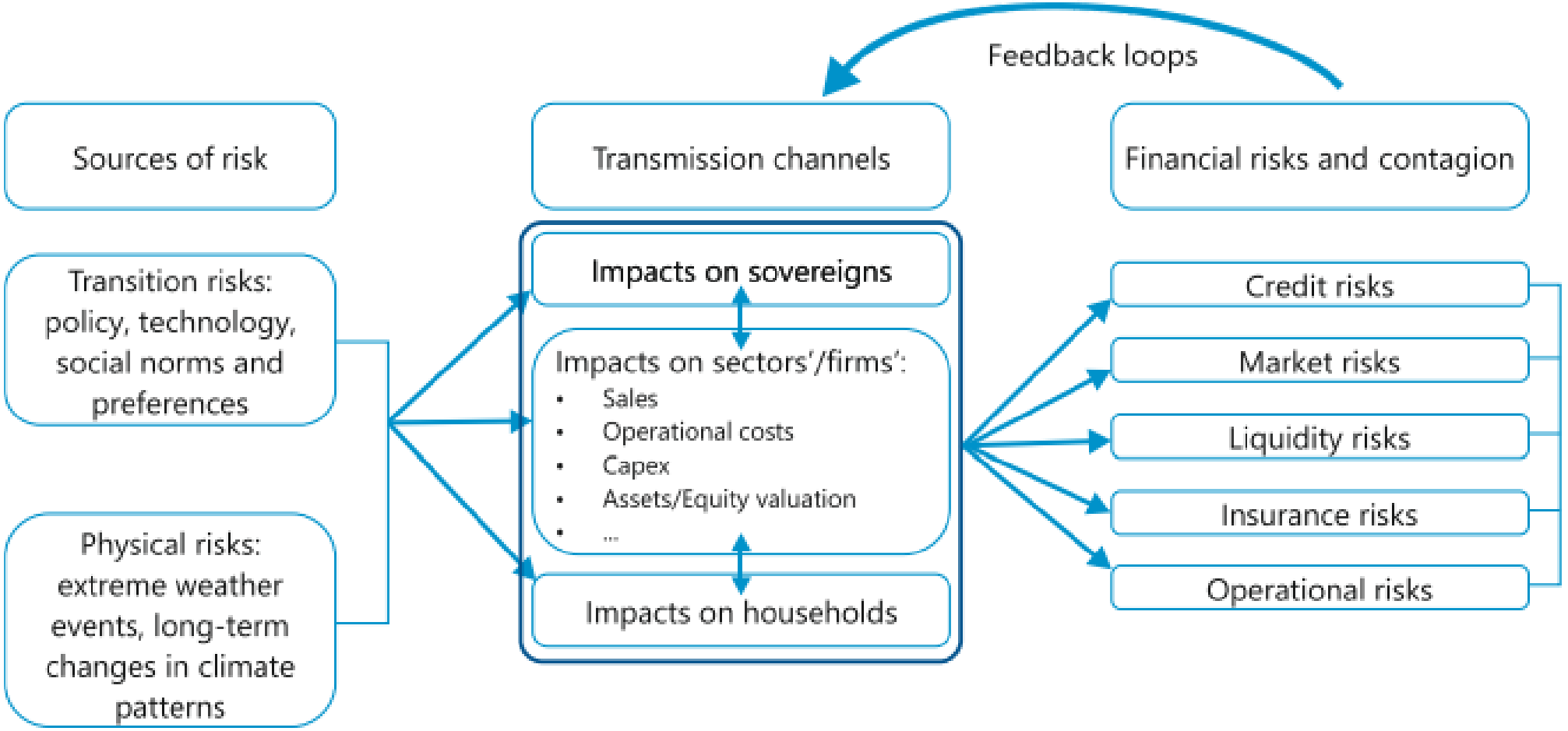


Economic losses = insured + uninsured losses
Source: Swiss Re Institute

S 11.4. Analytical progress: complexity of models, mis-pricing of these risks

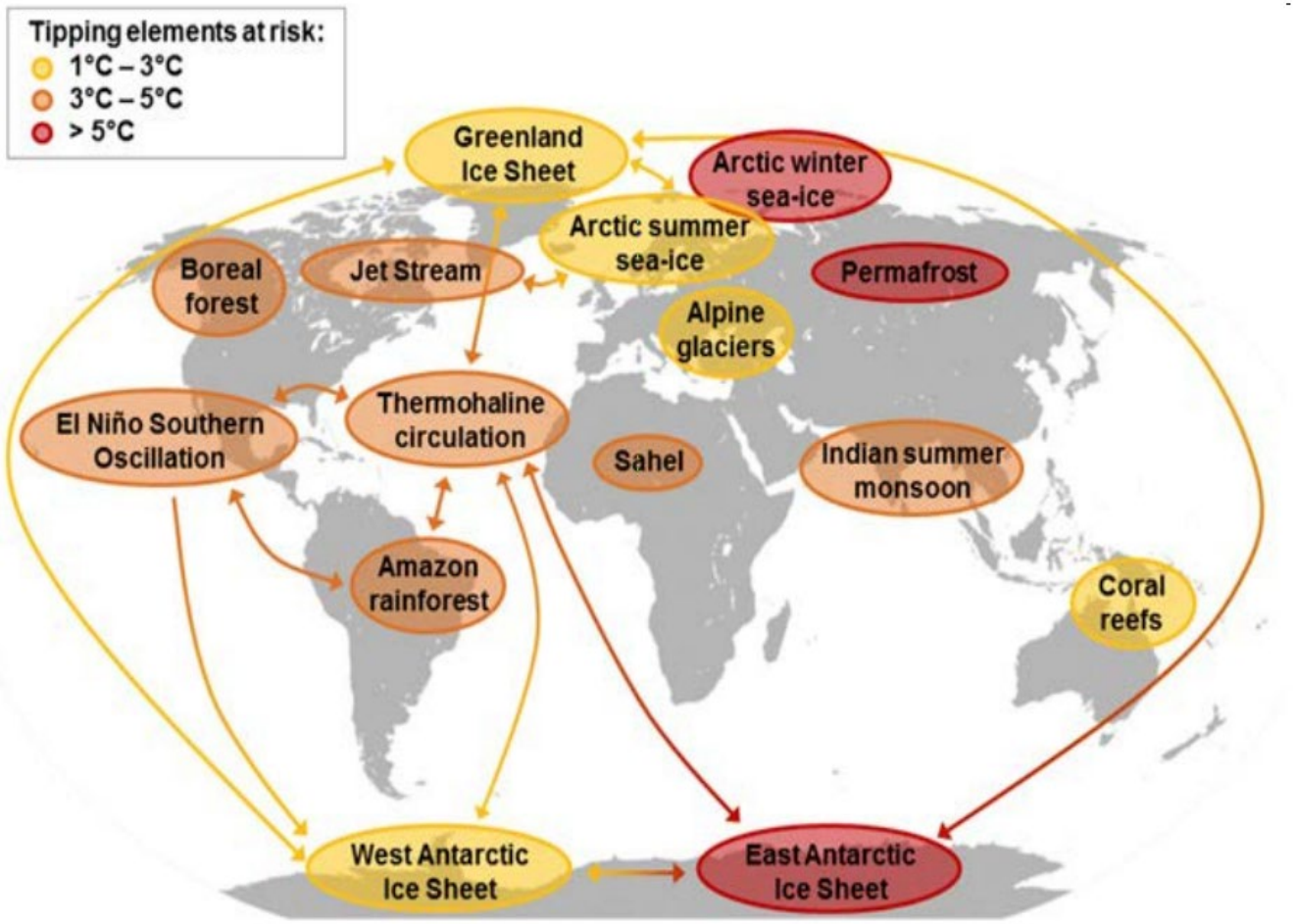
Two Main Channels for Modelling Systemic Risks → Financial Stability

Physical Risks (direct impact on financial stability through cost, uninsured losses, etc)
Transition Risks (abrupt drop in asset value in anticipation of changes, « stranded »)



Source: Bolton et al. (2020)

Quantifying these physical and transition global risks is complex….. Mis-pricing is linked to ramifications of radical uncertainty



The individual tipping elements are colour-coded according to estimated thresholds in global average surface temperature. Arrows show the potential interactions among the tipping elements that could generate cascades, based on expert elicitation.

Source: Steffen et al. (2018)

Impacts on socioeconomic systems:

- First Integrated Assessment Models (IAMs): do not account for tail risks (Weitzman 2011); predicted outcomes and ensuing policy recommendations could be misleading (Stern 2016)
- Tipping points are complex, trigger irreversible consequences with nonlinearity, cascading effects…
- Add global inequality effects, migrations, conflicts, etc…

Example: ramifications of "Melting of Polar Ice Sheets"?

Therefore, these global risks (Green Swans) continue to be mis-priced ……

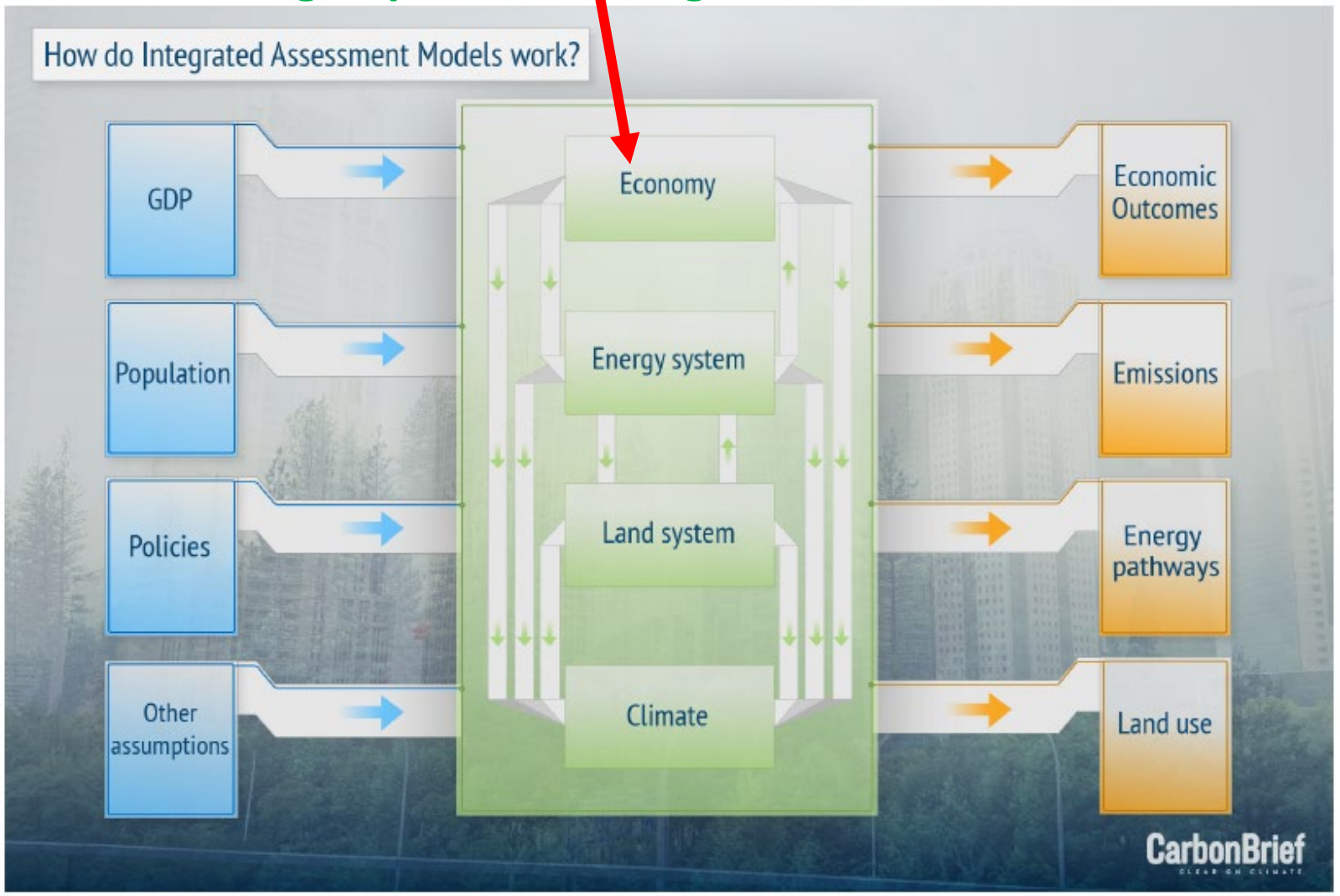
- **Traditional, backward-looking risk management** (e.g. VaR models) cannot model well, quantify these risks; extreme disasters cannot be ruled out with sudden realisation of extreme risks (Weitzman 2011); **need for an epistemological break:** our minds comfortable with historical, linear, deterministic models; CC different, complex, non-linear; cascading effects cross-border & cross-sectors;

- **Even scenario-based forward looking risk assessment faces significant methodological challenges related to:** Inability of macroeconomic-climate models to holistically capture a large range of social, economic and geopolitical chain reactions; lack of granularity at the corporate level; uncertainty regarding adequate mitigation actions of new technologies

- **Alternative approaches can help:** Non-equilibrium models (beyond more sophisticated DSGEs with climate modules); sensitivity analysis with more complex scenarios; specific country, sector, firm case studies; regulatory interventions and other public policies 2017 Stern–Stiglitz report, exclusive carbon pricing cannot be a silver bullet to address full complexity of CC.

- **In addition:** Need to acknowledge **radical uncertainty** and think in terms of system-wide transition; pure risk-based approach might not be sufficient

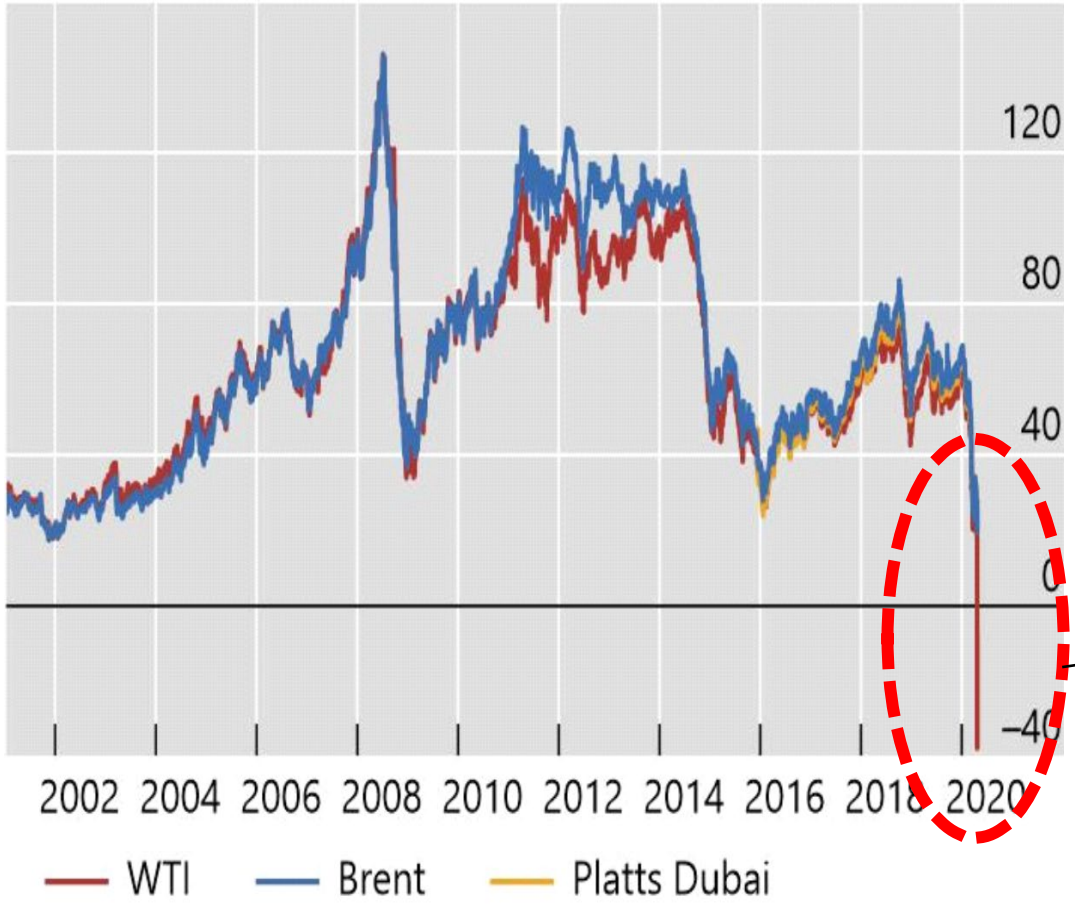
Modelling interactions is complex….. IAMs best tools available and yet difficult to grasp all cascading effects of CC-related risks



(https://www.carbonbrief.org/wp-content/uploads/2018/10/iams-3-01.png)

The mis-pricing of these global risks….. stranded assets: example during crises when abrupt transition (sudden re-pricing) of CC-related risks could create huge asset value losses….

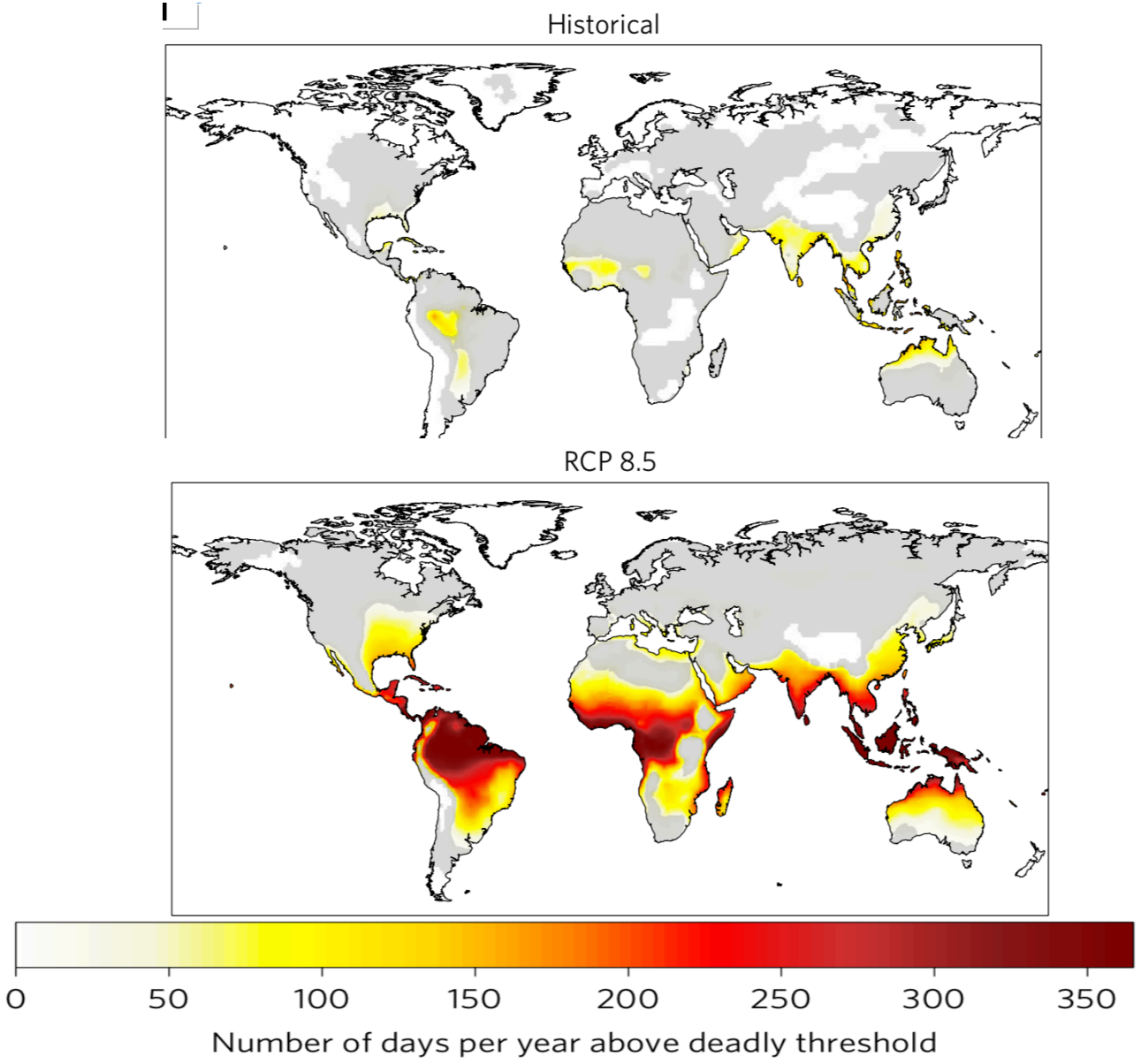
Oil Prices



S&P 500 Oil & Gas Market Cap

Sources: Bloomberg

GHG emissions impact temperatures on where we could live → trigger complex new risks



* Source; Global Risk of Deadly Heat (Science 2017)

- **Human beings must regulate their internal heat, and so they are exposed to the mix of :**
  - External temperatures and
  - Humidity
- **In 2000*, this was already a severe risk:**
  - 13.2% of the planet's land area where 30.6% of the population resides…
  - was exposed to 20 or more days when temperatures and humidity surpassed the threshold beyond which such conditions become deadly.
- **By the end of the century, in a BAU scenario, entire regions of the world would be inhabitable.**

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CC-related risks have multiple ramifications, one example: migration risks complex to assess

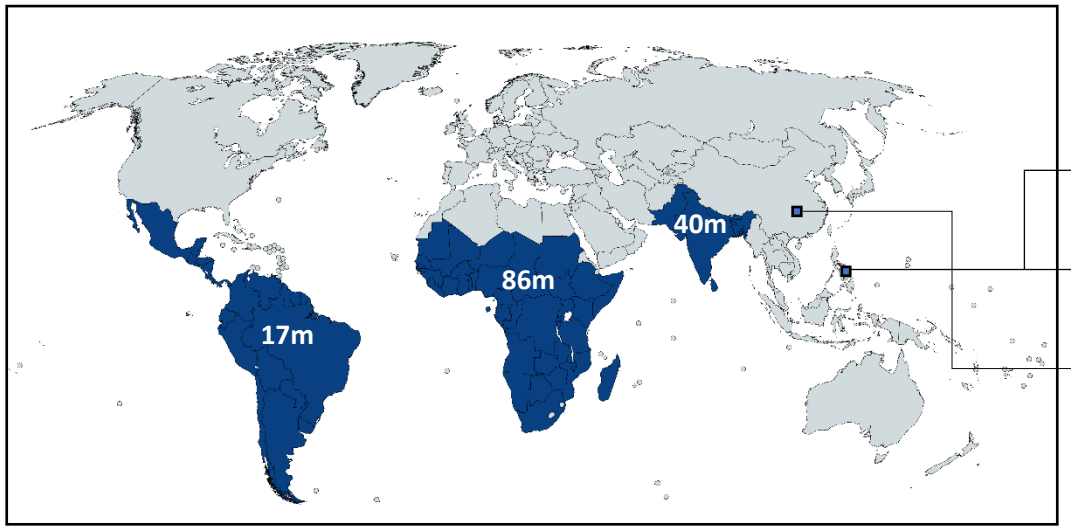
- Changes in the global environment cause an increasing number of human displacements

"By 2050, climate change could force more than **143 million people in just 3 regions to move <u>within</u> their countries**"

– World Bank Group[1]

Core threat to the stability of a country's economic sector

+24 million people[2] were newly displaced by sudden-onset climate-related hazards worldwide in 2016



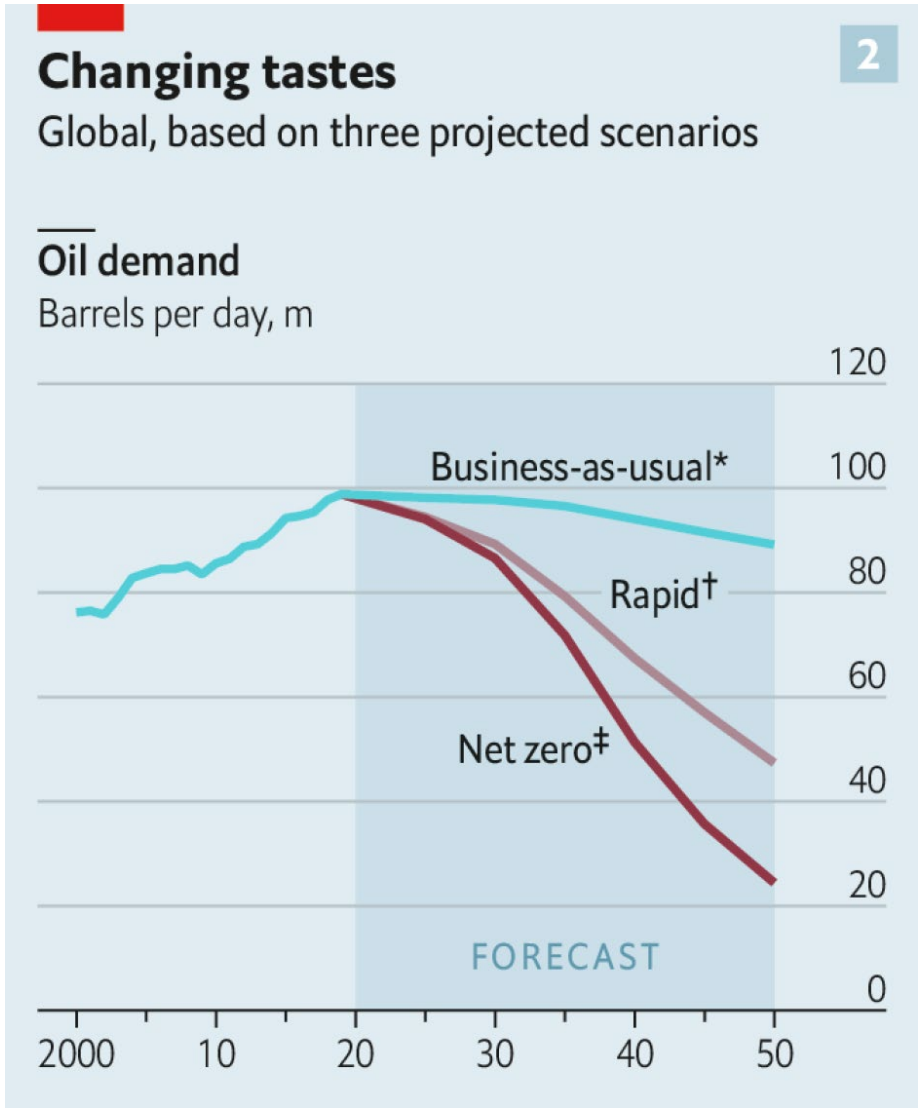
3 largest displacement events in 2016 were climate-related:

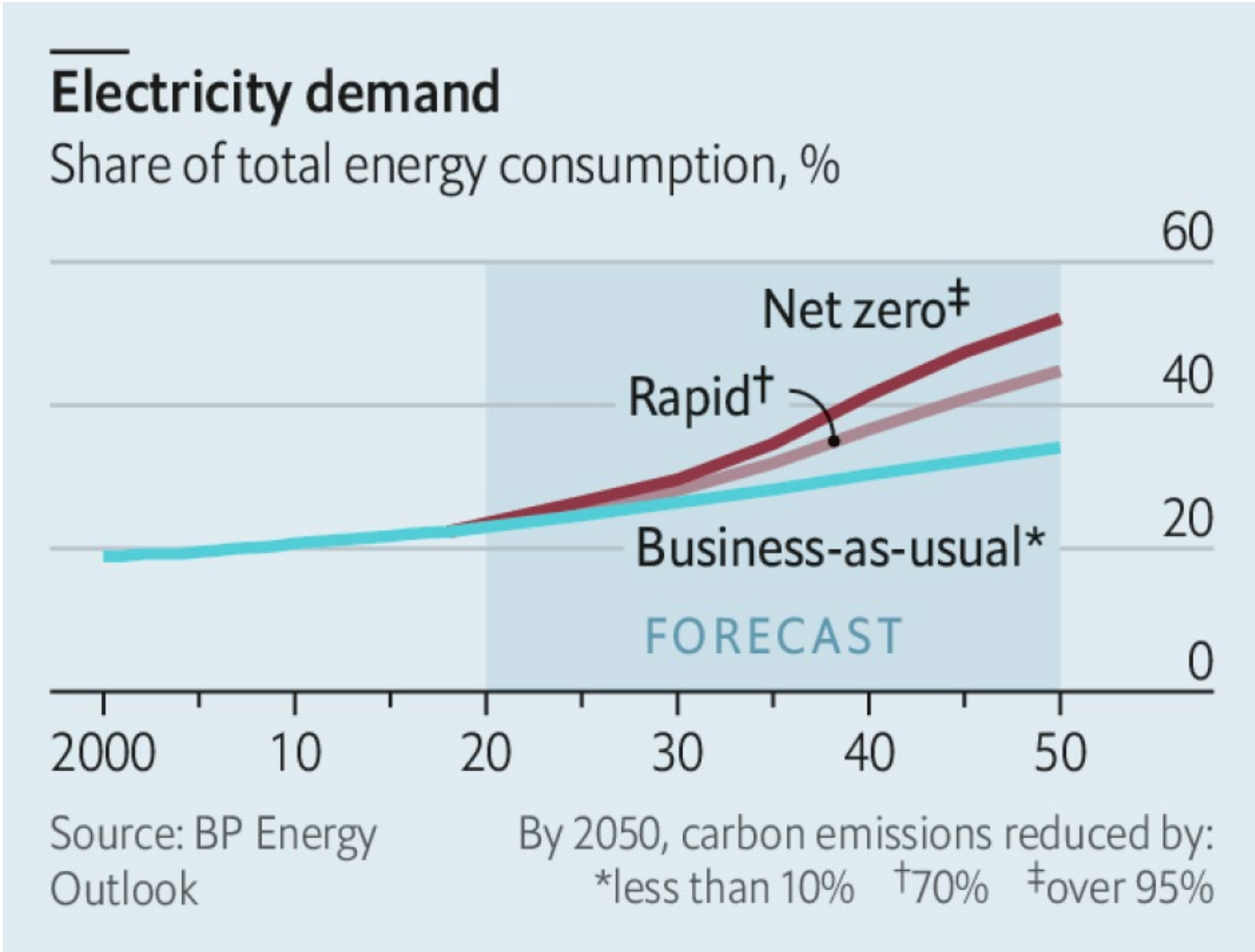
- Typhoon Nock-Ten
  2.6m people
- Typhoon Haima
  2.4m people
- Yangtze River floods
  1.9m people

2.8% of the population of these 3 regions is at risk

Sources: (1) Groundswell, Preparing for internal climate migration, World Bank Group, 2018
(2) Internal displacement monitoring centre database 2017

Industry reports (BP 2020) are already recognizing that baseline scenarios need to factor declining demand for oil and other fossil fuels





Source: The Economist, 19th September, 2020

S 11.5. Institutional progress: need for global coordination cooperation

Growing social awareness needs triggering institutional progress: more acceptance for "insurance" mechanisms against Green Swans

- **"Pricing" of Green Swan risk of pandemic not necessarily like Pigovian (carbon) tax, more like insurance**: can portion of the risks of Covid19 or any pandemic be incorporated in the final costs of our GVCs, our logistical and physical transportation costs, etc.? Can insurance cost against pandemic be considered?

- **Insurance important issue**: illustrates **benefits of cooperation and small cost of insurance**
  - Insuring risks of pandemic vs. our super-efficient, just-in-time, zero storage cost systems; our global networks of production and consumption developed very well but without considering or pricing properly this risk.
  - Ex: huge social benefits of cooperation, pooling risks and buying insurance: in 2004, the Indian Ocean tsunami (est. death toll of 227,898 people in 14 countries and billions in damage). No early warning in place; now yes, with investment of USD 200 million and annual operating costs around USD 25 million shared between 28 countries

Institutional progress: acceptance of the need for more global cooperation & coordination

With regulators, financial sector: *climate-related prudential regulation* surely needed, but in what form? How to coordinate with other interventions?

With Governments, development banks: *promoting sustainable investments and long-termism:* Integrate sustainability factors into central banks' own portfolios (e.g. Banque de France)

With National Treasuries: *policy mix, including green fiscal policy*

With IFIs: *International monetary and financial cooperation; perhaps even new agencies* and new funding (green) instruments

With standard-setters: *ecological accounting frameworks; disclosure of exposures; n*ew approaches (e.g. natural capital) to account for economy-nature interactions…

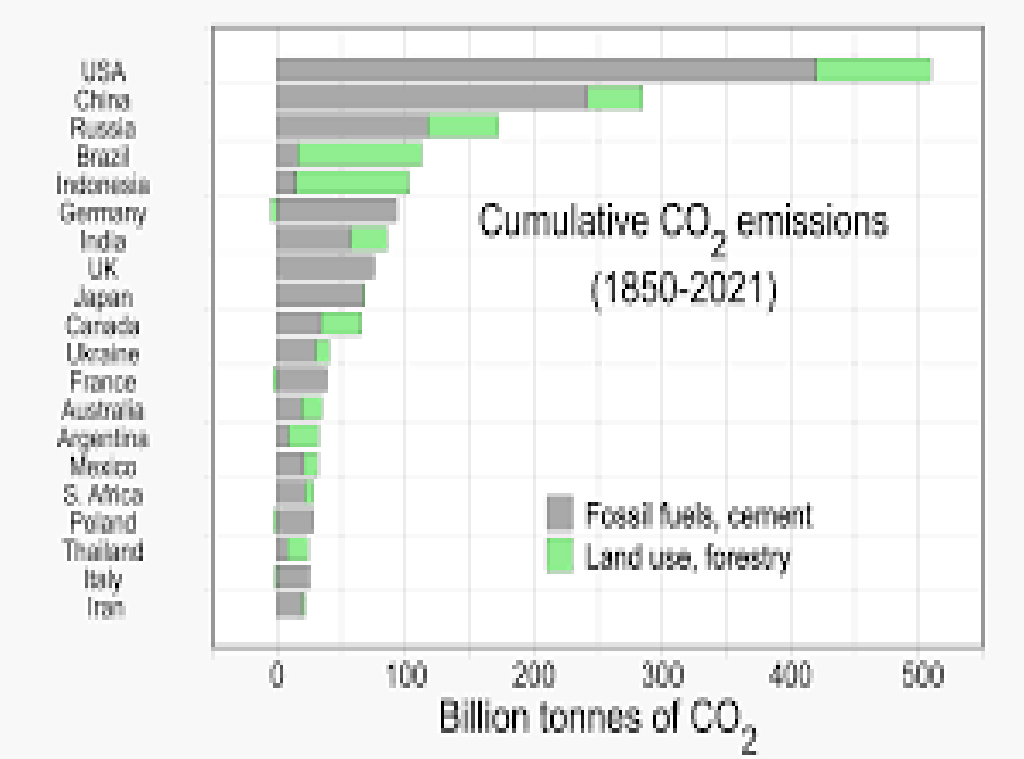
And of course and very importantly, with the private sector and civil society…

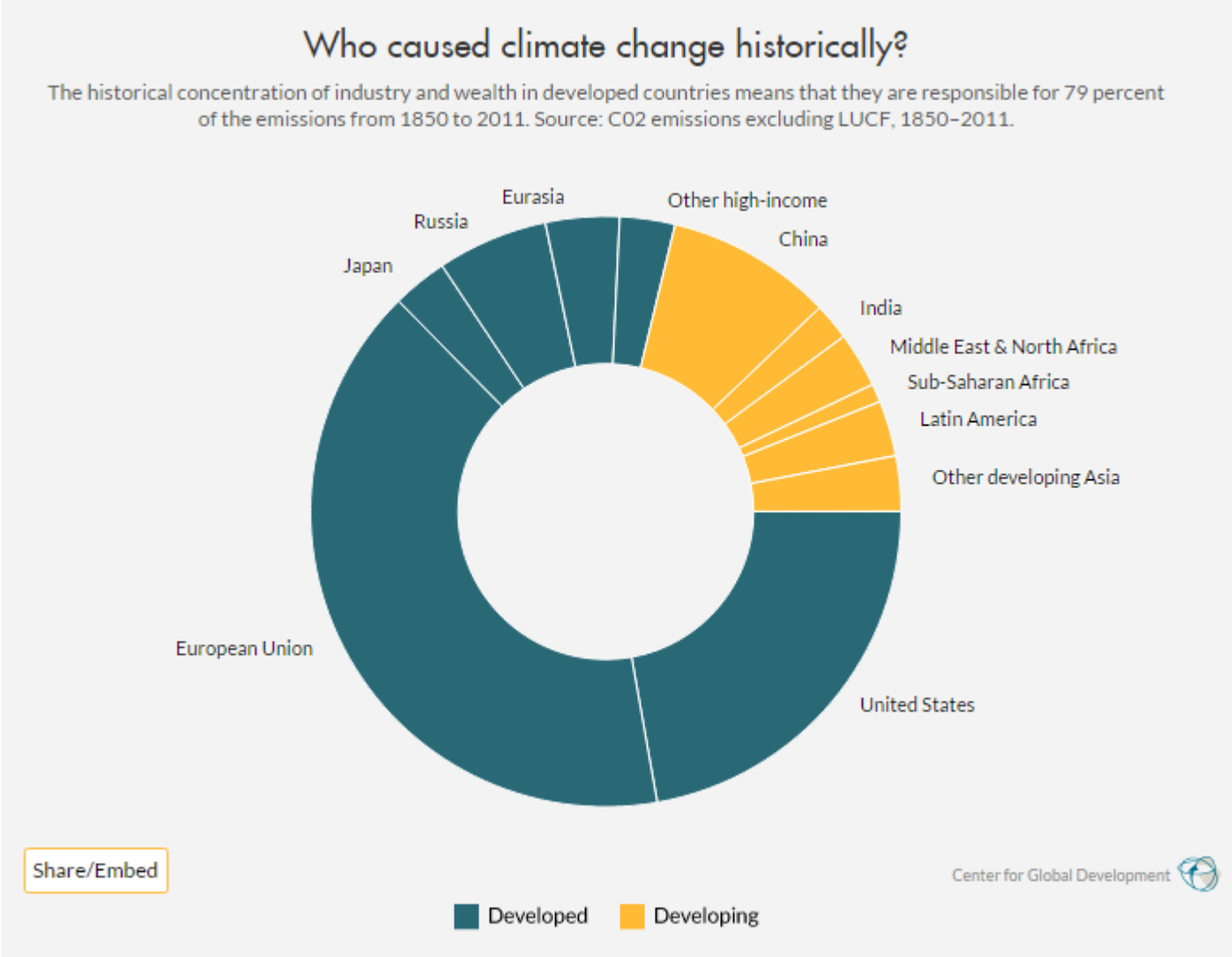
Distributional consequences of climate change: affect poor countries and poor households in rich countries

- **Poor countries** will be most hit by climate change related events (eg., rising sea levels, extreme weather events, lack of prevention, lack of health facilities, etc.)
- In **rich countries poor households** can be hit most by individual climate polices compared to higher-income households:
  - Face more difficult budget constraints that offer limited choice of consumption "greener" baskets;
  - Have harder borrowing constraints that constraint procuring more "green" durables;
  - Have different skill endowments, more difficult to adapt, lower wages; and
- **Some climate policy tools can be regressive** (eg., carbon taxes for different fuels, certain mandatory standards, subsidies and regulatory tools). Compensation & transfers during transition need to be considered

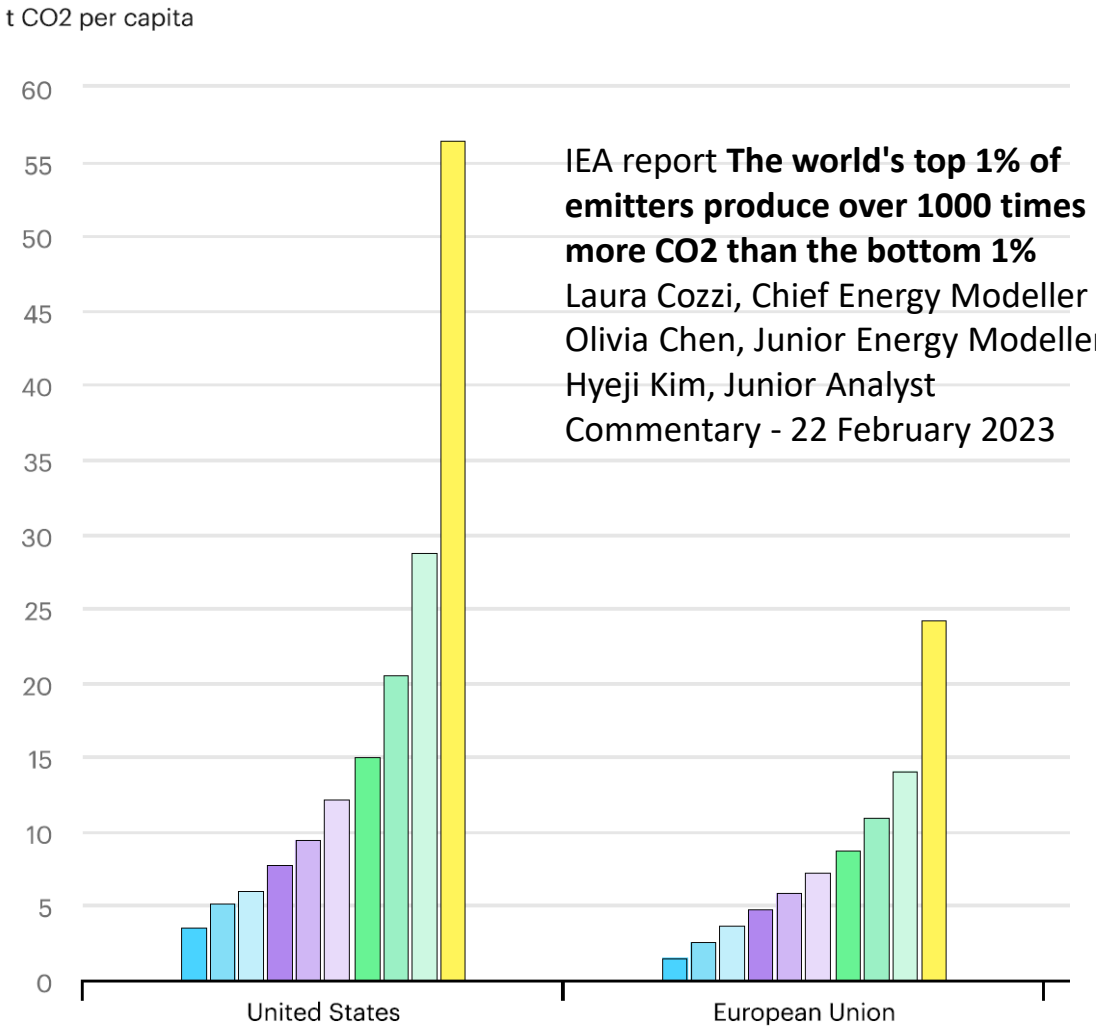
See "Distributional effects of climate policies" Bruegel, 2018 by Georg Zachmann, Gustav Fredriksson and Grégory Claeys

Main GHGs emitters from historical & legacy perspective till 2021

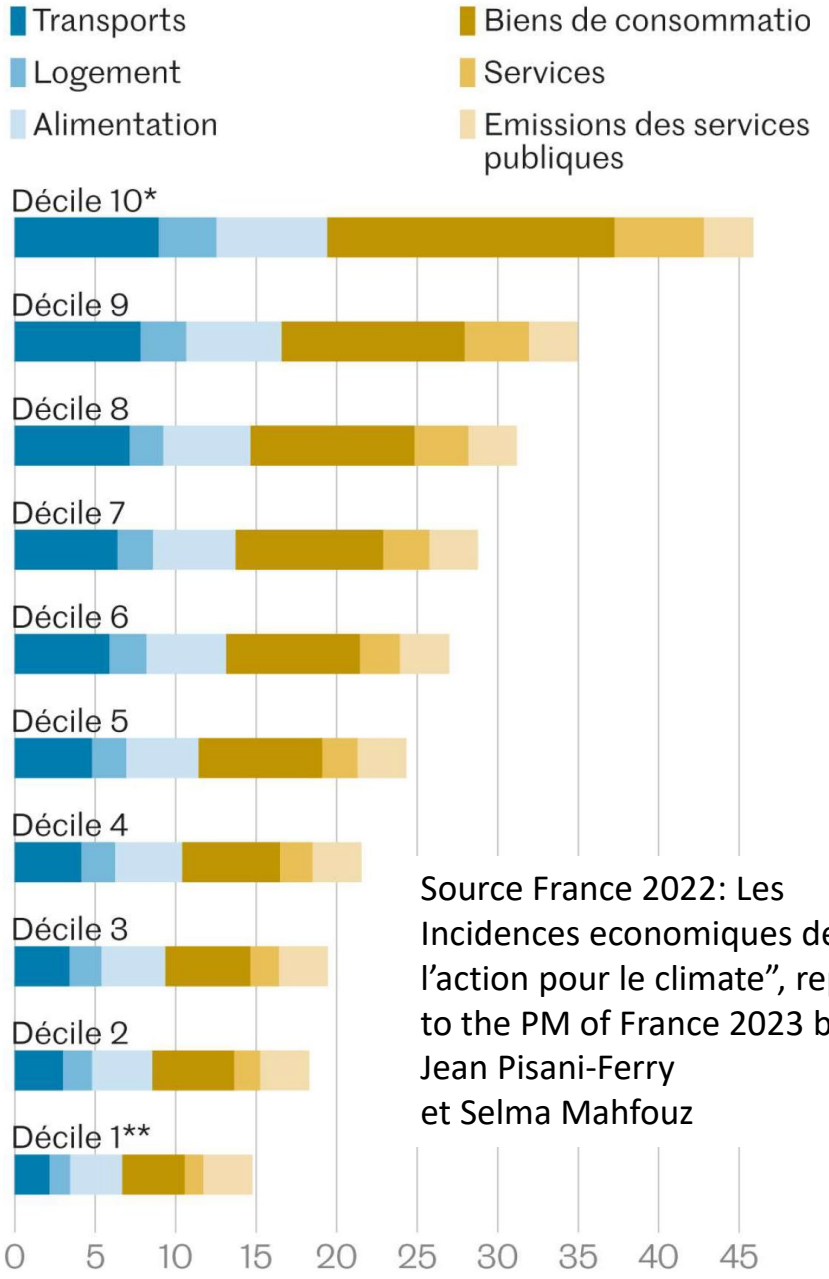




Average emission of GHG (tons of CO2 equivalent, per year & per capita) by decile of the distribution of income and type of usage

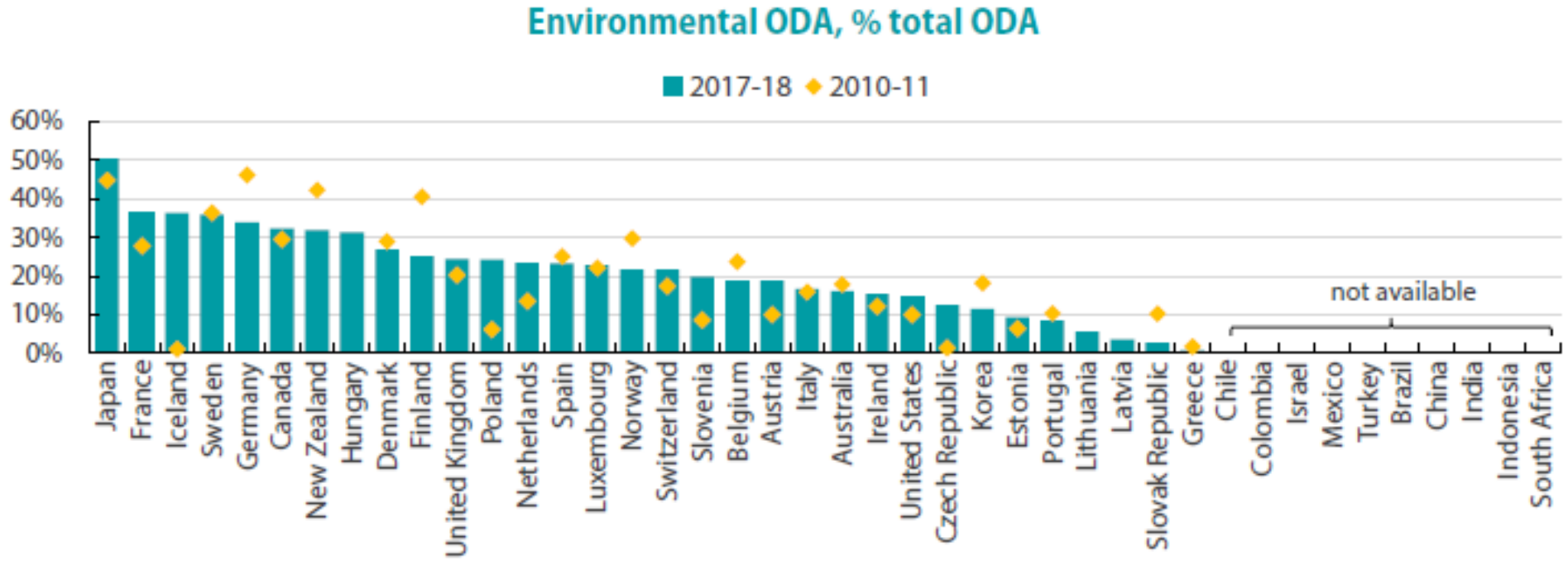


IEA report **The world's top 1% of emitters produce over 1000 times more CO2 than the bottom 1%**
Laura Cozzi, Chief Energy Modeller
Olivia Chen, Junior Energy Modeller
Hyeji Kim, Junior Analyst
Commentary - 22 February 2023



Source France 2022: Les Incidences economiques de l'action pour le climate", report to the PM of France 2023 by Jean Pisani-Ferry
et Selma Mahfouz

Distributional consequences of climate change: affect poor countries and poor households in rich countries



Note: Environmentally related Official Development Assistance is identified using the set of "Rio Markers". The Rio Markers screen for policy objectives of a cross-sectorial nature, including climate change, biodiversity and desertification. This variable includes only data on bilateral commitments and is calculated from microdata on individual projects. There is no internationally agreed methodology for tracking actual disbursements of ODA related to each environmental objective. Thus, it remains difficult to determine the environmental purpose of existing commitments and projects. There are also data gaps for some donors. Moreover, Rio markers for ODA refer to donors' commitments (i.e. policy objectives).

Source: OECD (2020), "Creditor Reporting System: Aid activities", OECD International Development Statistics (database).

Challenge #1: Addressing Climate Change is a big global Macroeconomic Issue

- CC is not a simple, albeit very large, **traditional "shock"** (eg. Oil in 70-80s); CC needs major **structural transformation** and reallocation of resources; a **Schumpeterian creative-destruction replacement of our whole global capital stock** to decarbonize production/consumption processes.

- **Public & private real sector agents and financial system** need to play similar role of engineering, banks in 18-19th centuries to innovate and finance structural change from agrarian societies as during the Industrial revolution.

- **Macroeconomic issue** because such reallocation in the real economy to reach NZ and mitigate risks requires changes in investment, savings, relative prices (carbon content)

- **Mitigation strategies available**: (1) decarbonize critical sectors (transport, etc) with clean energy (green electricity) AND (2) invest massively on structural transformation of countries primary energy matrix (change from fossil → renewables)

- **Adaption strategies** and investment efforts will also have to be in play and funded if mitigation strategies take too long

Challenge # 2: the macroeconomic & financial challenges are very different between rich advanced economies and EMEs

- **For rich advanced economies**, usual macro limits (fiscal space, debt levels after GFC/Covid, acceptance of higher taxation –carbon– and manage impact on inflation)

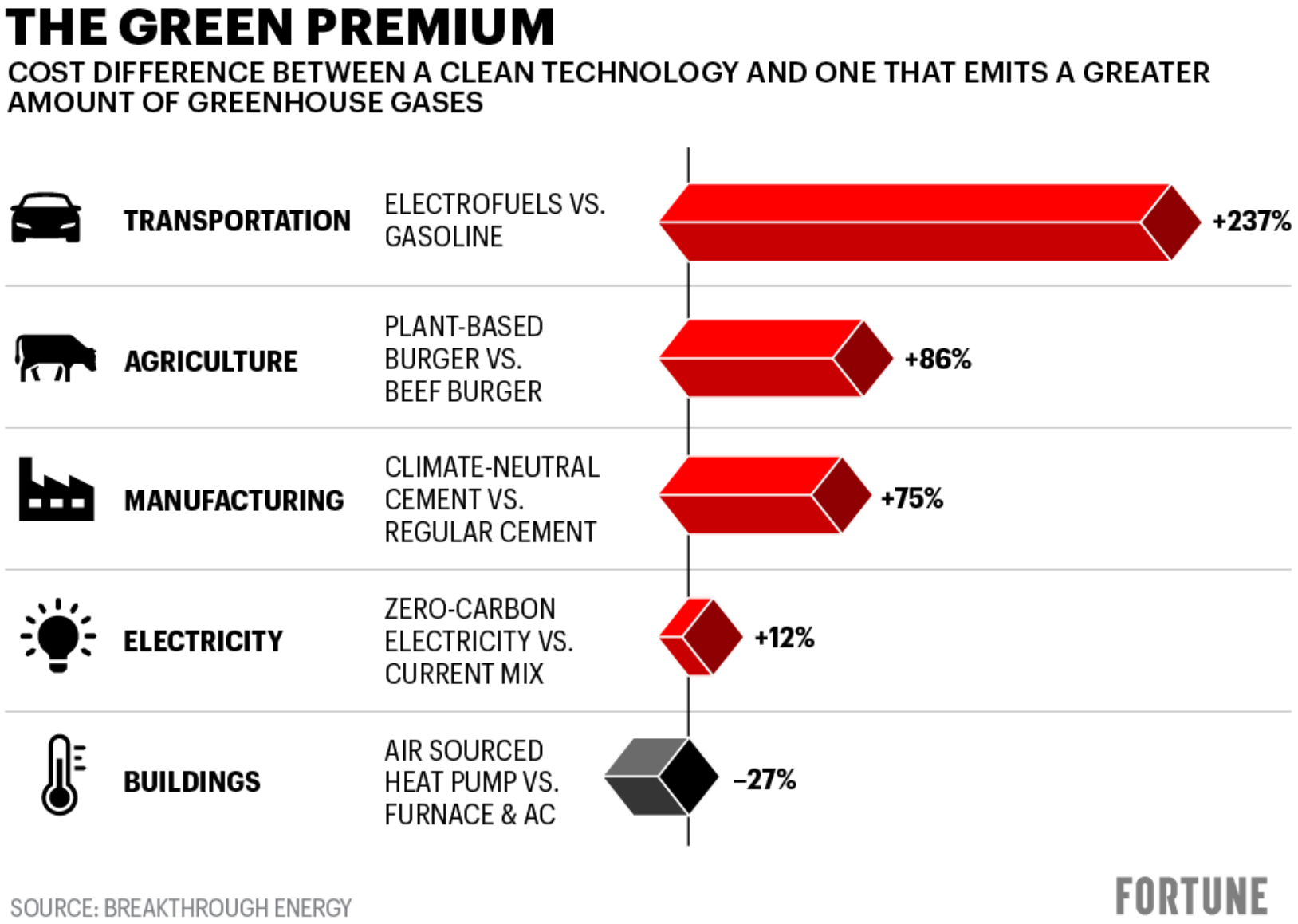
- **For EMEs with higher domestic savings or more access to foreign savings**, also usual macro limits but in many cases different policy space available and different sequence depending on energy matrix, etc

- **For EMEs with limited policy space or limited access**, more difficult macro constraints, hence: macro risk mitigation needed (using MDBs, pooling of risks) and/or credit enhancement (below IG)

- **For poor small countries, small States**, external public funding from rich countries, more official development assistance, grants, concessional financing and private donations, etc

- **Bottom line is** to push more capital to flow into developing countries to prevent adoption or continuation by them of Advanced Economies' high carbon growth models & then allow them to develop and grow with a low carbon, inclusive, socially just transition to NZ

Poor countries & poor households affected by higher cost of transition

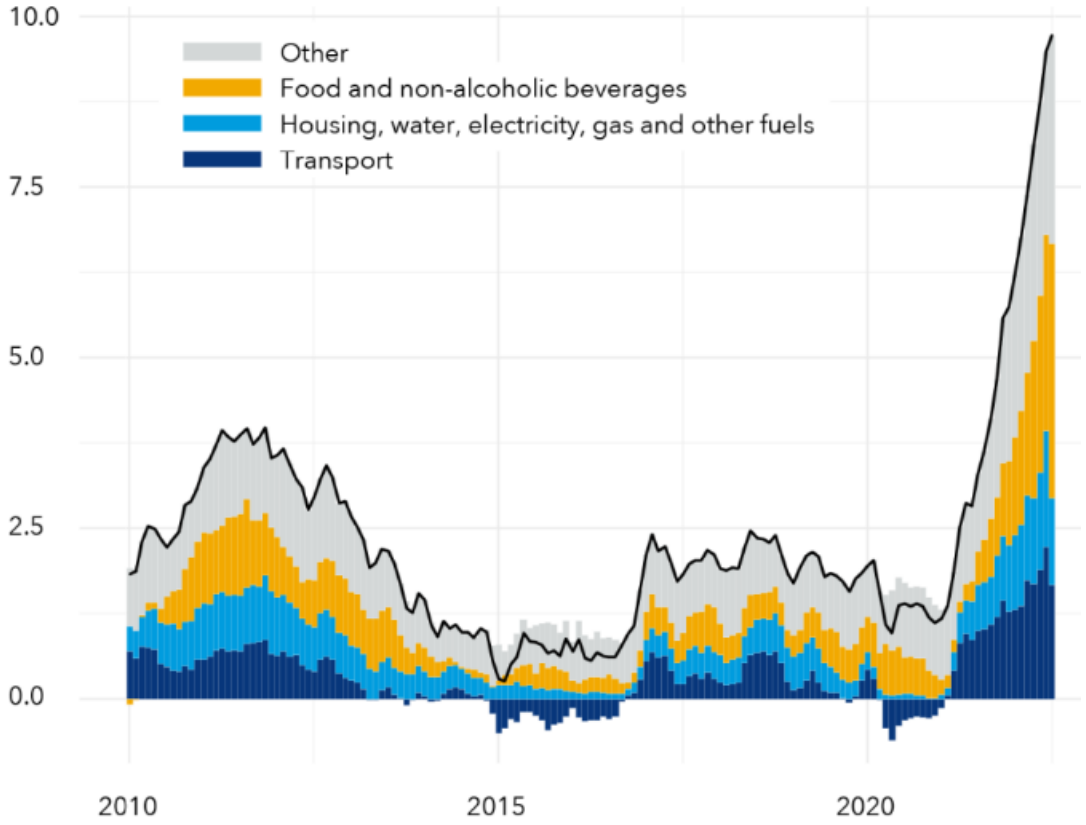


Poor households consumption basket costs affected by higher food & energy prices

Inflation drivers

Food and energy prices continue to drive the global inflation surge.

(percent, median inflation rate)

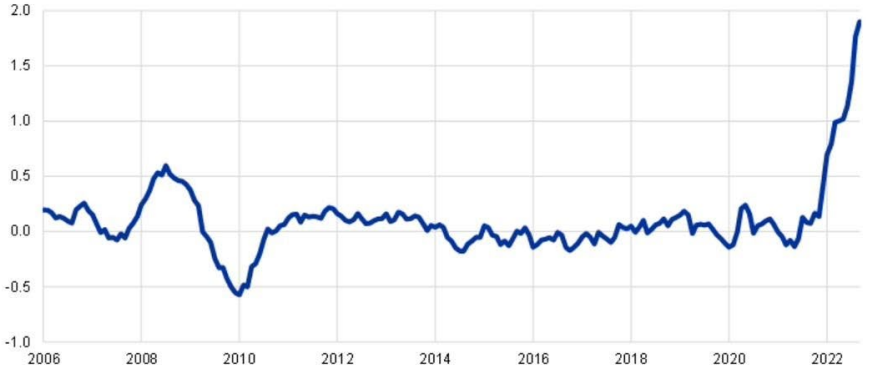


Source: IMF CPI database and IMF staff calculations.
Note: Chart shows median total inflation and in select categories across 88 countries, including 28 advanced economies and 60 emerging and developing economies.

Chart B

Inflation difference between the lowest and highest income quintile households in the euro area

(percentages)



Sources: Eurostat Household Budget Survey, ISTAT and ECB calculations.

Notes: Chart B shows the difference between the effective inflation rates for low-income households (first quintile) and high-income households (fifth quintile). Quintile-specific inflation rates are calculated based on quintile-specific consumption baskets (Chart A) excluding spending on "rents and owner-occupied housing costs". Weights based on the HBS are updated annually in line with updates to the official HICP weights.

S 11.6. Policy implications (1): The urgency of Net Zero (NZ) Policy Goal, Strategies, Global, National commitments

Why the urgency? The “Carbon Budget”

Estimation of remaining carbon budgets from early 2020 in Gt of CO2 equivalent: How much additional G tonnes of CO2 can we emit in total before tipping-point (since 2015 we emit ~30-40Gt of CO2 per year): “do the math”

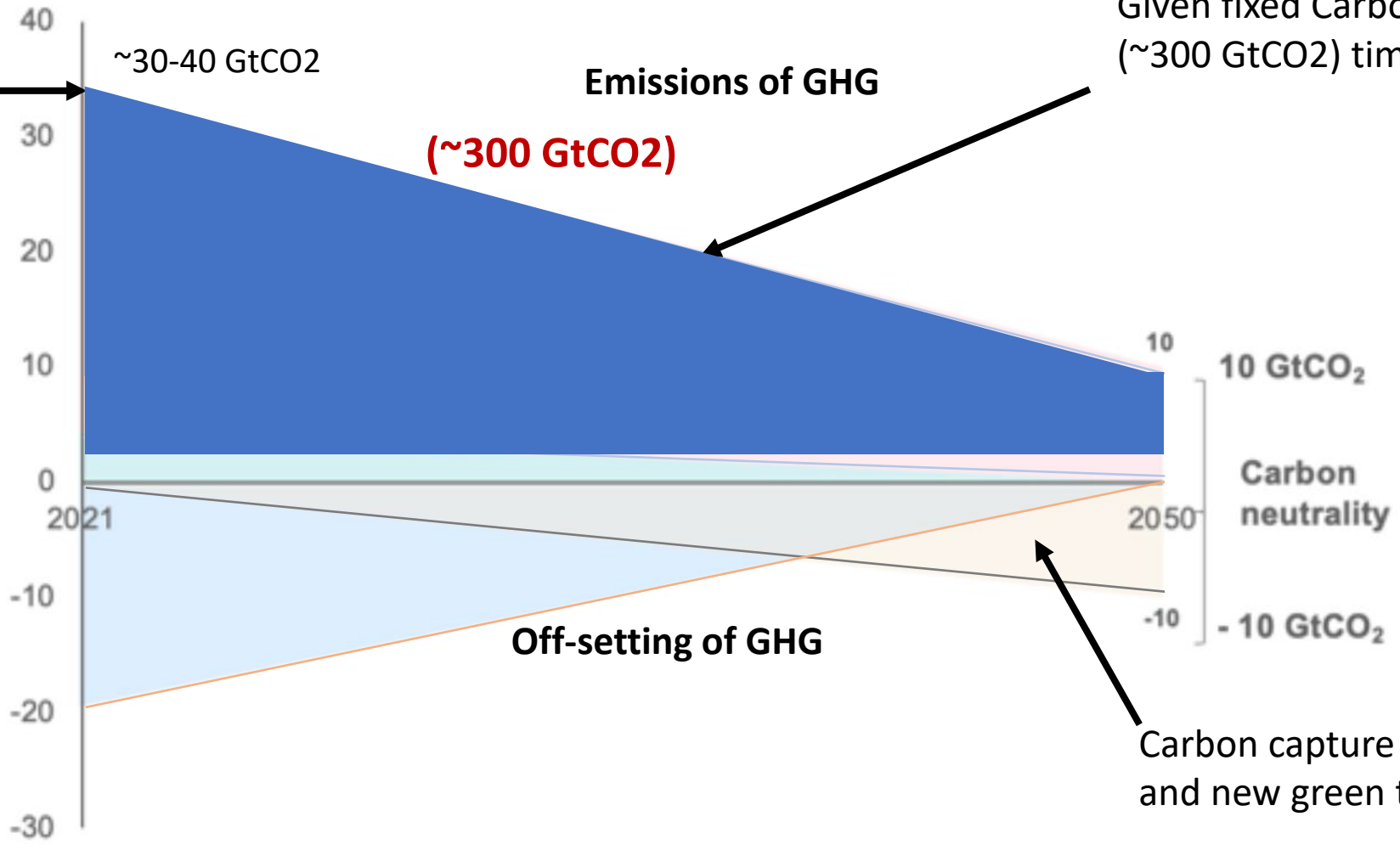
	(2) … with a probability of …				
	17%	33%	50%	67%	83%
(1) to limit warming to…	**(3) there remains an available carbon budget of (in GtCO2):**				
+ 1.5 °C	900	650	500	400	**300**
+ 1.7 °C	1450	1050	850	700	550
+ 2.0 °C	2300	1700	1350	1150	900

Source: Boissinot J, "La Finance Verte" (Dunod, 2002) based from data in GIEC, AR6, WG1 report (SPM).

How to implement trajectory to net zero emissions for remaining carbon budget: Need to reduce emissions AND finance off-setting new green technologies

Given fixed Carbon Budget to keep 1.5C, (~300 GtCO2) time is of the essence

Current annual Emission of GHG



Carbon capture (avoid deforestation) and new green technologies

Source: IPCC, Carbone4, Bolton et al

Global Action: Paris Accord

- The Paris Accord, also known as the Paris Agreement, is a landmark international treaty adopted at the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris, France, on December 12, 2015.
- **Key Objectives of the Paris Agreement**:
- **Temperature Goal**: Limit global warming to well below 2 degrees Celsius above pre-industrial levels. Pursue efforts to limit the temperature increase to 1.5 degrees Celsius, recognizing that this would significantly reduce the risks and impacts of climate change.
- **Global Peaking and Neutrality**: Achieve global peaking of greenhouse gas emissions as soon as possible, recognizing that this will take longer for developing countries. Undertake rapid reductions thereafter to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century.
- **Nationally Determined Contributions** (NDCs): Each country must prepare, communicate, and maintain successive NDCs that it intends to achieve. NDCs are to be updated every five years, with each successive NDC representing a progression beyond the previous one and reflecting the country's highest possible ambition.
- **Transparency and Accountability**: Establish a robust transparency and accountability framework to monitor, report, and verify parties' progress toward their NDCs. Provide flexibility to accommodate different national capacities and circumstances.
- **Financial Support**: Developed countries are to provide financial resources to assist developing countries in both mitigation and adaptation efforts. Mobilize climate finance from a variety of sources, instruments, and channels, aiming to achieve a balance between adaptation and mitigation.
- **Adaptation**: Enhance adaptive capacity, strengthen resilience, and reduce vulnerability to climate change. Recognize the importance of support and international cooperation in achieving adaptation efforts.
- **Loss and Damage**: Address the impacts of climate change that are beyond the limits of adaptation through mechanisms and measures that provide support to affected countries.
- **Implementation and Ratification**: The Paris Agreement was opened for signature on April 22, 2016, and entered into force on November 4, 2016, after being ratified by at least 55 countries accounting for at least 55% of global greenhouse gas emissions. As of now, nearly all UNFCCC member states have signed and ratified the agreement.

National Determined Contributions (NDCs)

- NDCs represent the commitments made by each country to reduce national emissions and adapt to the impacts of climate change. These commitments are self-determined by each country, reflecting their national circumstances, capabilities, and levels of development. NDCs typically include:

- **Emission Reduction Targets**: Quantitative targets for reducing greenhouse gas emissions by a certain year (e.g., 2030), often expressed as a percentage reduction from a base year or relative to a business-as-usual scenario.
- **Adaptation Measures**: Plans and actions to enhance resilience to climate change impacts, including efforts to protect communities, ecosystems, and economies.
- **Implementation Plans**: Detailed strategies for achieving the targets and measures, including policies, regulations, and investments in renewable energy, energy efficiency, and other low-carbon technologies.
- **Support Needs**: Some NDCs include information on the financial, technical, and capacity-building support needed from the international community to achieve their goals.
- NDCs are submitted to the United Nations Framework Convention on Climate Change (UNFCCC) and are subject to regular updates and reviews. Countries are encouraged to increase the ambition of their NDCs over time, reflecting advances in technology, economic development, and a growing understanding of climate science. The collective progress of NDCs is reviewed periodically to assess global efforts and ensure that the world is on track to meet the goals of the Paris Agreement.

Actions been taken: new national policies (US, EU, China, Brazil, etc) & Institutional arrangements to coordinate actions globally

- **New policies** updating nationally determined contribution (NDC)
  - USA (Inflation Reduction Act, Infrastructure Investment and Jobs Act)
  - European Union (Green Deal)
  - China (increase supply of renewables, etc)
  - Brazil (new green agenda, Ecological Transition Plan (Plano de Transição Ecológica), of MoF, green agenda of BCB, FEBRABAN, actions by Brazil G20 Presidency)
- **New institutional arrangements** after COPs, G20
  - Private financial sector alliance (Glasgow Financial Alliance for Net Zero, GFANZ)
  - Public development banks alliance (Finance in Common, FICS)
  - Ministers of Finance & Central Banks alliances (Network for Greening the Financial System, NGFS)

Where do we want to go? Toward multi-faceted policies, mobilizing all agents & building from national to global coordination

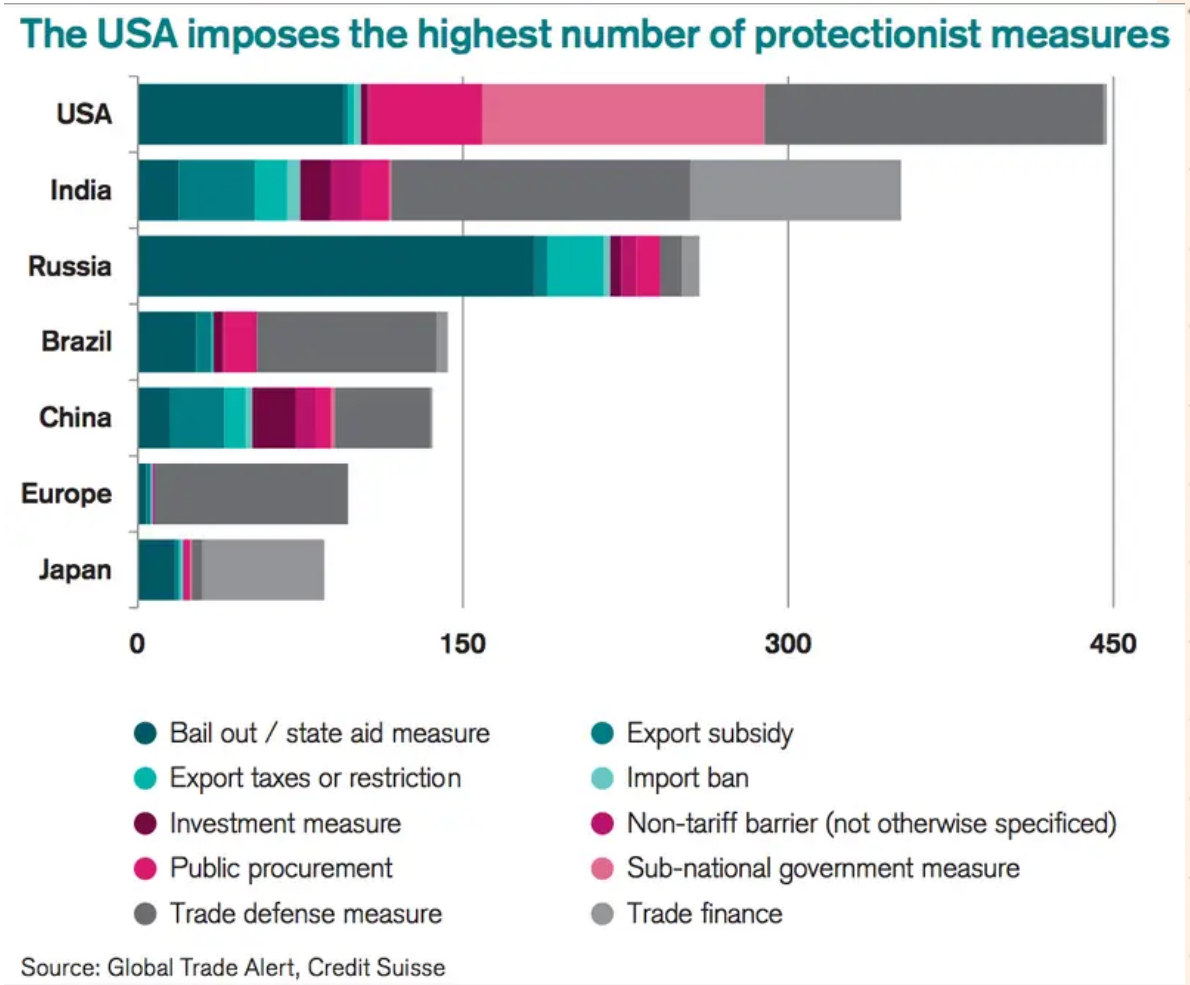
- **Governments, agencies, ministries, CBs** (carbon pricing, taxation, regulated well-functioning carbon markets, investment in R&D, new green technologies, carbon capture, etc); Coordination of public policies from local, to regional and global, because CC-risks are global externality

- **Private Sector real and financial** (scale-up new lab technologies into industrial investments, implementing in real economy and financing transition to NZ)

- **Regulators, rating agencies, auditors** (design and enforce green taxonomies (ESG, etc), transparent disclosure for adequate risk assessment (Task Force on Climate-Related Financial Disclosures at FSB), new accounting principles (IFRS) for CC risks yet unpriced)

- **Civil society** requesting transparency and action; **Investors** (firms, pension funds, etc) that avoid disclosure and/or stay non-compliant are facing increasing reputational risks

Protectionism



Period: 2010-2015

Biden slaps tariffs on array of Chinese goods

Product	Old tariff	New tariff	Effective year
Steel and aluminium products	0%-7.5%	25%	2024
Semiconductors	25%	50%	2025
Electric vehicles	25%	100%	2024
Lithium-ion EV batteries	7.50%	25%	2024
Lithium-ion battery storage	7.50%	25%	2026
Battery parts	7.50%	25%	2024
Graphite and permanent magnets	0%	25%	2026
Other critical minerals	0%	25%	2024
Solar cells	25%	50%	2024
Ship-to-shore cranes	0%	25%	2024
Syringes and needles	0%	50%	2024
Personal protective equipment	0%-7.5%	25%	2024
Rubber medical and surgical gloves	7.50%	25%	2026

Source: White House

Period: 2024

S 11.7. Policy implications (2): New Investments, R&D, New Technologies

List of technologies for NZ (**Renewable Energy Technologies**)

1. **Solar Power**
    - Photovoltaic (PV) panels
    - Solar thermal energy systems
    - Concentrated solar power (CSP)
2. **Wind Power**
    - Onshore wind turbines
    - Offshore wind turbines

1. **Hydropower**
    - Large-scale hydroelectric dams
    - Small-scale hydroelectric systems
    - Pumped storage hydropower
2. **Geothermal Energy**
    - Geothermal power plants
    - Geothermal heating and cooling systems
3. **Biomass Energy**
    - Biomass power plants
    - Biofuels (ethanol, biodiesel)
    - Biogas

List of technologies for NZ (**Energy Storage Technologies and Carbon Capture)**

Energy Storage Technologies

1. **Battery Storage**
   - Lithium-ion batteries
   - Solid-state batteries
   - Flow batteries
2. **Thermal Storage**
   - Molten salt storage
   - Phase change materials
3. **Mechanical Storage**
   - Pumped hydro storage
   - Compressed air energy storage (CAES)
   - Flywheels

Carbon Capture, Utilization, and Storage (CCUS)

1. **Carbon Capture and Storage (CCS)**
   - Post-combustion capture
   - Pre-combustion capture
   - Oxy-fuel combustion
2. **Direct Air Capture (DAC)**
   - Chemical capture systems
   - Physical capture systems
3. **Carbon Utilization**
   - Enhanced oil recovery (EOR)
   - Conversion to chemicals and fuels
   - Mineralization and concrete production

List of technologies for NZ (**Efficiency**)

Energy Efficiency Technologies

1. **Building Efficiency**
   - High-performance building materials
   - Smart building systems
   - LED lighting
2. **Industrial Efficiency**
   - Combined heat and power (CHP) systems
   - Waste heat recovery
   - Advanced manufacturing processes
3. **Transportation Efficiency**
   - Electric vehicles (EVs)
   - Hydrogen fuel cell vehicles
   - Public transportation improvements

Smart Grid and Grid Modernization

1. **Smart Meters**
   - Real-time energy usage tracking
   - Dynamic pricing systems
2. **Advanced Grid Infrastructure**
   - Grid automation and control systems
   - Distributed energy resources (DER) integration
3. **Microgrids**
   - Localized grid systems
   - Renewable energy integration

List of technologies for NZ (Others)

Sustainable Agriculture and Land Use

1. **Precision Agriculture**
    - IoT sensors and data analytics
    - Automated irrigation systems
2. **Agroforestry**
    - Integrated farming systems
    - Reforestation and afforestation
3. **Soil Carbon Sequestration**
    - No-till farming
    - Cover cropping

Advanced Nuclear Technologies

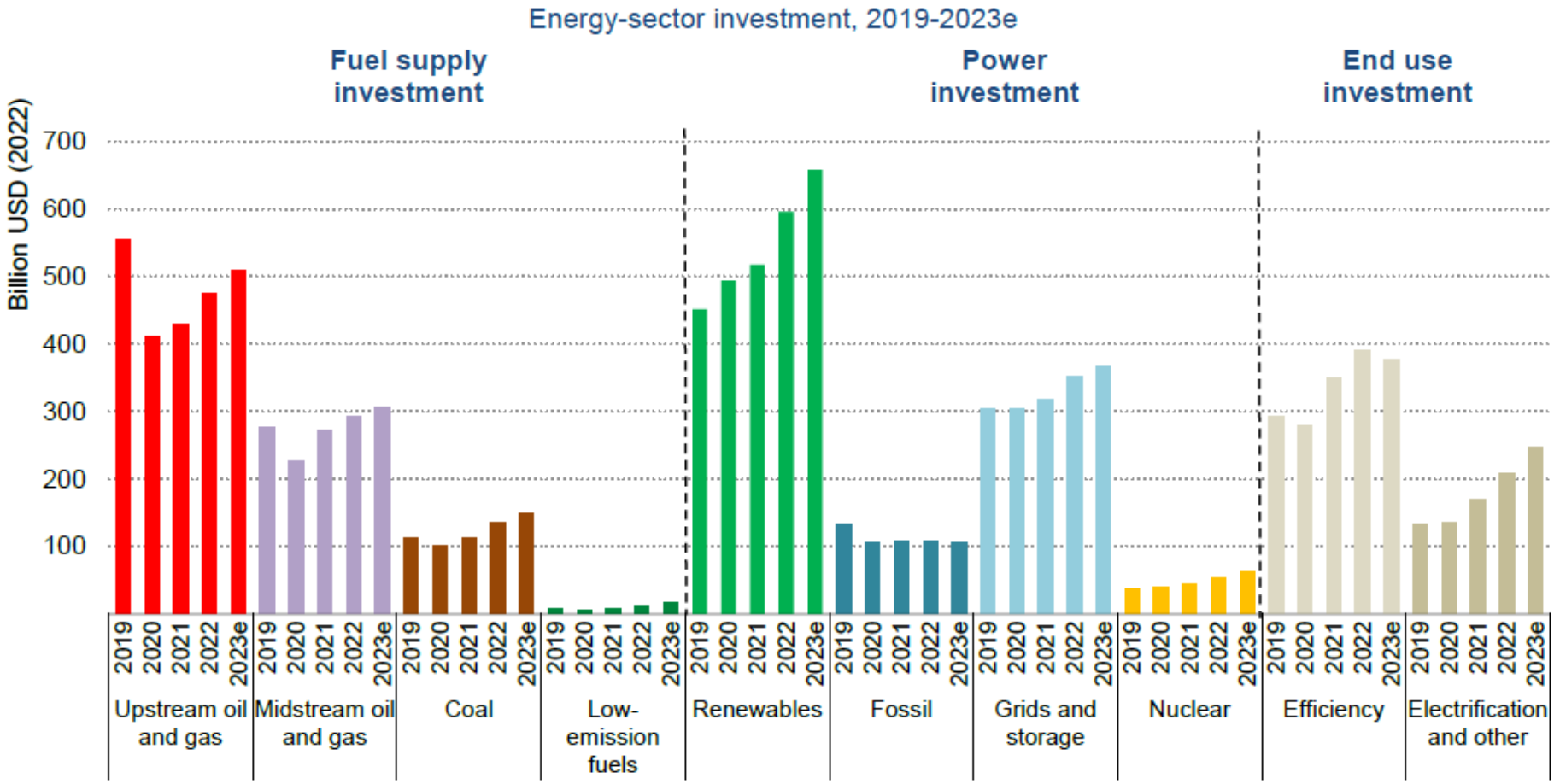
1. **Small Modular Reactors (SMRs)**
    - Compact and scalable nuclear reactors
2. **Generation IV Reactors**
    - High-temperature gas-cooled reactors (HTGR)
    - Molten salt reactors (MSR)

Other Emerging Technologies

1. **Hydrogen Production**
    - Green hydrogen (electrolysis using renewable energy)
    - Blue hydrogen (natural gas with CCS)
2. **Artificial Photosynthesis**
    - Solar fuel generation
    - Synthetic leaf technologies
3. **Ocean Energy**
    - Tidal power
    - Wave energy

Responding to Challenges: Global Investments in Energy Transition Today

Increases across almost all categories push anticipated spending in 2023 up to a record USD 2.8 trillion



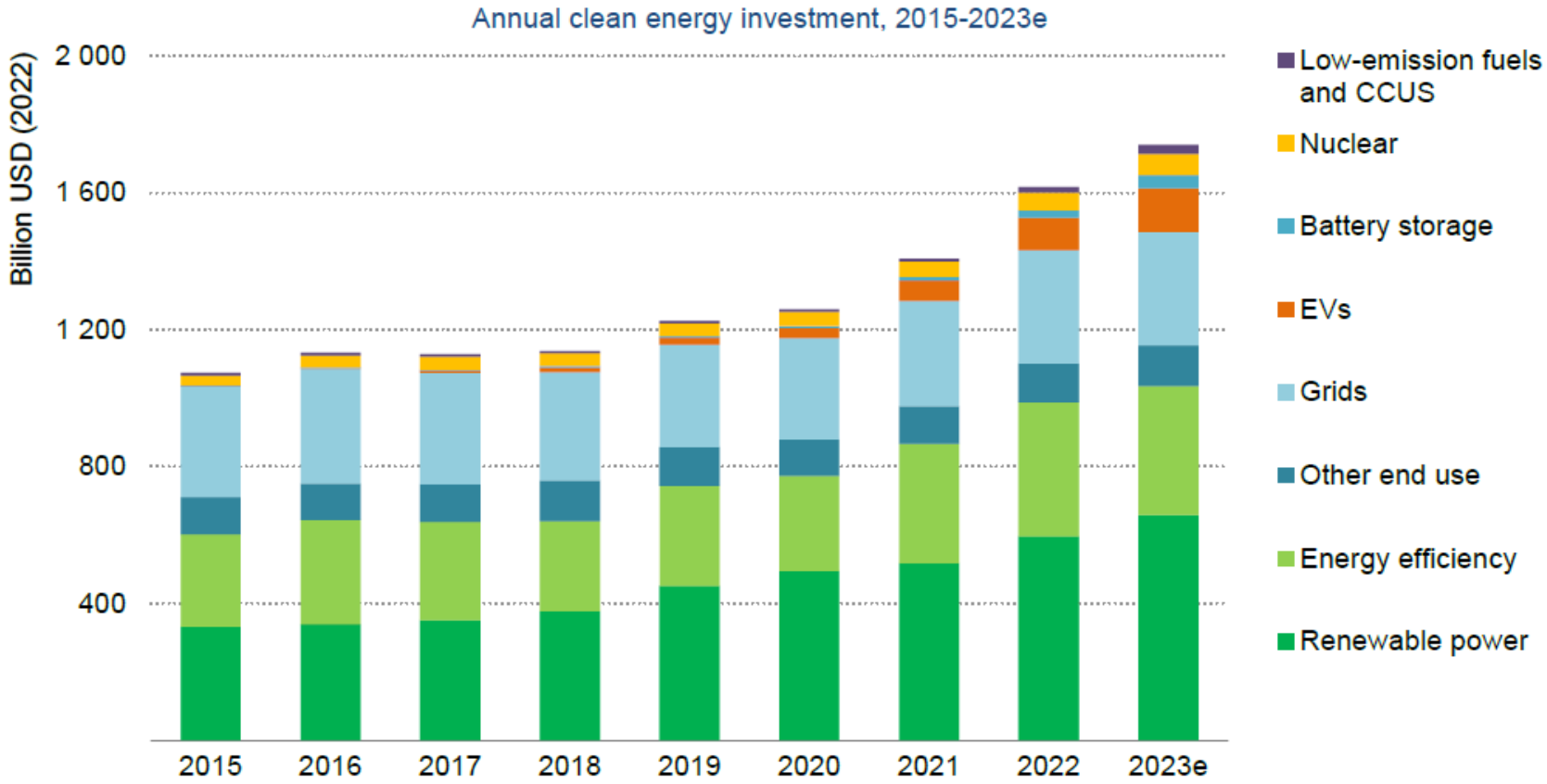
IEA. CC BY 4.0.

Notes: "Low-emission fuels" include modern liquid and gaseous bioenergy, low-emission hydrogen and low-emission hydrogen-based fuels; "Other end use" refers to renewables for end use and electrification in the buildings, transport and industrial sectors. The terms grids and networks are used interchangeably in this report and do not distinguish between transmission and distribution; 2023e = estimated values for 2023..

Source: International Energy Agency Annual Report (2023)

Responding to Challenges: Global Investments in Energy Transition Today

Renewables, led by solar, and EVs are leading the expected increase in clean energy investment in 2023



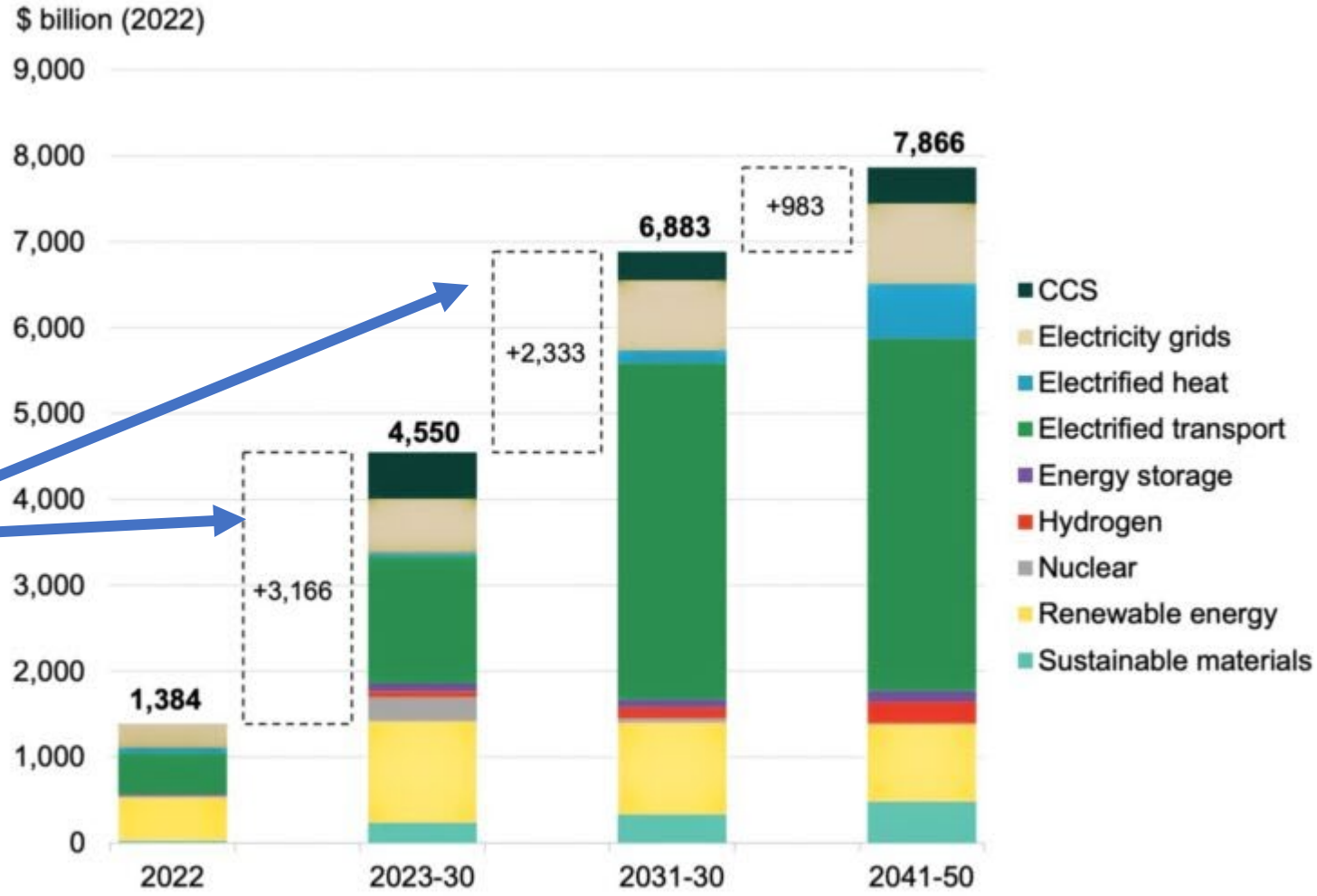
Source: International Energy Agency Annual Report (2023)

Notes: "Low-emission fuels" include modern liquid and gaseous bioenergy, low-emission hydrogen and hydrogen-based fuels that do not emit any CO_2 from fossil fuels directly when used and emit very little when being produced; "Other end use" refers to renewables for end use and electrification in the buildings, transport and industrial sectors. 2023e = estimated values for 2023; CCUS = carbon capture, utilisation and storage; EV = electric vehicle.

Problem #1:
Investments in Energy Transition to reach Net Zero are still insufficient

- US$1.1-1.3 trillion was invested globally in the green energy transition in 2022
- **But it's not enough**. To meet global net-zero targets, investment needs to triple to US$4.55 trillion every year until 2030 → see gaps
- How to fill these gaps & finance this effort urgently is key; with limited room for manoeuvre (taxes, debt + inflation)

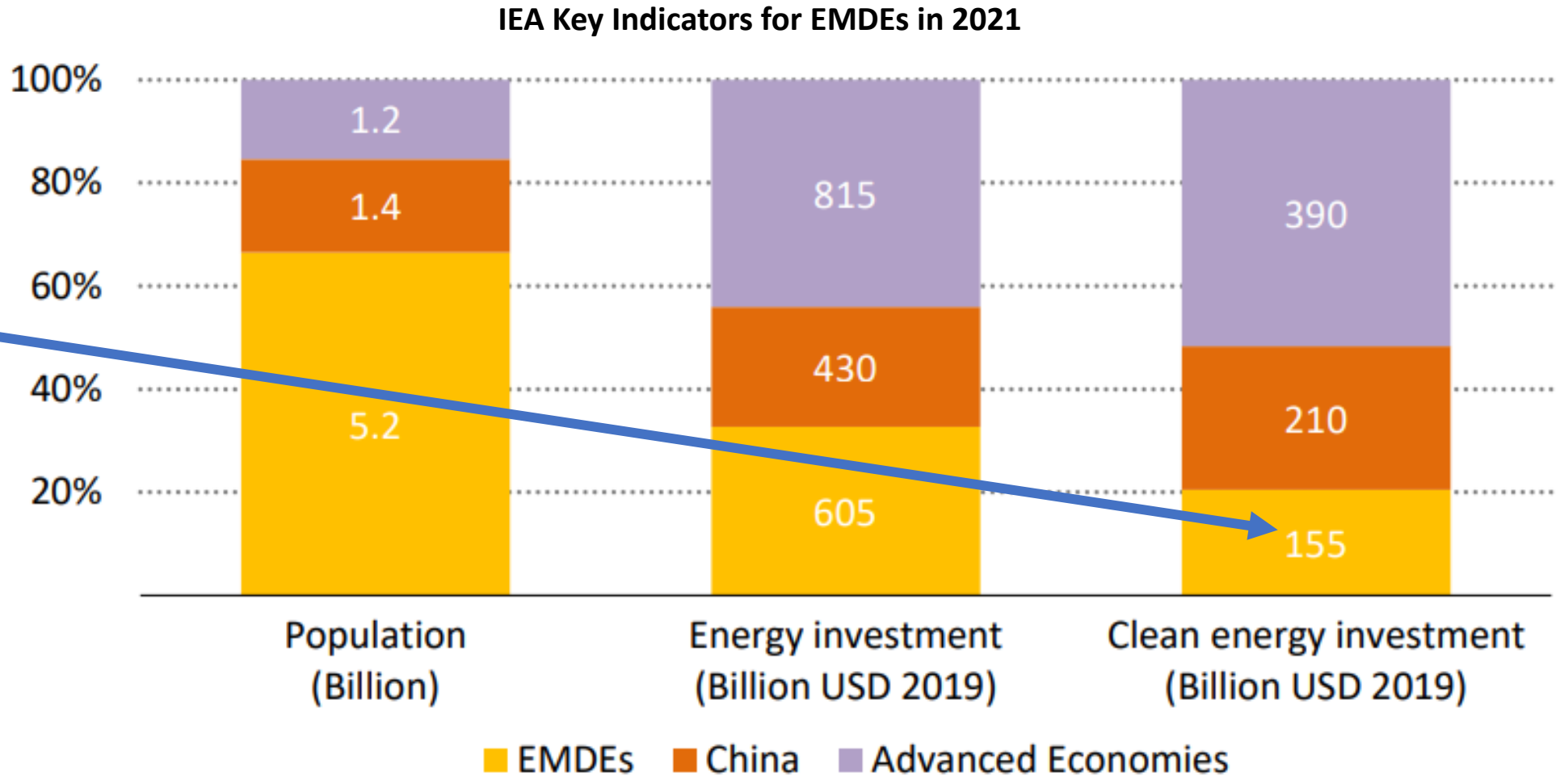
2022 energy transition and grid investment versus required annual investment in 2023-30, 2031-40, and 2041-50 in NEO 2022 Net Zero Scenario



Source: BloombergNEF
Note: future values are from the New Energy Outlook 2022, except electrified transport, which is from the Electric Vehicle Outlook 2021 Net-Zero Scenario. The Net-Zero Scenario target global net zero by 2050 in line with 1.77 degrees Celsius of warming. Investment includes electricity grids

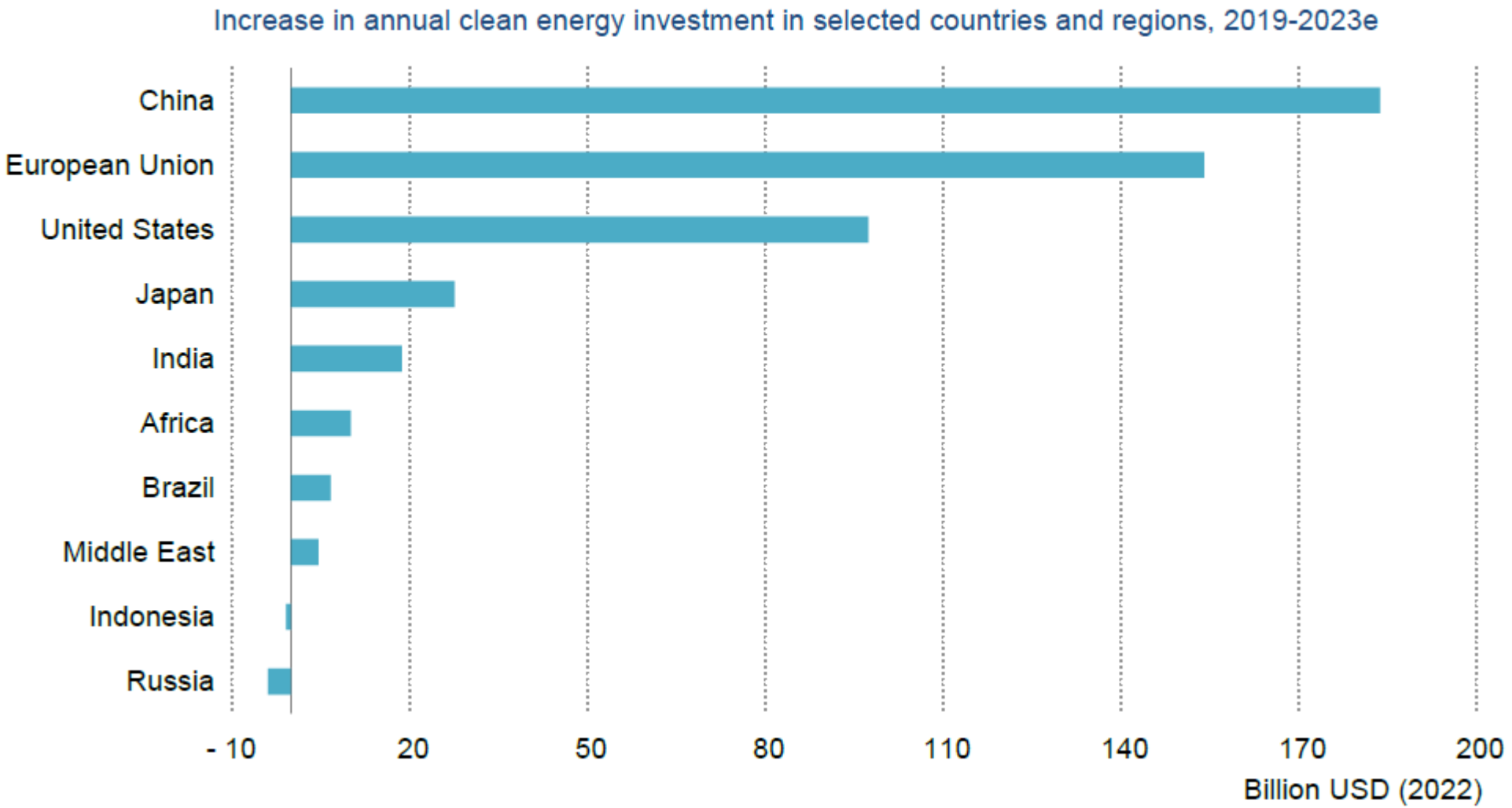
Problem # 2: Not enough clean energy investment where it counts: developing world

- Emerging market and developing economies account for 2/3 of world's population but only 20% of global clean energy investment
- So green financing mobilization and direction needs to go the developing countries using all existing and new mechanisms



Source: *IEA World Energy Investment 2021 Special Report*

The increase in clean energy spending in recent years is impressive but heavily concentrated in a handful of countries



Source: International Energy Agency Annual Report (2023)

The estimation of the investment needs for EMEs

Figure 3.1. Investment/spending needs for climate action per year by 2030

Categories of investment			Needs by 2030
Transforming the energy system	Power system	Zero carbon generation	$300–400bn
		Transmission and distribution	$200–250bn
		Storage and back-up capacity	$50–75bn
		Early phase-out of coal	$40–50bn
	Transport system	Low emission transport infrastructure	$400–500bn
		Fleet electrification/hydrogen	$100–150bn
	Industry	Energy efficiency	$10–20bn
		Industrial processes	$10–20bn
	Buildings	Electrification	$20–40bn
		Energy efficiency and GHG abatement	$70–80bn
	Green hydrogen	Production	$20–30bn
		Transport and storage	$20–30bn
	Just transition	Targeted programmes and safety nets	$50–100bn
Coping with loss and damage			$200–400bn
Investing in adaptation and resilience			$200–250bn
Investing in natural capital		Sustainable agriculture	$100–150bn
		Afforestation and conservation	$100–150bn
		Biodiversity	$75–100bn
Mitigating methane emissions from fossil fuels and waste			$40–60bn

Note: The financing needs are estimated for the year 2030 and as such do not represent cumulative investments for the decade 2020–30. Source: Authors

Failure to deliver the climate finance commitment of $100 billion per year by 2020 made by developed countries at successive COPs has eroded trust.

Emerging markets and developing countries (EMDCs) other than China will need to spend around $1 trillion per year by 2025 (4.1% of GDP compared with 2.2% in 2019) and around $2.4 trillion per year by 2030 (6.5% of GDP), on the specific investment and spending priorities

Source: Report of the Independent High-Level Expert Group on Climate Finance (November 2022)

Overview of the latest available figures on climate finance flows from the UNFCCC and the Climate Policy Initiative (CPI). The UNFCCC Standing Committee on Finance (2020; 2022a) estimates that global climate finance flows reached $775 billion on average in 2017/18, and $803 billion in 2019/20.

According to CPI (2020; 2022), climate finance flows amounted to $574 billion in 2017/18, and $653 billion in 2019/20. Differences in accounting definitions and methodologies explain in part the variation in estimates.

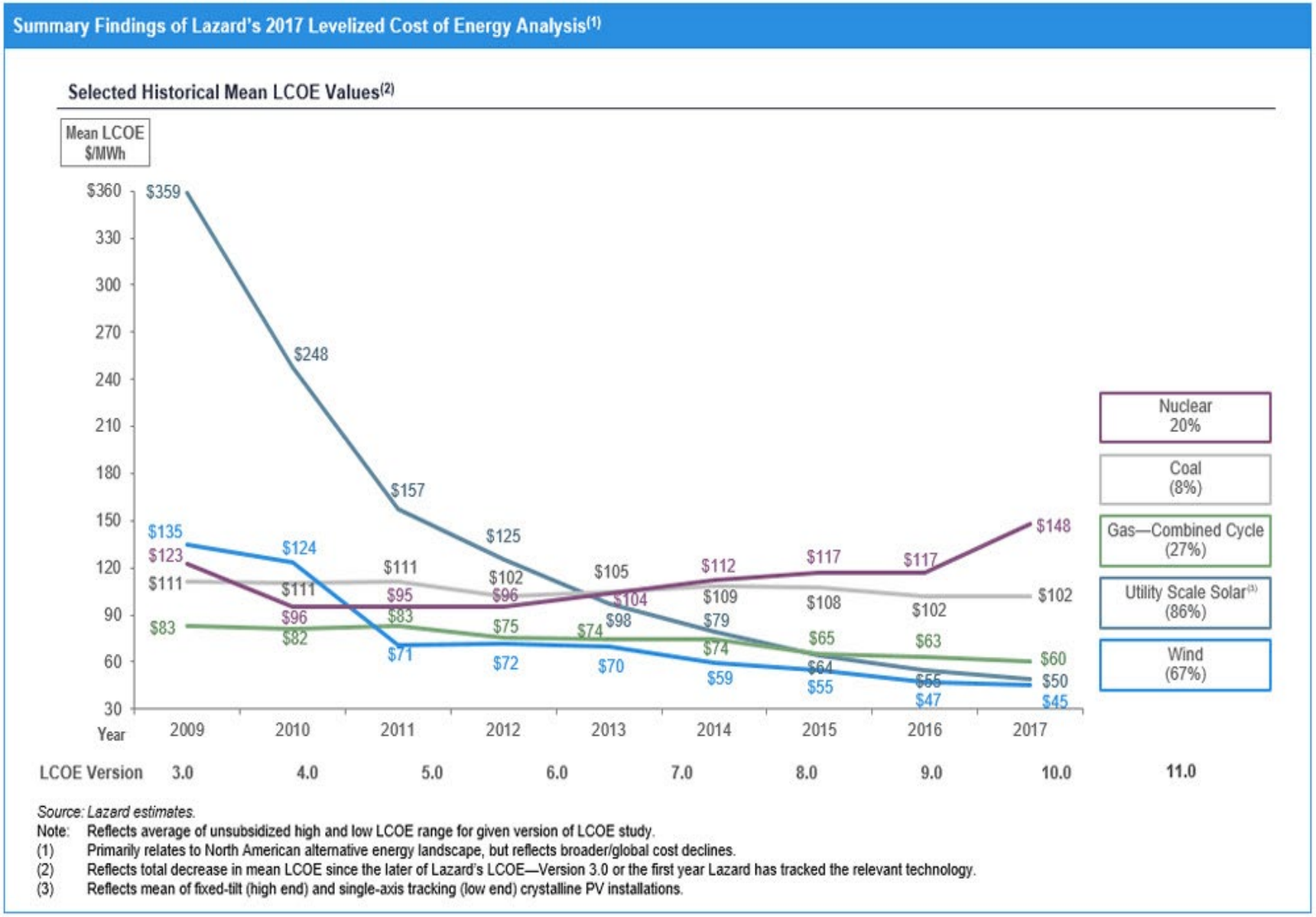
Table A1.2. Disaggregated analysis of global climate flows in CPI (2022) for 2019/2020 (annual average)

		US$ bn	%
Sources split			
Public		334	51
of which	*Development finance institutions*	*237*	*36*
	Multilateral climate funds	*4*	*1*
	State-owned enterprises	*13*	*2*
	State-owned finance institutions	*45*	*7*
	Governments	*32*	*5*
	Other	*3*	*0*
Private		318	49
of which	*Unknown*	*7*	*1*
	Commercial finance institutions	*122*	*19*
	Funds	*5*	*1*
	Households and individuals	*55*	*8*
	Institutional investors	*4*	*1*
	Corporations	*125*	*19*
Instrument split			
Grants		30	5
Debt		409	63
of which	*Low-cost project debt*	*61*	*9*
	Project-level market rate debt	*236*	*36*
	debt	*112*	*17*
Equity		207	32
of which	*Project-level equity*	*51*	*8*
	Equity	*156*	*24*
Unknown		8	1

Thematic split		
Mitigation	586	90
Adaptation	49	8
Dual uses	17	3
Sectoral split		
Energy systems	336	51
Transport	169	26
Land use	16	2
Water and waste	24	4
Industry	7	1
Buildings and infrastructure	52	8
Other and cross-sectoral	48	7
Destination split		
Domestic	494	76
International	158	24

Source: CPI (2022)

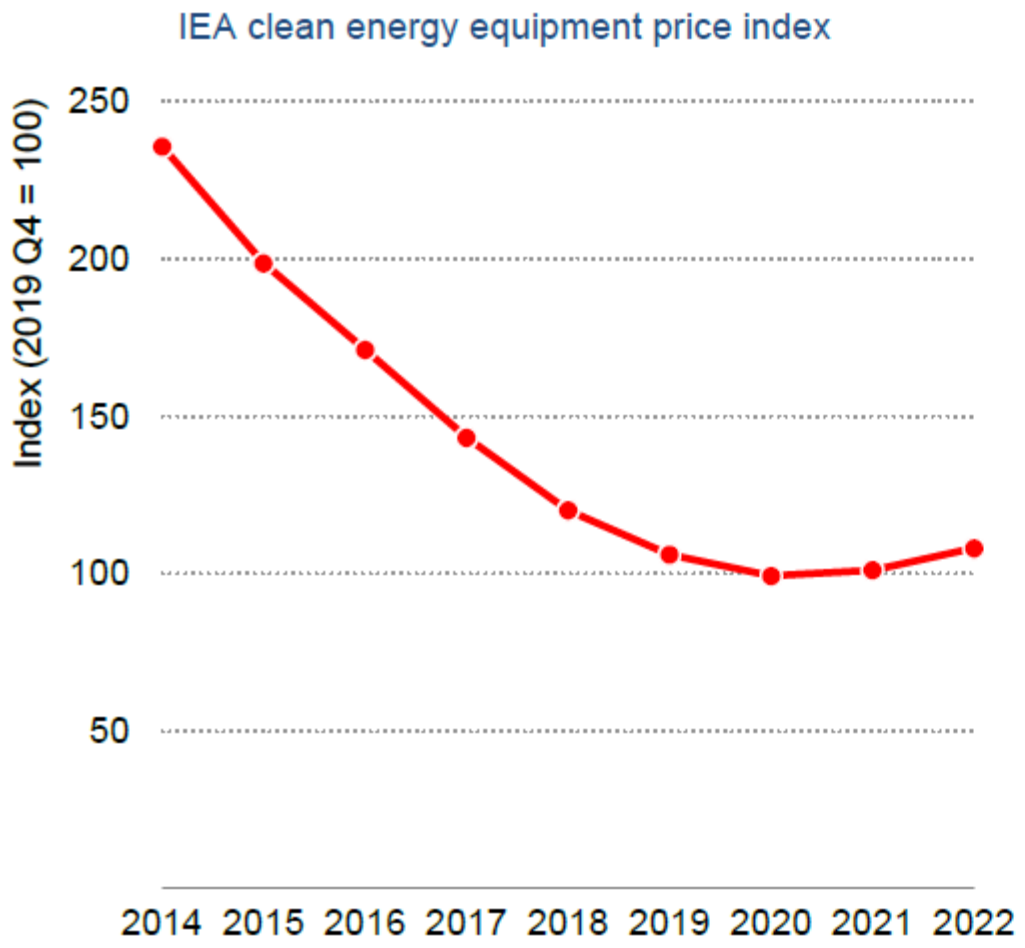
Technological solution #1: Relative costs in energy production changing: a shifting to “renewable”…

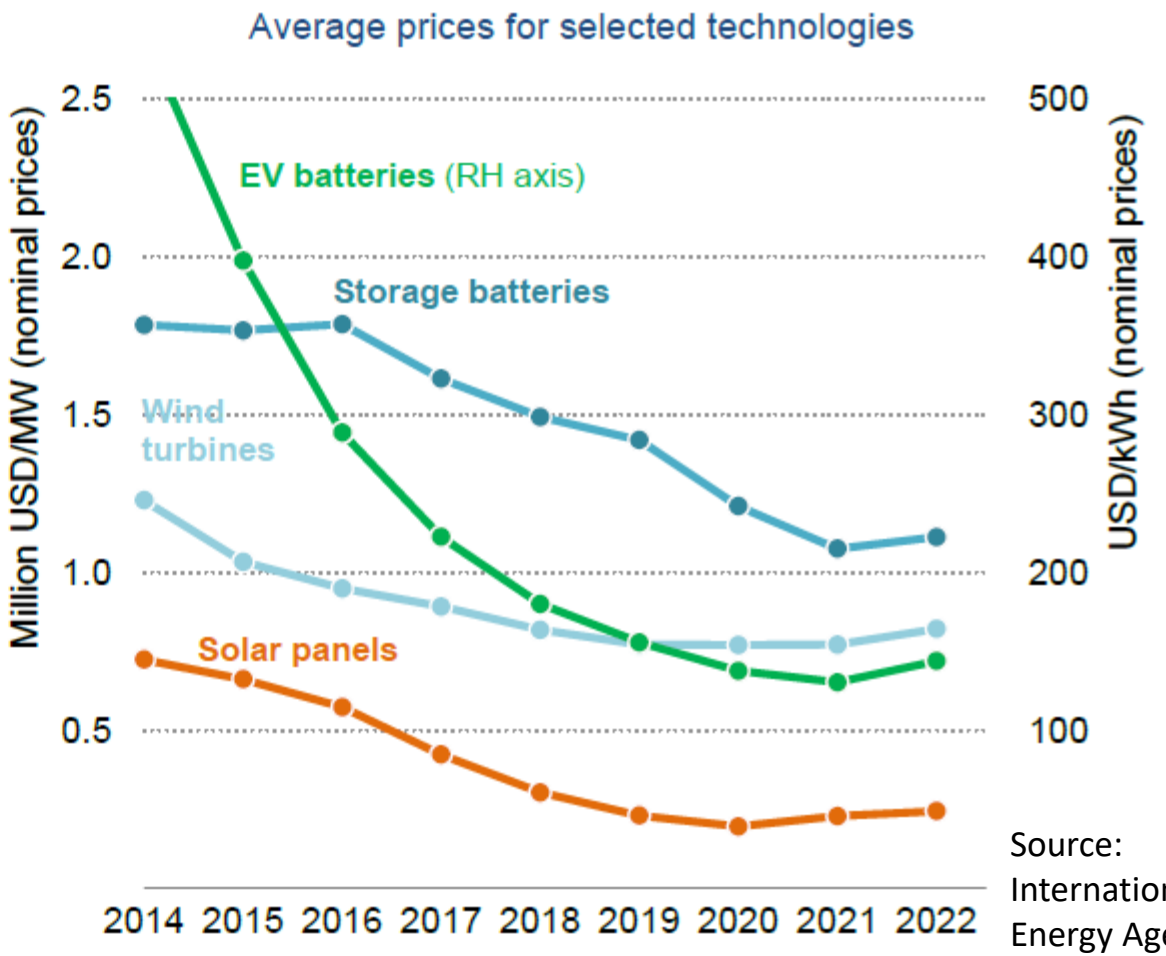


Source: Lazard 2017 Levelized Cost of Energy Analysis

- Key technologies like (i) natural gas per generation (ii) utility-scale wind and (iii) Utility-scale solar are now cheaper on a life time basis than a marginal cost of running nuclear or coal plants
- This is different from years ago
- They could be forced to retire
- Comparison with renewable will be more favorable outside of the US where natural gas is cheap.

Clean energy costs edged higher in 2022, but pressures are easing in 2023 and mature clean technologies remain very cost-competitive in today's fuel-price environment





Source: International Energy Agency Annual Report (2023)

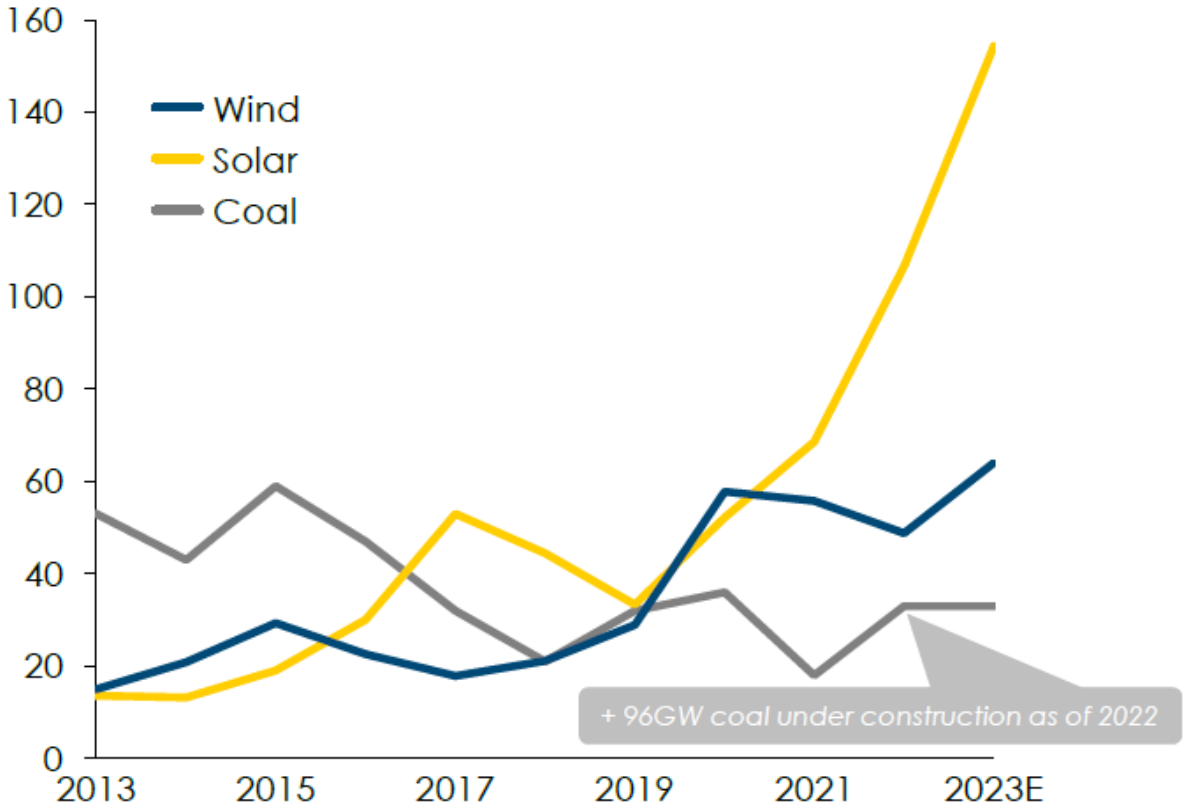
IE

Notes: The IEA clean energy equipment price index tracks price movements of a fixed basket of equipment products that are central to the clean energy transition, weighted according to their share of global average annual investment in 2020-2022: solar PV modules (48%), wind turbines (36%), EV batteries (13%) and utility-scale batteries (3%). Prices are tracked on a quarterly basis with Q4 2019 defined as 100.

Example:
New green energy supply growing (China) but not yet matching demand growth

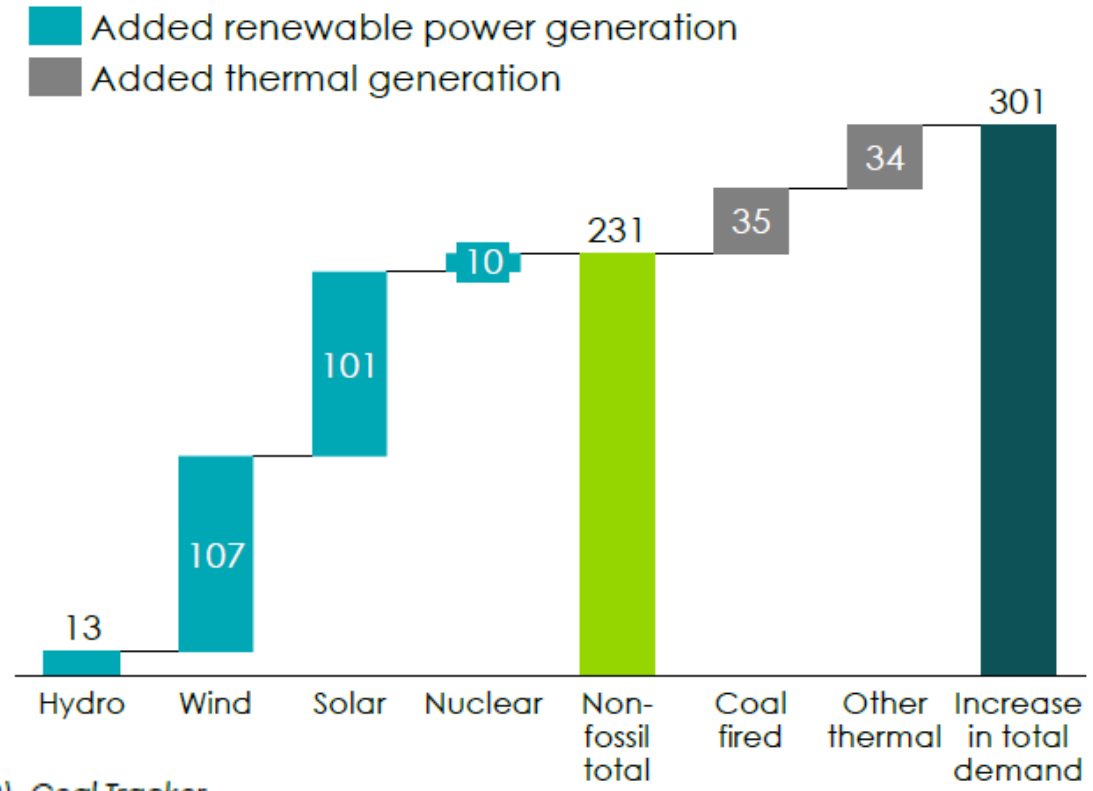
Renewables capacity additions are scaling but 27GW new coal capacity added in 2022

GW



New clean energy generation between 2021-2022 not enough to meet growing demand

TWh



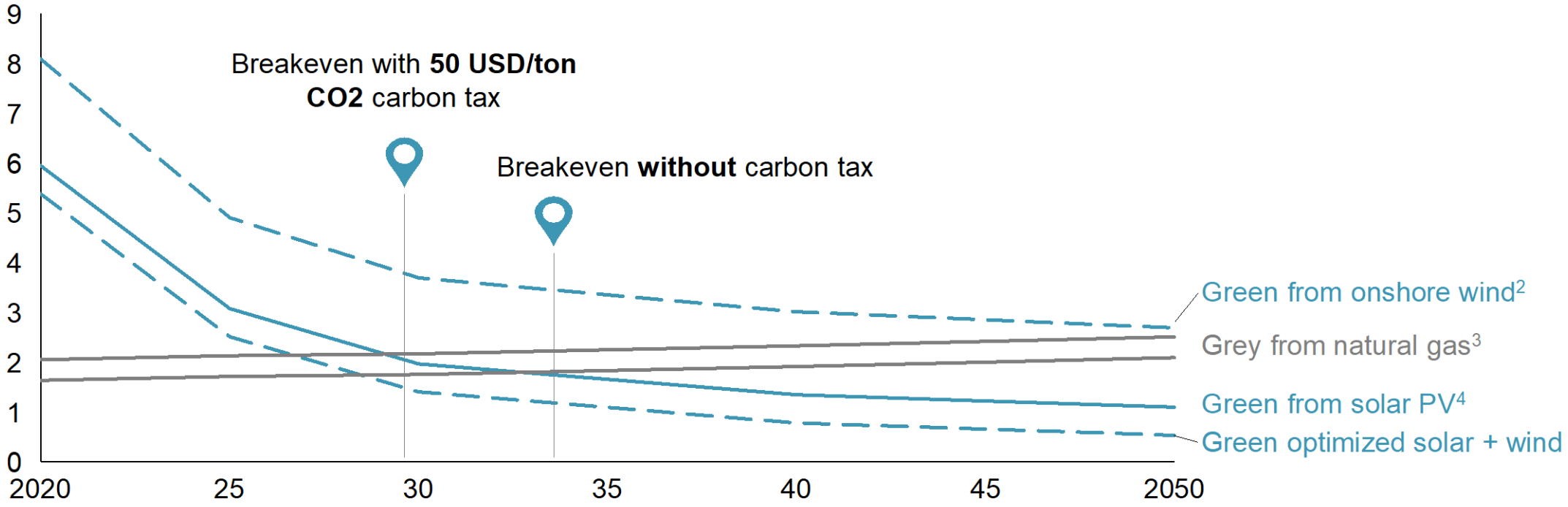
Source: BNEF (2023), *Interactive data tool – generation*; Energy Foundation China (2023), *Coal Tracker*

Example: some developing countries using lower costs of new green technologies (green Hydrogen) ex of Chile

5. Green H2 in Chile could become competitive vs grey H2 by 2030

Hydrogen production cost[1], USD / kg

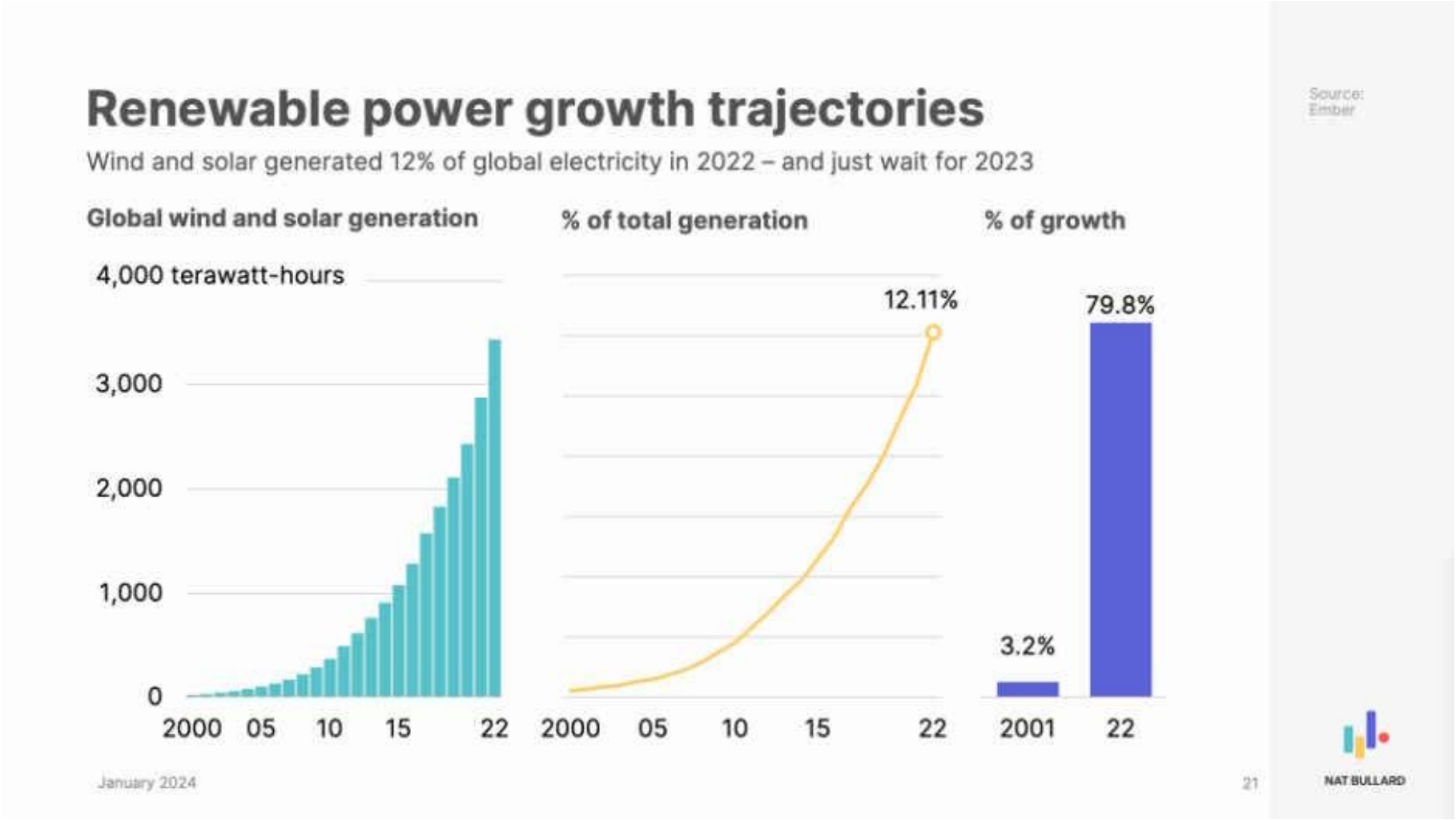
Preliminary



1. Based on 7% WACC
2. Based on onshore wind located in the South with 24% load factor and LCOE decreasing from 59 USD/MWh in 2020 to 46 USD/MWh in 2050
3. Based on steam methane reforming (SMR) and natural gas prices increasing from 8.13 USD/Mmbtu in 2020 to 11.22 USD/Mmbtu in 2050. High case includes 50 USD/ton CO2 carbon tax
4. Based on solar PV located in the North with 28% load factor and LCOE decreasing from 31 USD/MWh in 2020 to 12 USD/MWh in 2050

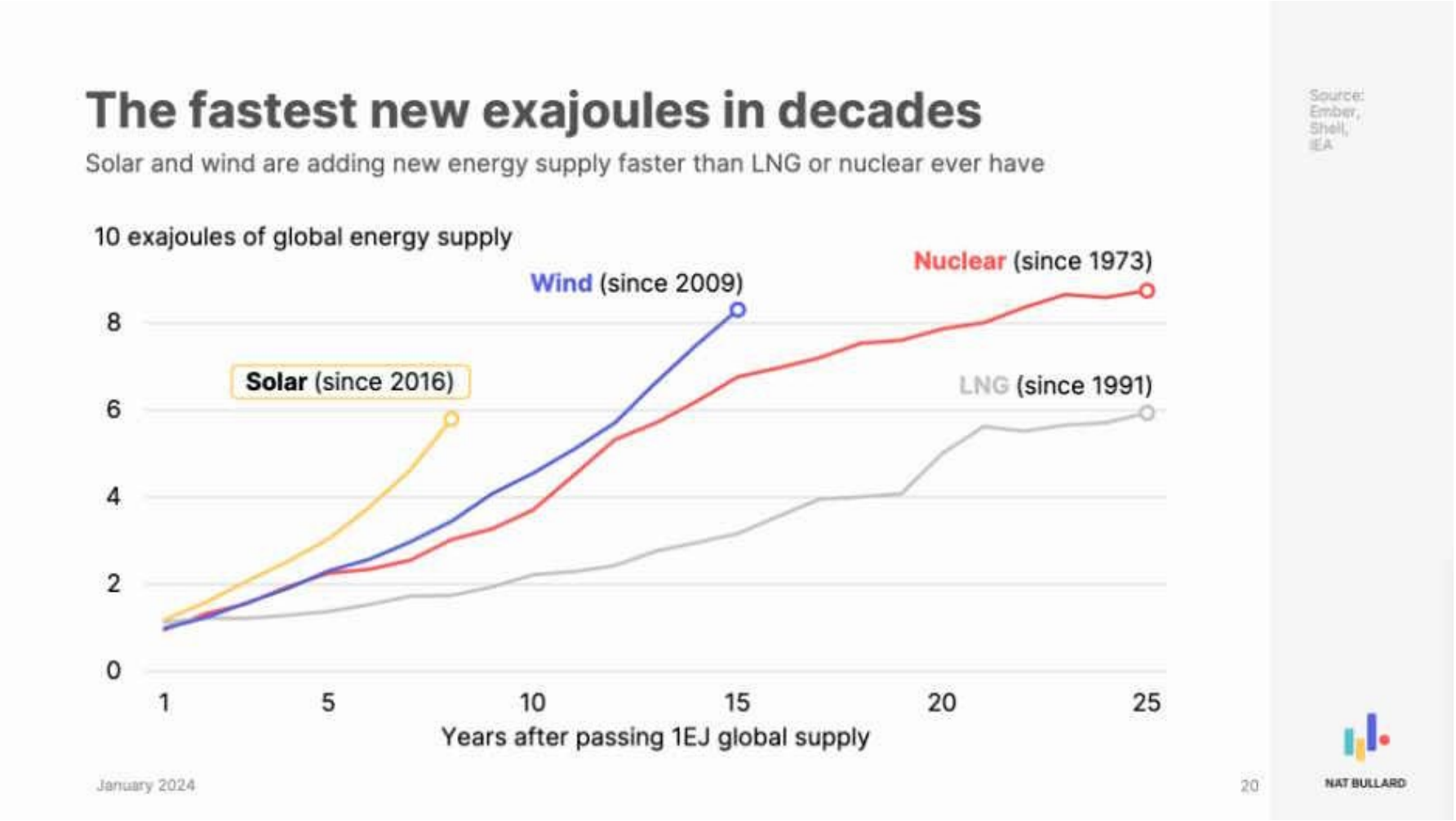
Source: McKinsey Hydrogen Cost Model

Real investment opportunities of the transition to Net Zero: renewable energy sectors



Source: [Nat Bullard]

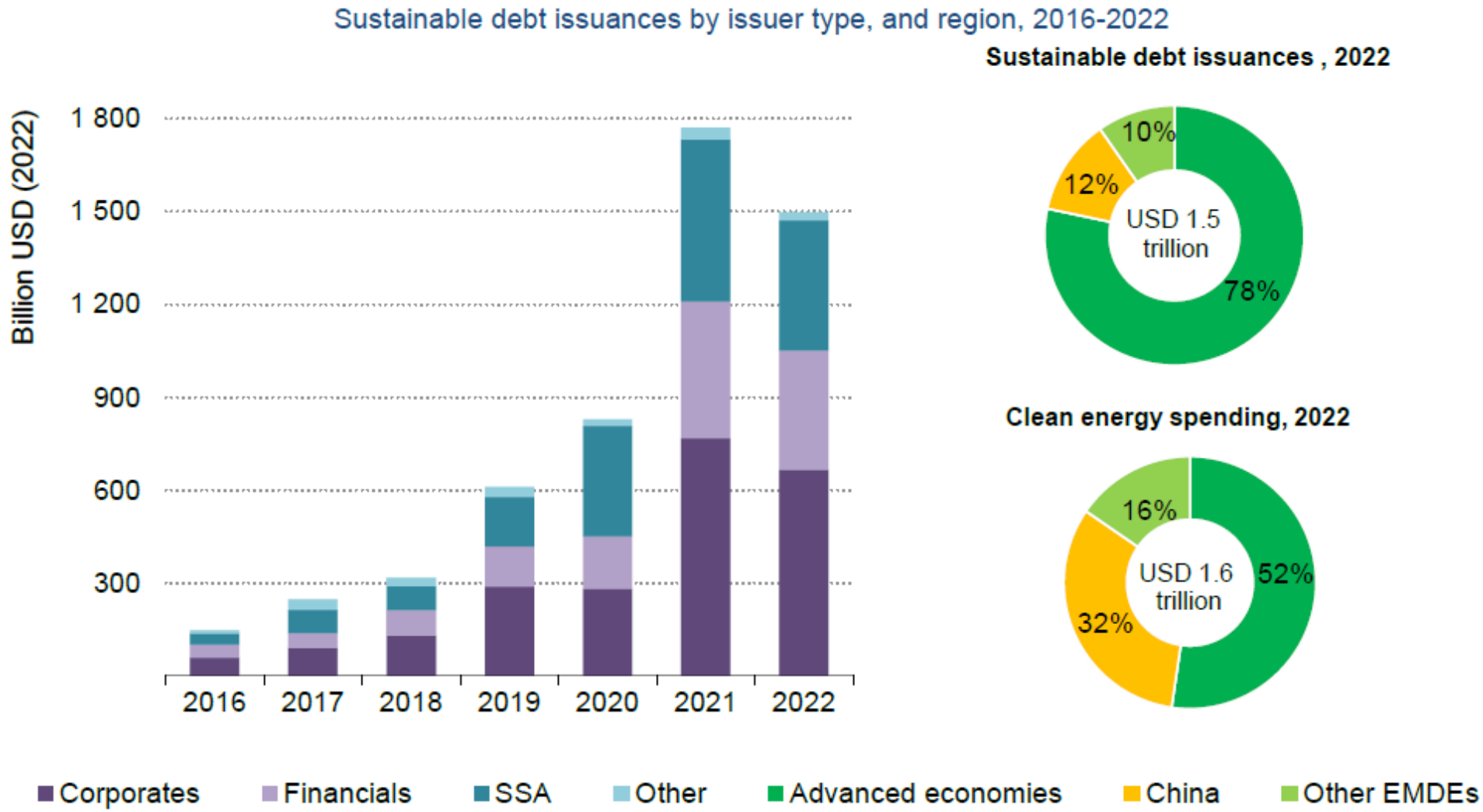
Real investment opportunities of the transition to Net Zero: renewable energy sectors



Source: Nat Bullard

S 11.8. Policy implications (3): The financing of NZ, Green Finance, debt, taxation including carbon

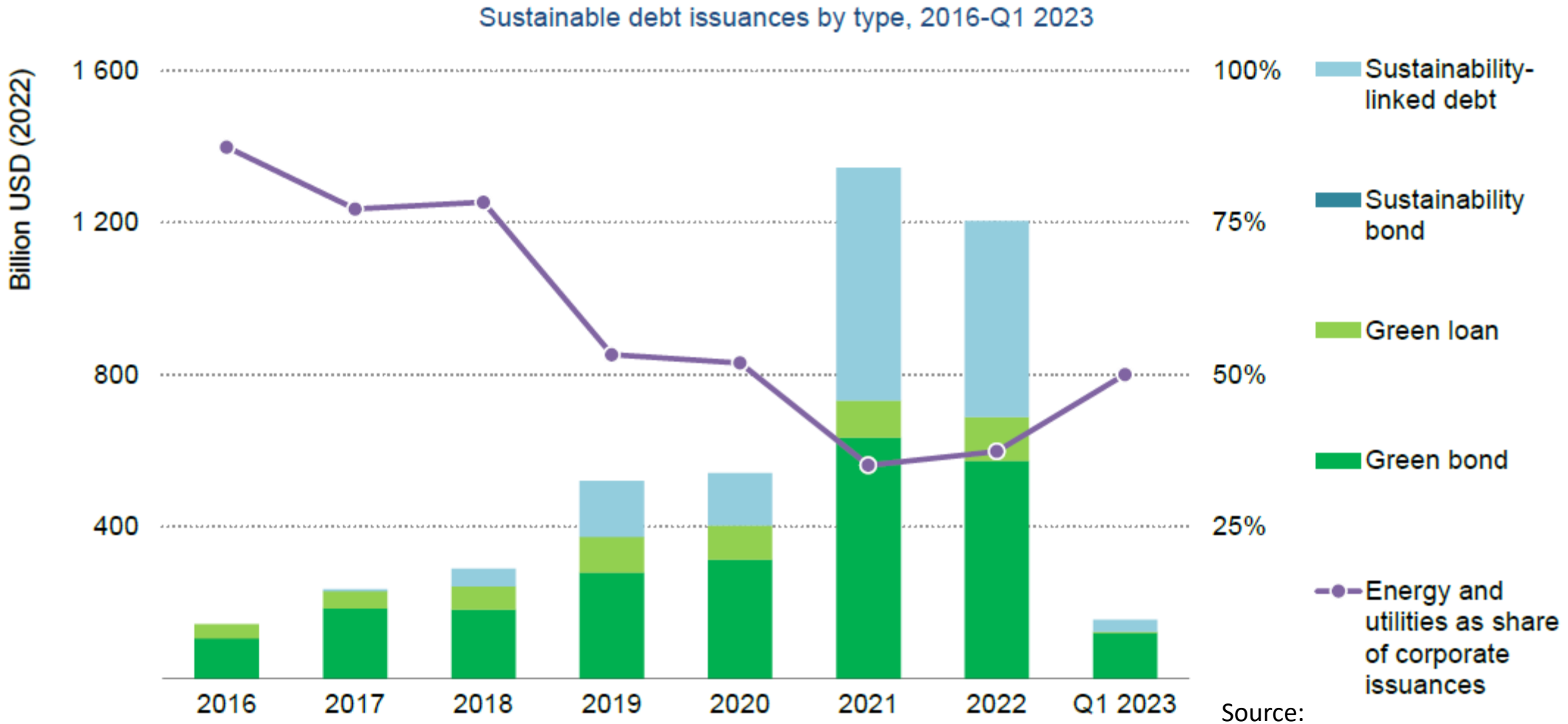
Expanding access to finance will be vital: sustainable finance has weathered the storm of the energy crisis, but remains heavily concentrated in advanced economies



Source: International Energy Agency Annual Report (2023)

Notes: SSA = sovereigns, supranationals and agencies; this category also includes municipals; Other = asset-based securities and project bonds.
Sources: Bloomberg; Refinitiv.

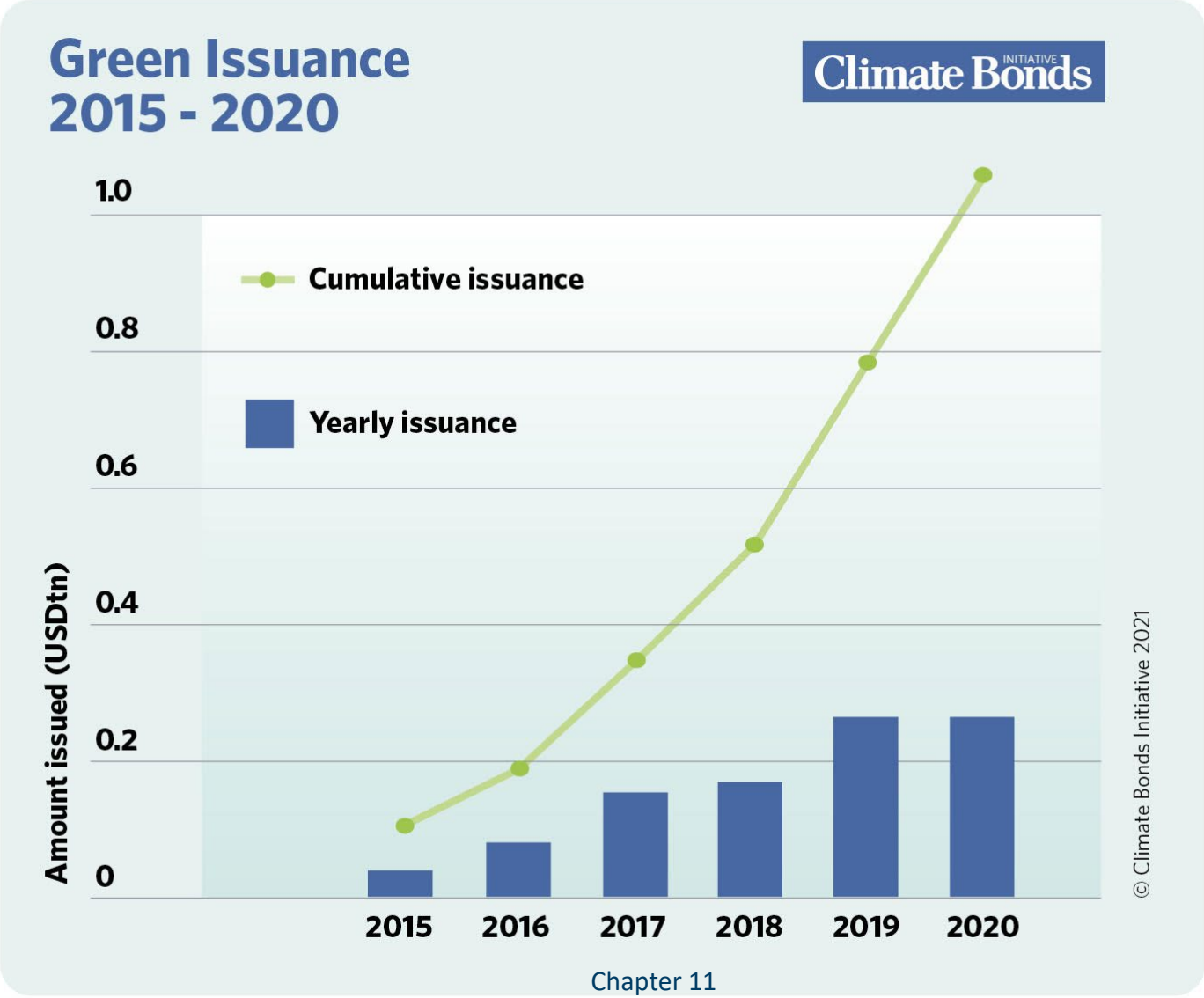
Labelled sustainable debt issuances fell in 2022 for the first time, but were still significantly higher than in 2020, including from issuers of corporate energy and utility debt



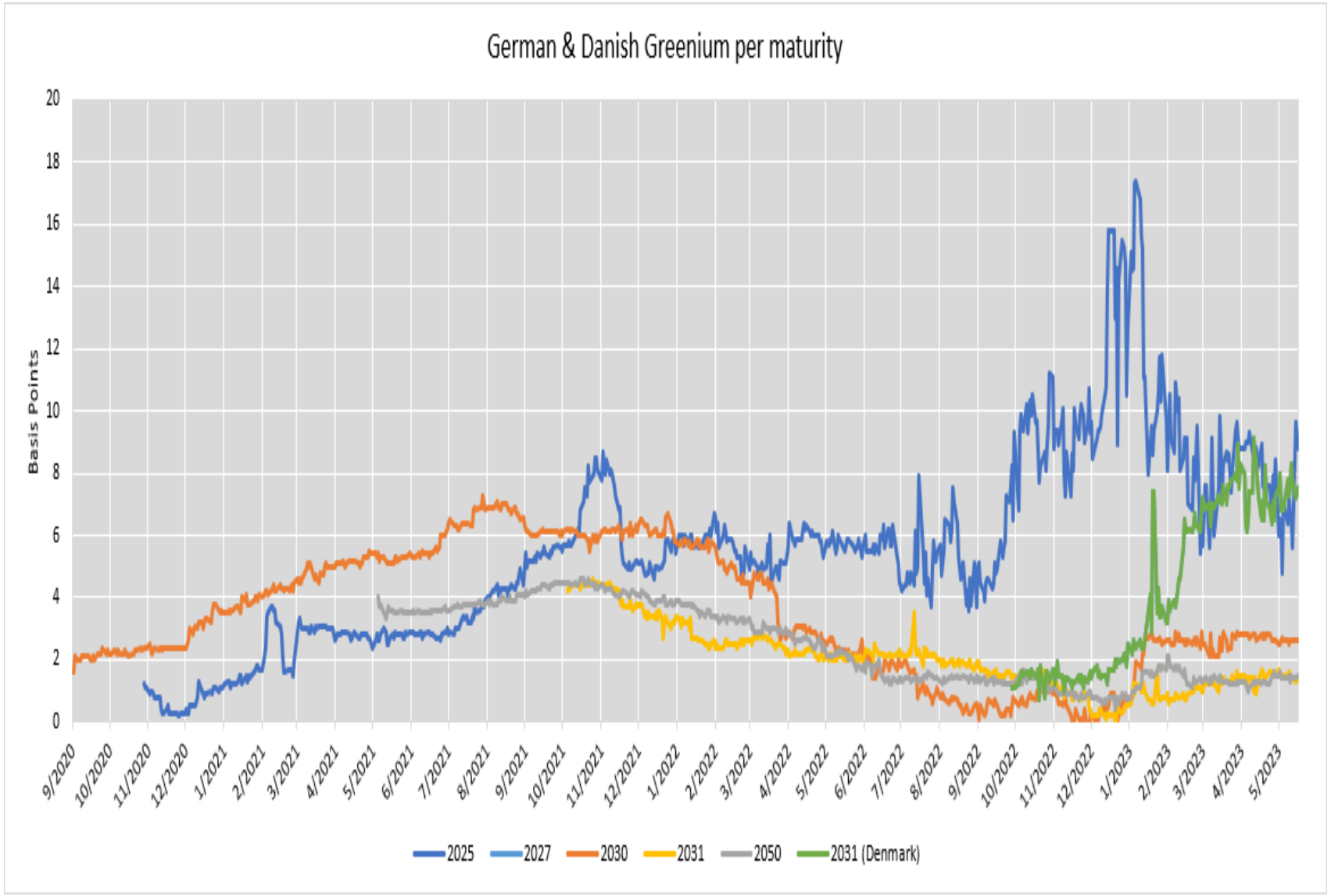
Source: IEA analysis based on data from Bloomberg (2023).

Source: International Energy Agency Annual Report (2023)

Financial solution #1: Green Finance is making progress with Green bond issuances, market is growing fast

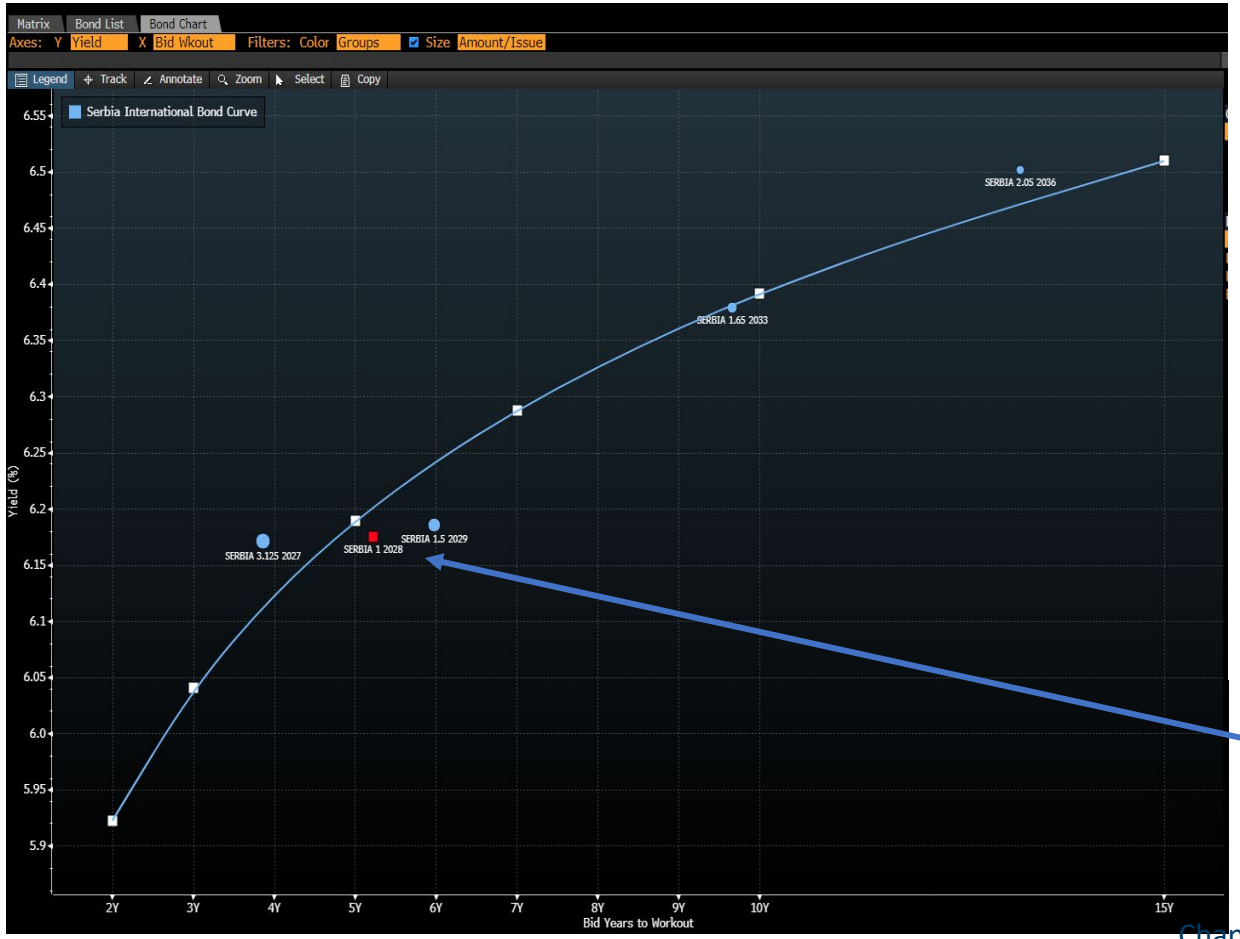


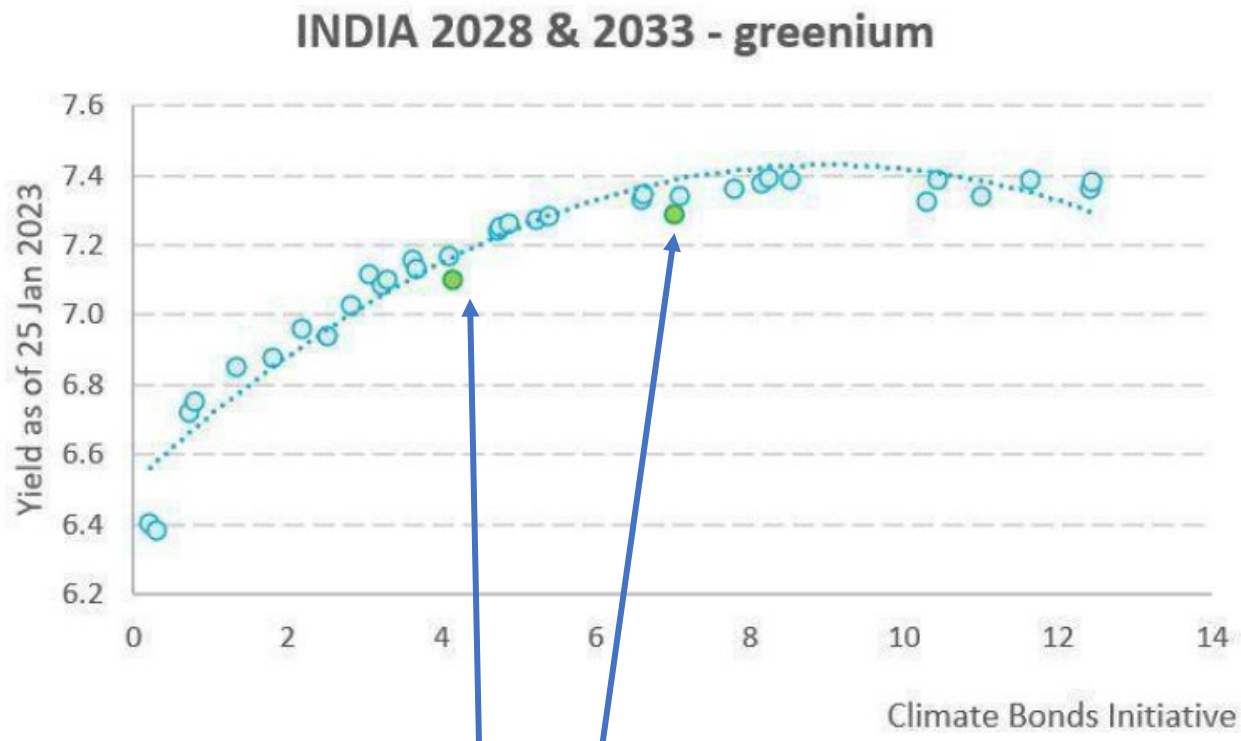
Easier for rich countries: green bond markets showing “green premia”



But also true for developing countries: some sub-IG bond green issuances showing “green premia”

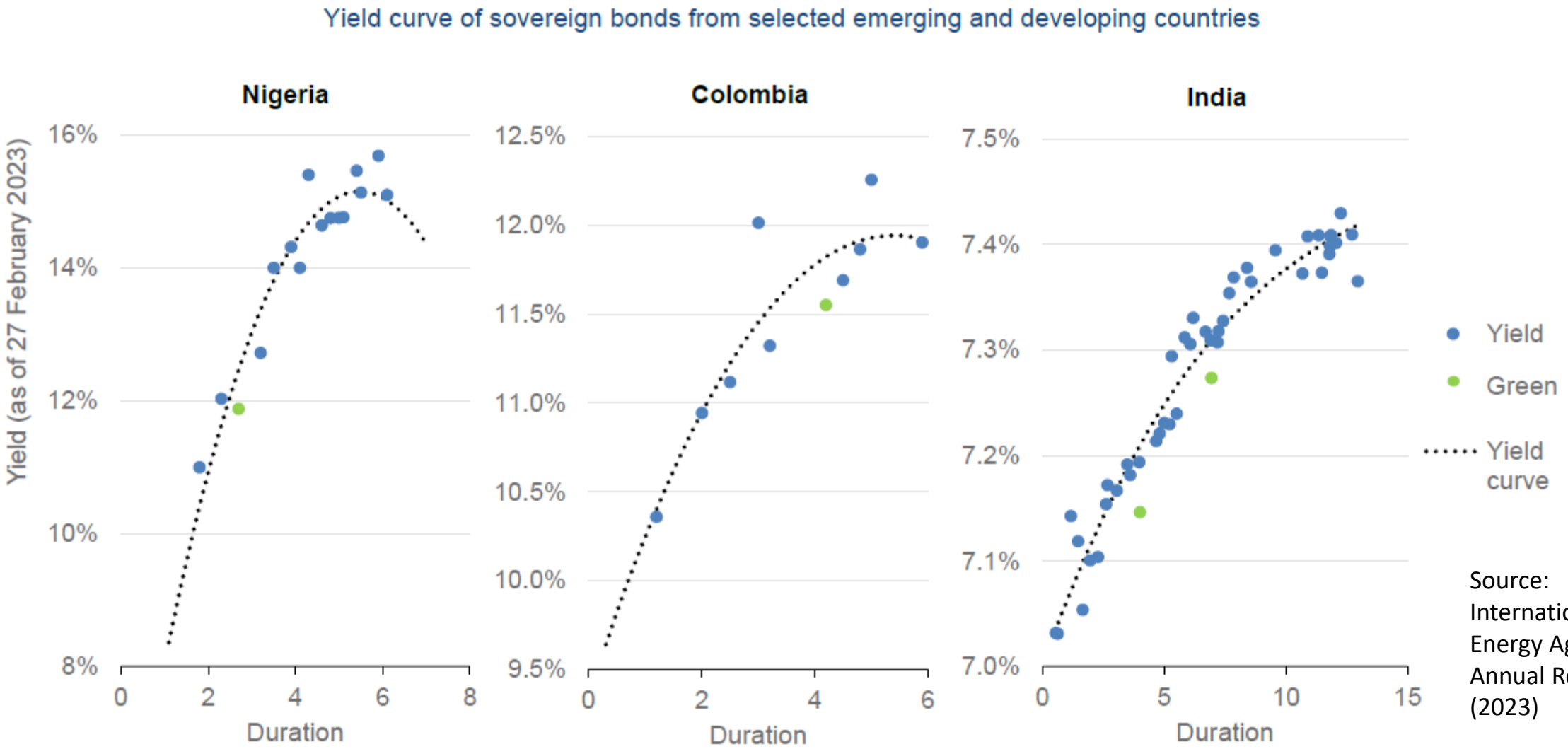
Serbia (~BB rating) Green Bond (red dot) yield compared to other yields of its issuances (July 2023)





Green bond issuance Cost, below yield curve

Sovereign green bonds in EMDEs have benefited from a greenium, demonstrating their value as a tool for governments that already have high debt burdens



Source: International Energy Agency Annual Report (2023)

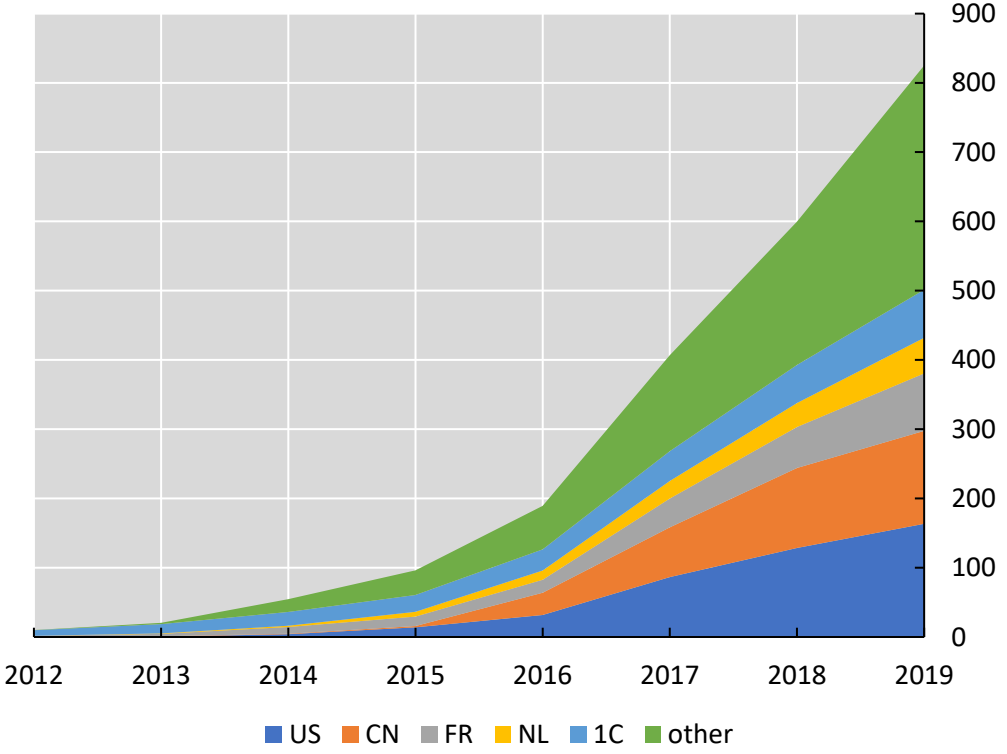
Sources: IEA analysis based on data from Refinitiv and Bloomberg (2023).

Financing of transition and mitigation, the example of “Green Bonds”

- Europe has led global issuance and Asia-Pacific region is catching-up.
- Green bond label granted if individual projects are deemed sufficiently in line with the Green Bond Principles (GBPs) of the International Capital Market Association (ICMA), and the use of proceeds can be ascertained.

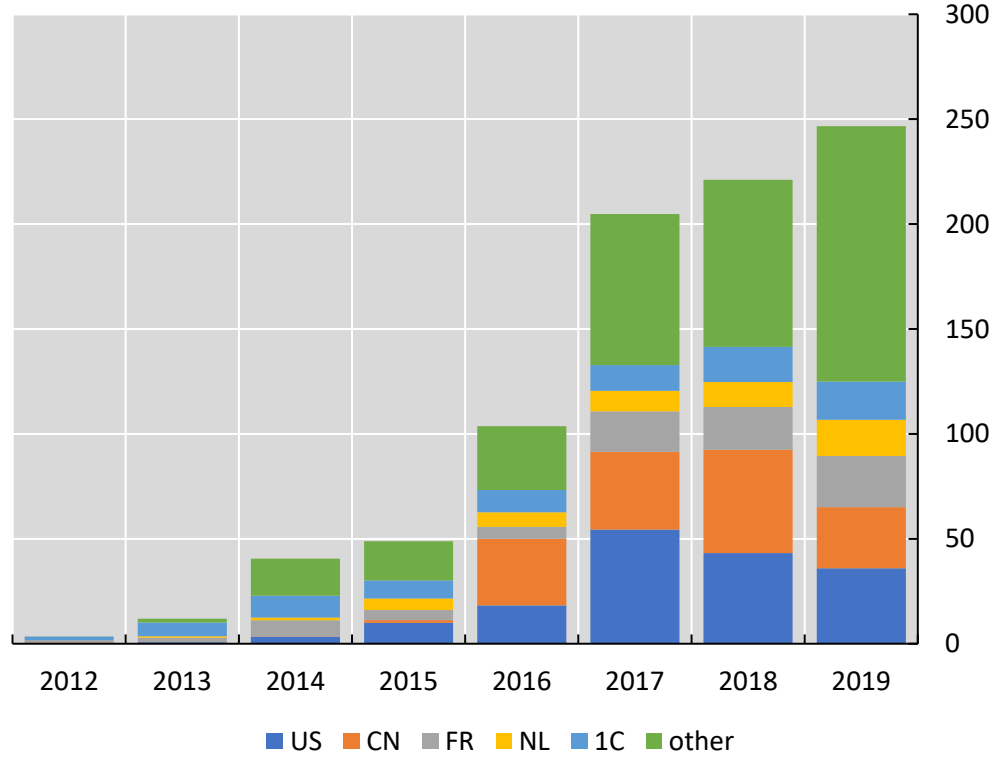
Outstanding green bonds by headquarter country

USD billion



Gross issuance of green bonds by headquarter country

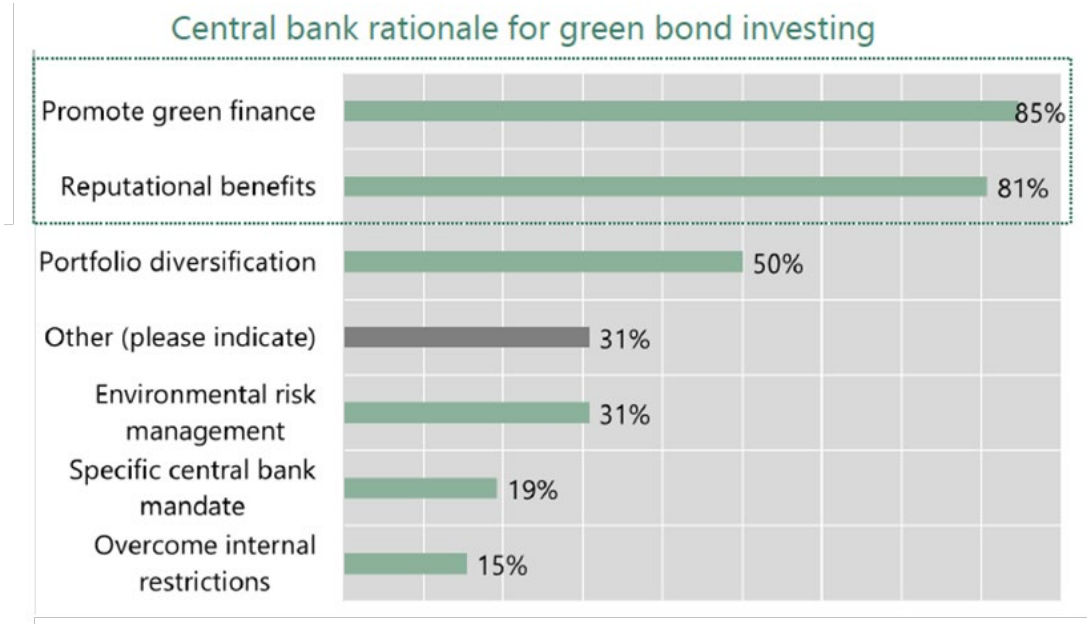
USD billion

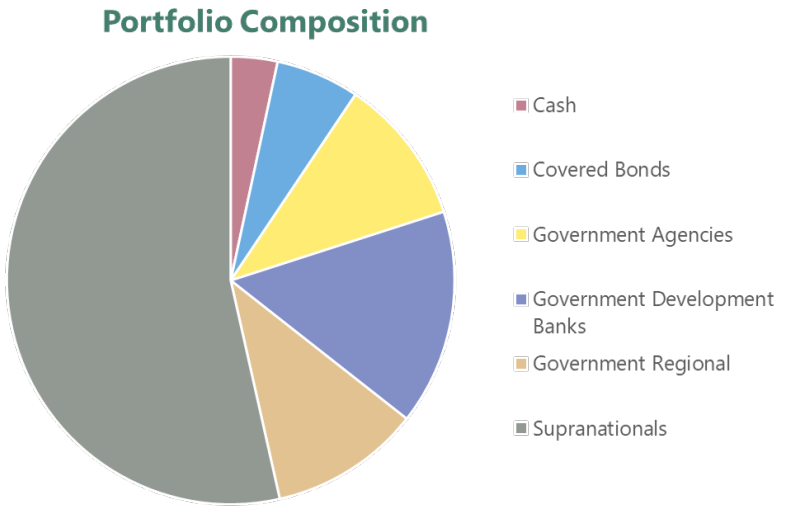


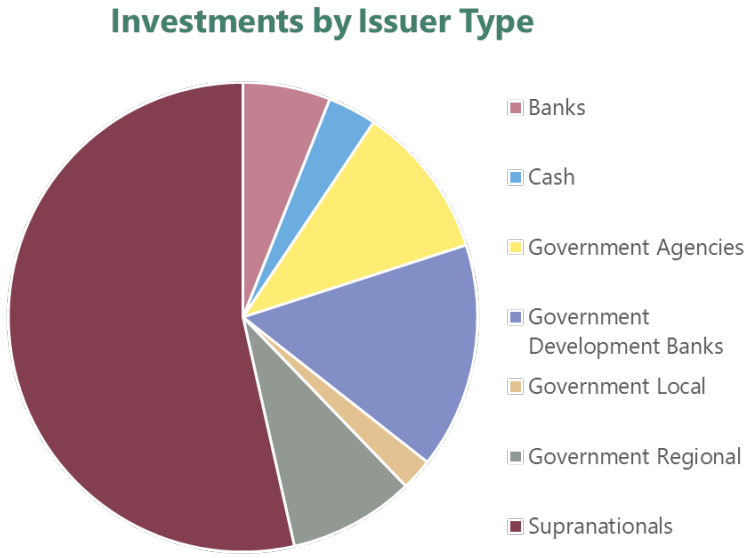
Sources: Climate Bond Initiative, Dealogic and ICMA. Data as of-end September, 2019; BIS calculations.
US = United States, CN = China, FR = France, NL = Netherlands, 1C = International Organisation.

Bank for International Settlements: Green Bond investment pools

- Development of Green Bond BIS investment pools (BISIPs) in USD and EUR in 2019.
- Launched in cooperation with a group of 26 global central banks to meet specific central bank needs.
  - USD Green Bond BISIP launched in Sept 2019: currently 7 central bank investors; fund size is above USD 1 billion.
  - EUR Green Bond BISIP exp. to be launched in early 2021
- Green Bonds comply with the ICMA Green Bond Principles and CBI Climate Bond Standard; enhanced due diligence process when purchasing green bonds to ensure greenness.





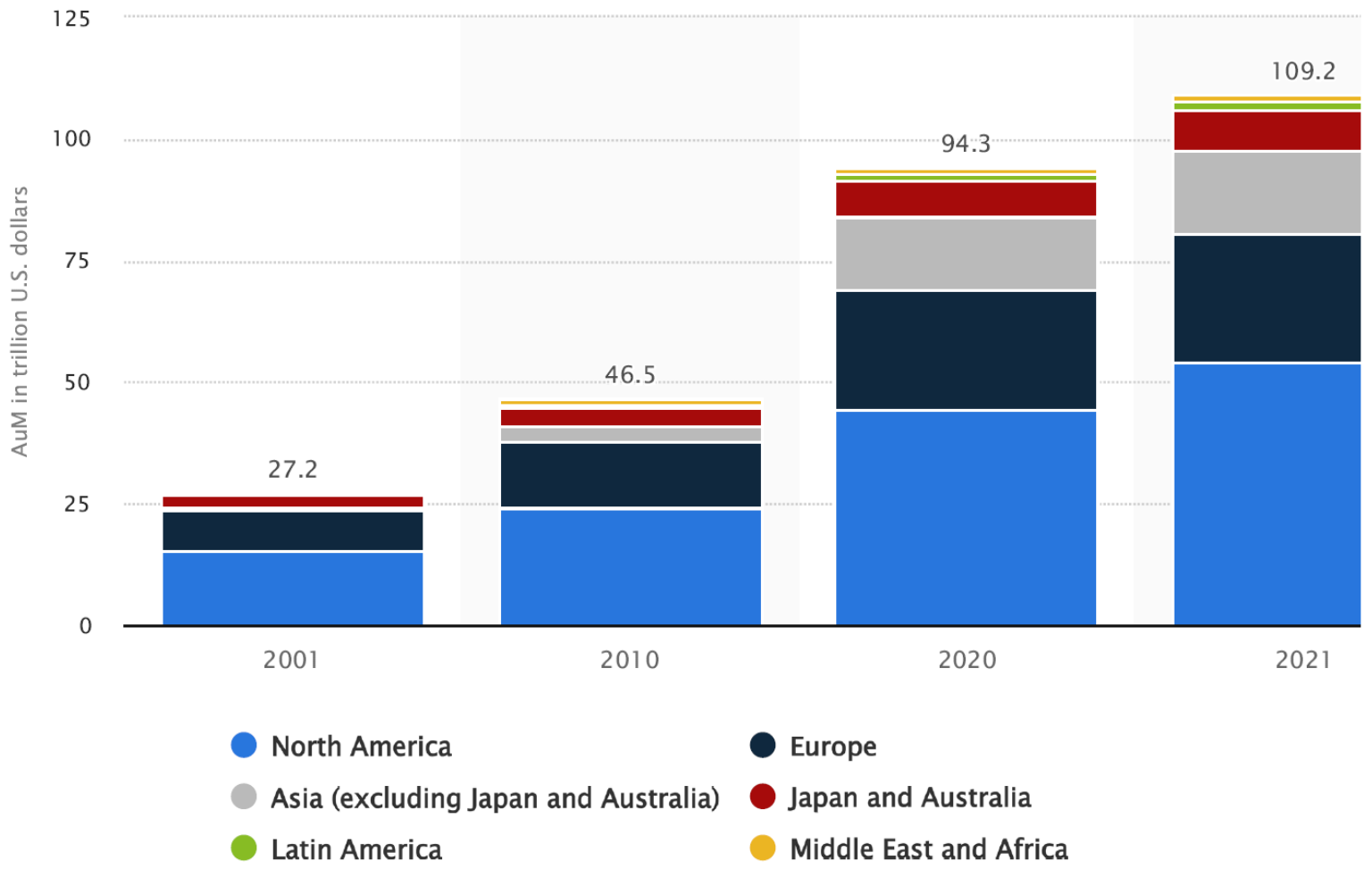


Financial solution # 2: where more financing could come from? Incentivize Private Large Asset Managers to diversify risks

Top 10 global managers

	Change	Company	Total AUM (€m
1	–	BlackRock	7,091,39
2	–	Vanguard Asset Management	5,931,34
3	–	Fidelity Investments	3,093,46
4	–	State Street Global Advisors	2,833,93
5	–	Capital Group	1,948,19
6	–	J.P. Morgan Asset Management	1,947,04
7	↑	PIMCO	1,805,79
8	↓	BNY Mellon Investment Management	1,802,21
9	–	Amundi	1,728,77
10	–	Goldman Sachs Asset Management	1,598,06

Source: IPE Research



GFANZ 500 firms, circa $130 tr AUM

Net-zero Asset Owner Alliance (NZAOA)

Net-zero Asset Managers Initiative (NZAM)

Paris Aligned Asset Owners (PAAO)

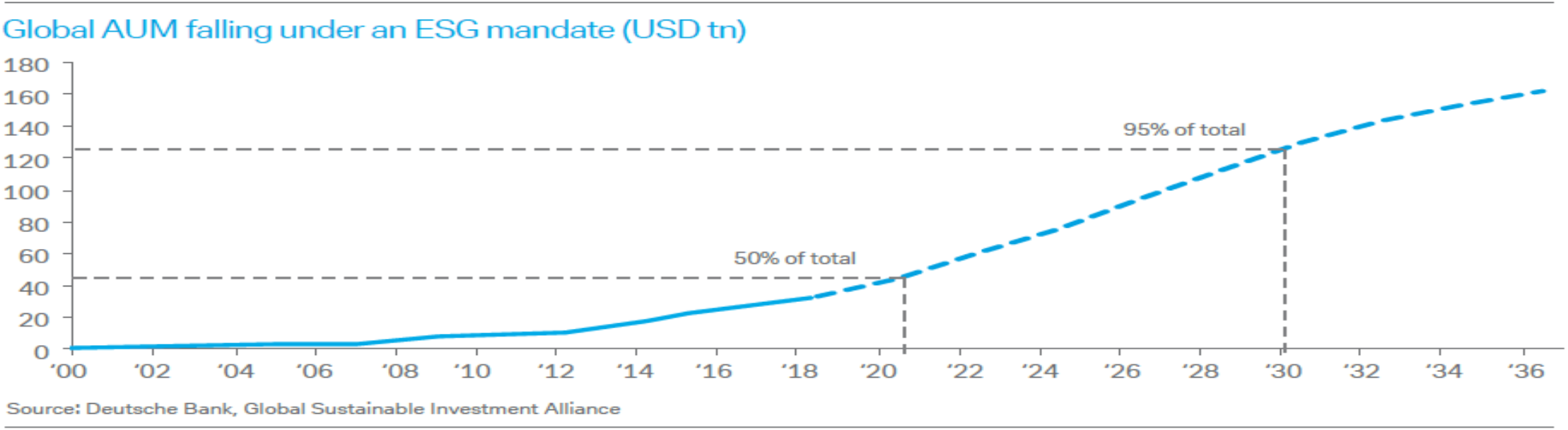
Net-zero Insurance Alliance (NZIA)

Net Zero Financial Service Providers Alliance (NZFSPA)

Net Zero Investment Consultants Initiative (NZICI)

Net-zero Banking Alliance (NZBA)

Financial solution #3: Improve Taxonomy for Investors ESG assets expected to continue to grow



ESG market could keep on growing :

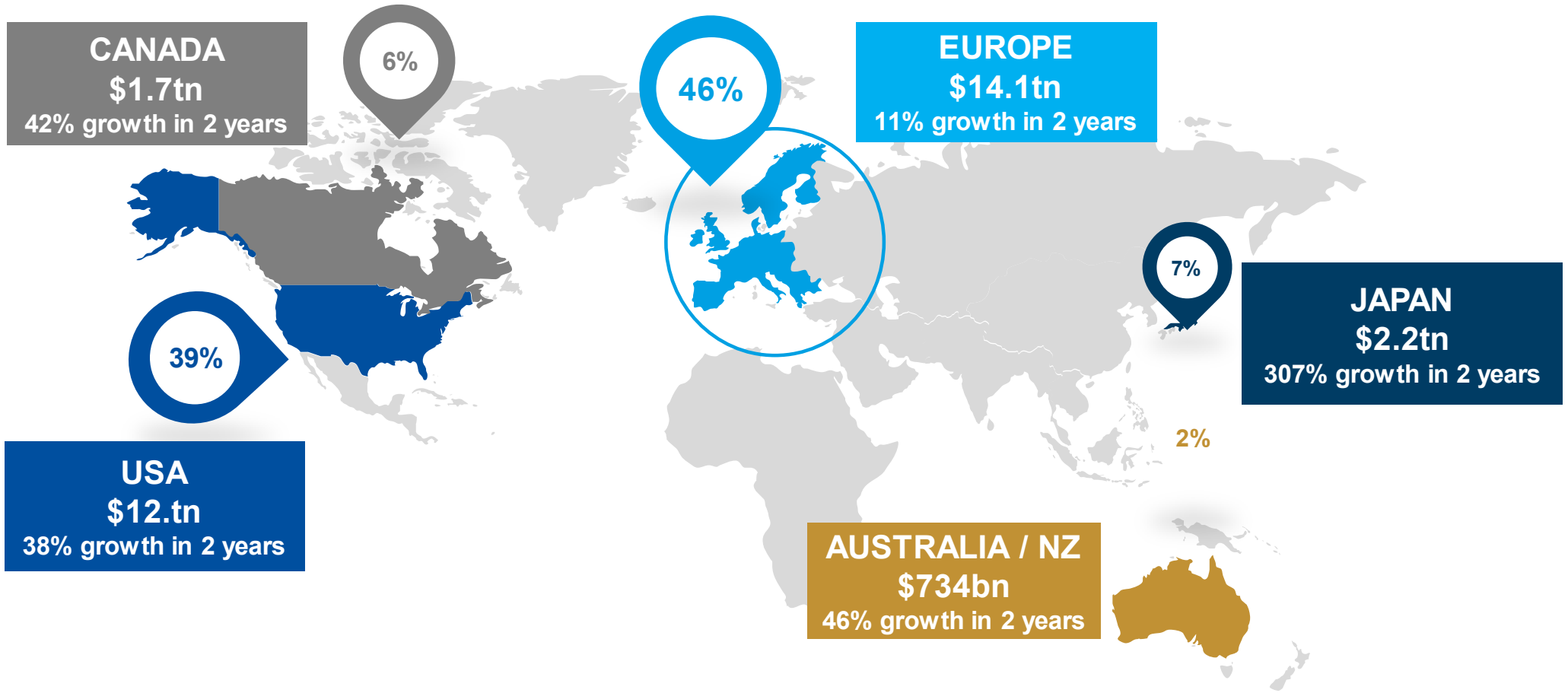
- From $30tn (about on third of total AUM now)…
- …towards $45tn (50% of total AUM) in 2021
- …and even $125tn (95% of total AUM) in 2030

ESG assets → opportunities, a Global $30-40trn (?) Market

$30.7tn
Global Responsible Investment

~ 40%*
of Global Assets under management

+34%
Growth in 2 years



CANADA
$1.7tn
42% growth in 2 years

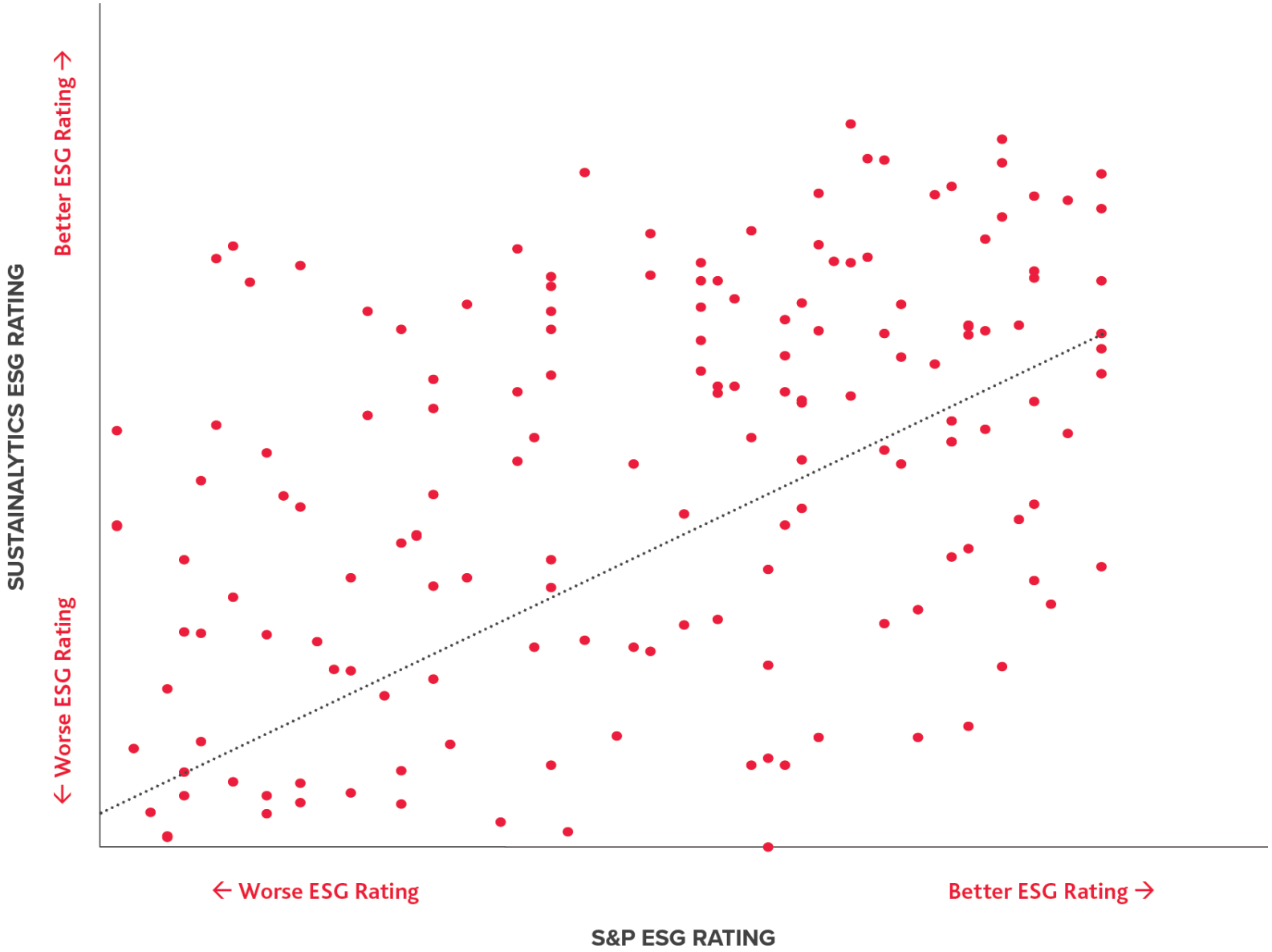
EUROPE
$14.1tn
11% growth in 2 years

JAPAN
$2.2tn
307% growth in 2 years

USA
$12.tn
38% growth in 2 years

AUSTRALIA / NZ
$734bn
46% growth in 2 years

Investors to pay attention: correlations between ESG indexes

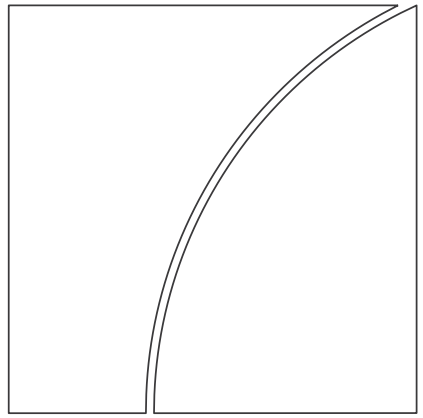


Decarbonize investment portfolio:

Goal: build 1,5C or 2C or higher, compatible financial investment portfolio (issue for AM, Pension Funds, etc)

Method: use “green taxonomy”, ESG, PRI, etc; also observe that **CO2 emissions concentrated in small number of issuers / assets**;

- cut marginal issuers and replacing them by lower emitters in same asset class (eg., geographically or risk category);
- repeat cuts progressively for number of years;
- simulated return is not significantly different, “greener” issuers have better financial performance
- incentive for emitters to reduce GHG and regain market demand



BANK FOR INTERNATIONAL SETTLEMENTS

BIS Working Papers

No 985

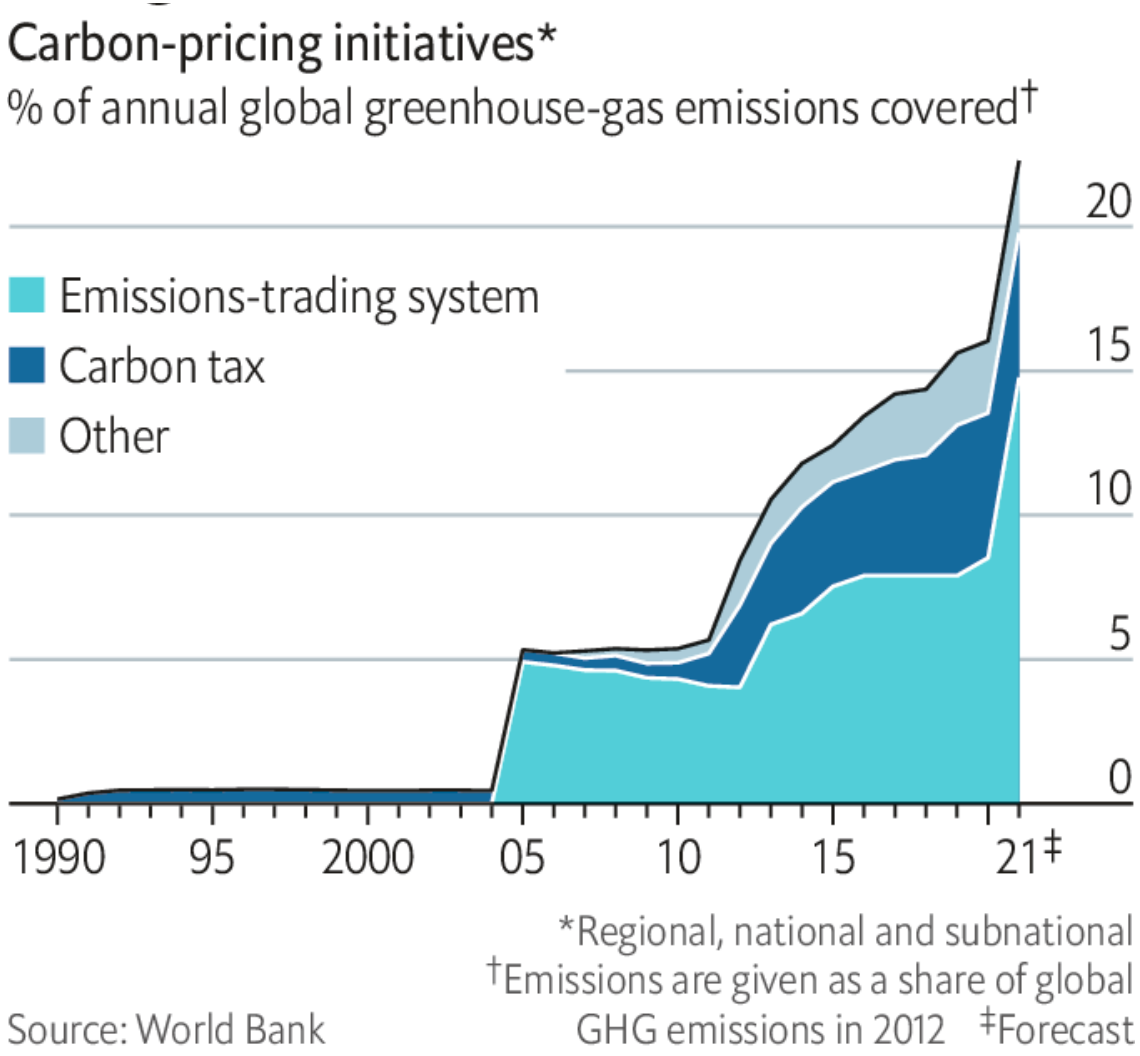
Building benchmarks portfolios with decreasing carbon footprints

by Eric Jondeau, Benoît Mojon, and Luiz Awazu Pereira da Silva

Monetary and Economic Department

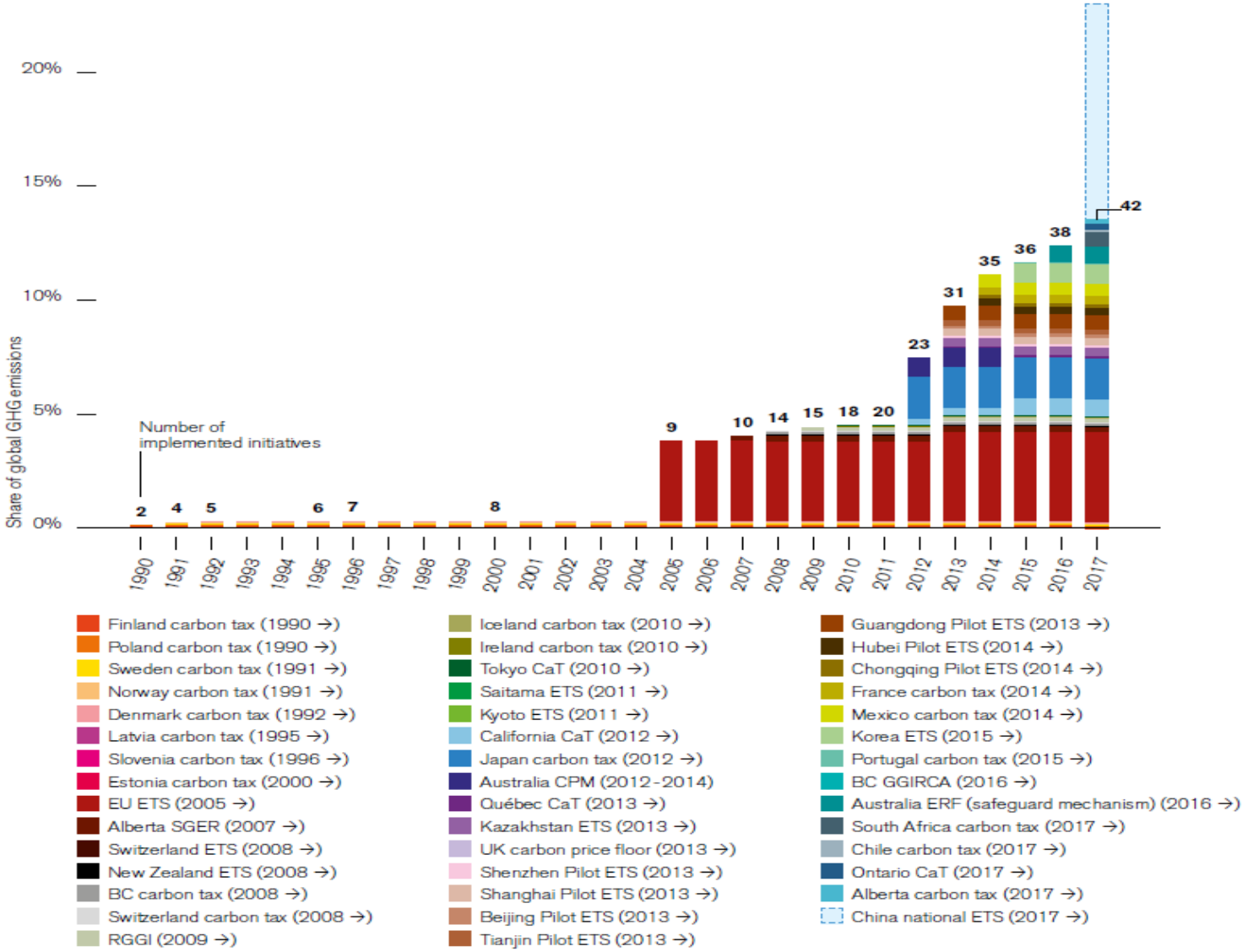
December 2021

Carbon Initiatives clear acceleration in recent years



Source: The Economist, 19th September, 2020

Carbon Initiatives clear acceleration in recent the recent years



Note: Only the introduction or removal of an ETS or carbon tax is shown. Emissions are given as a share of global GHG emissions in 2012. Annual changes in global, regional, national, and subnational GHG emissions are not shown in the graph. Data on the coverage of the city-level Kyoto ETS were not accessible and the British Columbia Greenhouse Gas Industrial Reporting and Control Act (GGIRCA) does not cover any emissions yet; their coverages are therefore shown as zero. The information on the Chinese national ETS represents early unofficial estimates based on the Chinese President's announcement in September 2015.

Clear acceleration:

- Since 2016, 8 new initiatives and 2 more planed in 2018
- Once the Chinese national ETS is implemented emissions covered by carbon pricing will represent between 20 to 25% GHG emissions.

US:

- Set back at the federal level
- But Washington State's launch of a baseline-and-credit ETS in 2017 and the extension of the California ETS until 2030. Massachusetts is scheduled to launch its own state-level ETS and Oregon and Virginia are working to introduce carbon pricing

Carbon price in EU ETS around Euro 70-100 / ton in recent years

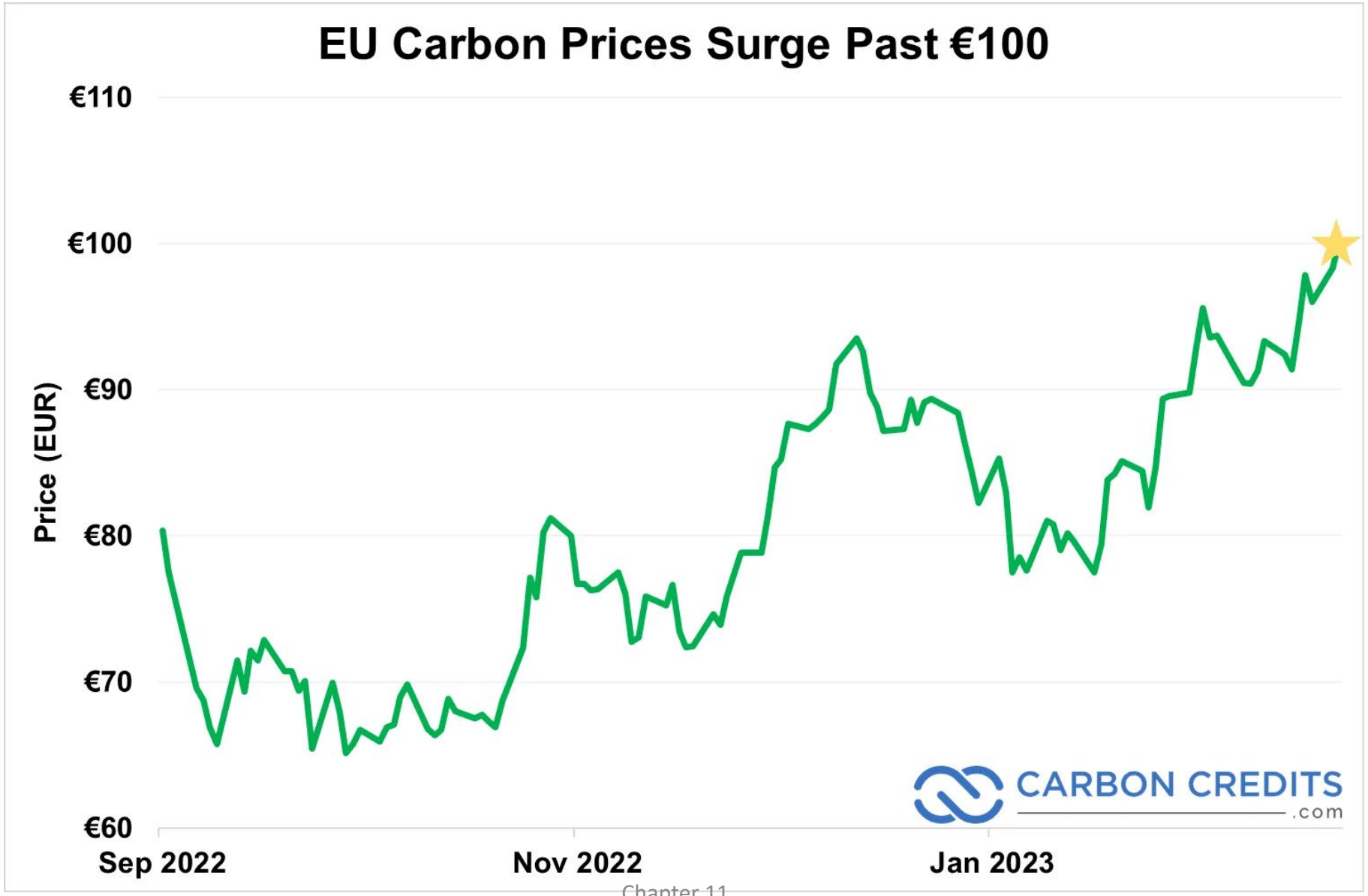


Table 1: New and innovative funding sources for climate finance at global level

Sources: Estimations based on the studies quoted in the respective chapters of the report

Source description	Est. annual financial revenues/US$	Calculation base /US$	When can it start?	Climate justice
Fossil fuel extraction levy Agreed at UNFCCC or coalitions of countries, implemented by national tax authorities	US$ 210 billion	$5 / ton CO2, base year 2021	Unclear	High
Air passenger levy Agreed by coalitions of countries or at ICAO	US$ 4-150 billion	Various levy rates, base year 2021	2025-2027	Medium - High
Maritime levy Agreed at IMO, implemented by IMO	US$ 60 billion	$100 / ton CO2eq, base year 2026	2027-8	High
Wealth tax Coordinated by coalition of willing countries, implemented by national tax authorities	> US$ 1 trillion	1% per year on wealth over $1 million, base year 2016	Unclear	High

Note on methodology: Estimated financial volumes at global level face particular limitations. The estimated revenues can also fluctuate significantly over time and annual revenue estimates are static estimates rather than post-behavioural. Studies on which the figures are based do not use unified base years which limits comparability.

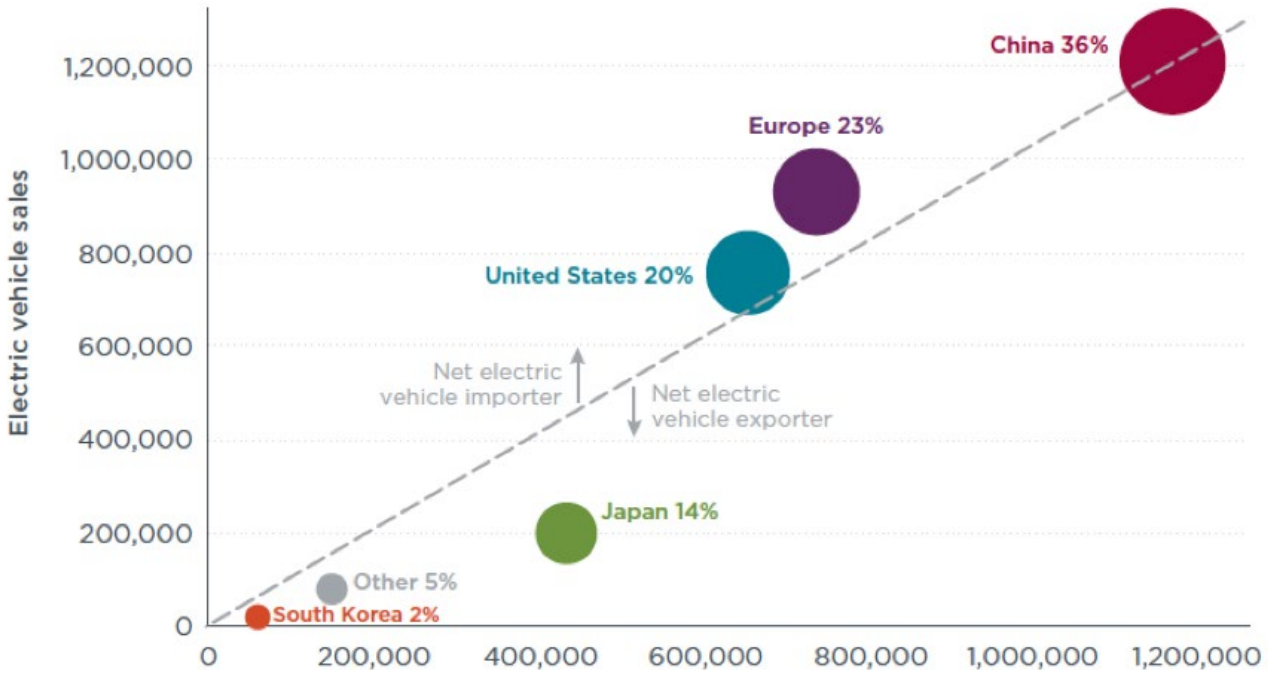
Source: Carbon Action Network (2023)

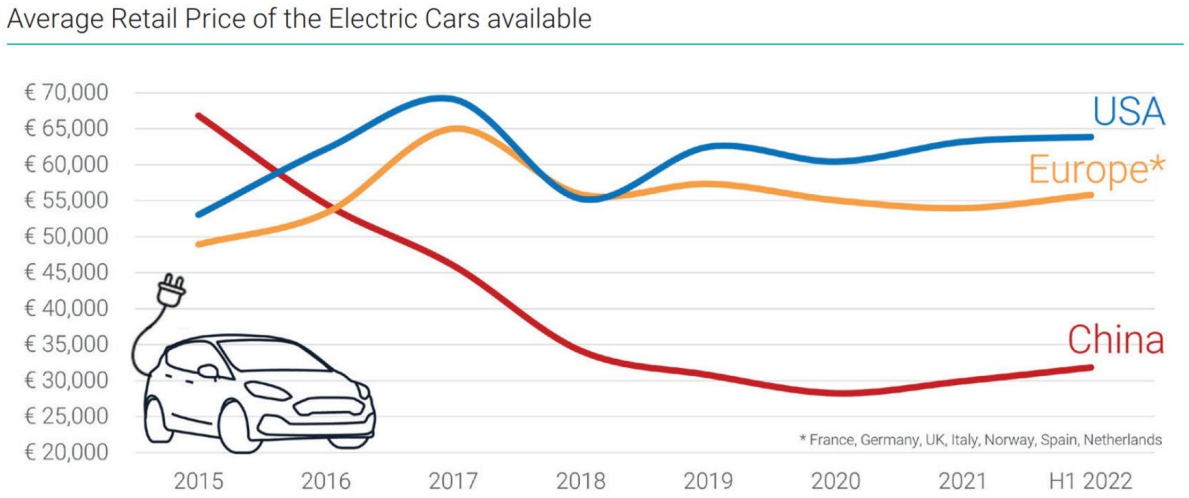
Reputation risk: changes in societies perception of CC-risks bring reputation risk for asset managers and investors' portfolio choices

BEFORE 3 to 5 years ago	TODAY
1 Deniers	1 Acceptance of climate change
2 One of many risks	2 Biggest risk
3 Limited regulations	3 Multiple regulations
4 No global agreement	4 COP 21
5 China blocking	5 China leading
6 Limited interest within populations	6 Millennials
7 Economics only	7 Impacts on health
8 « Abstract » topic	8 Observations in day to day lives
9 Cost of renewables	9 Competitive pricing
10 Few European investors	10 Major world investors

Ex: Green “Regulation” real economy changing rapidly Car Industry

- From 2035 onwards, the EU fleet-wide CO2 emission target for both cars and vans is 0 g CO2/km, corresponding to a 100% reduction.
- European Parliament adopted the European Climate Law, which raises the EU's target of reducing net greenhouse gas emissions at least 55% by 2030 (from the current 40%) and makes climate neutrality by 2050 legally binding
- USA – EPA 2032 standards require an industry-wide average target for light-duty vehicles of 85 grams of carbon dioxide per mile in model year 2032, a nearly 50% reduction from the 2026 standard
- U.S. greenhouse gas emissions to be reduced by 50-52% below 2005 levels in 2030. Reaching 100% carbon pollution-free electricity by 2035. Achieving a net-zero emissions economy by 2050





“Green” Regulation and Investment is already affecting Finance

- Financial supervisors began incorporating climate-related financial risks into the prudential framework; Green taxonomy important; avoid “green washing”
- New **Basel Committee on Banking Supervision Principles** (BCBS), 2022 (consultation doc 2023)
  - The standard sets out 18 principles covering corporate governance, internal controls, risk assessment, risk management, and reporting.
  - Extends Basel Core Principles for Effective Banking Supervision, while building on previous analytical reports and Scenario work of the Network for Greening the Financial System (NGFS)
- The **International Association of Insurance Supervisors** (IAIS) and the Sustainable Insurance Forum (SIF) published the Application Paper on the Supervision of Climate-related Risks in the Insurance Sector in 2021
- **International Financial Reporting Standards** (IFRS)-Financial Stability Board-TCFD Disclosure.
  - IFRS S1 sets out the general requirements for a complete set of sustainability-related financial disclosures.
  - IFRS S2 specifically requires companies to disclose the absolute gross GHG emissions they generated during the reporting period
  - The standards fully incorporate the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD). This means that organisations that comply with the requirements of IFRS S1 and S2 will also be meeting the requirements of TCFD
  - All companies can start applying IFRS S1/S2 now, which became effective for annual reporting as of January 1, 2024. IFRS S1/S2 will become mandatory when and if regulators integrate them into financial reporting frameworks and regulatory requirements

Role of green finance in the transition to NZ
→ make enough capital flow to EMEs and in right format adapted to each case

- **Ne green projects are profitable; impediment is macro-risks that need to be mitigated: investors will focus on "greener" projects, using ESG, PRI, and other criteria (risk & reputation)**
- **Global initiatives** (COPs, G20, Paris Summit) for pooling risk using MDBs balance sheets, enhancing credit ratings, reducing FX volatility
- Concrete outcomes need to be seen and frameworks implemented:
- **Pledges to fund NZ transition in poor and other developing countries need to be upheld** (Paris $100b fund, especially because **CC has severe distributional consequences** (poor countries and poor HH in rich countries)
- **Concessional Green Finance** for low income countries (SDRs, ODA, etc)
- **Blended Green Finance** with more resources for MDBs like World Bank, regional development banks, to absorb part of risks, develop new projects (more capital needed, new method for pooling risks)
- **New innovative Green Finance** for insurance of physical risks (1.5C portfolios, new indices, etc) for investors. **Not for moral reasons, for mitigating risks and for reputational reasons**

S 11.9. Policy implications (4): Role of Central Banks, guidance, inflation target, r*

Central Banks' broad Green Agenda, several forums of debate (countries, regions, Basel, NGFS), some consensus but lots of dissent too…

- **Monetary Policy**
  - Collateral frameworks (eg. "carbon neutral"? CC-related haircuts?)
  - Open Mkt Operations, standing facilities, reserve requirements (selectivity?)
  - QE and other non-standard tools (helicopter money, etc.); exclude assets?
- **Financial Stability and Regulation**
  - Microprudential instruments (stress tests, disclosure, supervision, etc)
  - Macroprudential instruments (systemic risk stress testing, new calibration with climate-related risks, etc)
- **Other Policies**
  - Specific financing schemes (directed credit to specific sectors, firms, etc?)
  - CB Reserve Management policies (favor green bonds? Improve definitions? etc)
  - Support for sustainable green finance ("green washing"?)

Role of central banks / supervisors to help combat Climate Change

- **False Dilemma**: to do nothing (preserve independence & credibility i.e. no creeping mandate) or to do everything (listen to more vocal parts of civil society because of urgency)

- **There is no "silver bullet".** Recognize that central banks alone cannot mitigate climate change, avoid becoming again "only game in town" in the road to Net Zero (NZ)
  - Need Governments (carbon pricing, carbon markets, investment in R&D, new green technologies, etc)
  - Need Private Sector (scale-up new technologies into investments, financing transition to NZ)
  - Need regulation, green taxonomies, local, regional and global cross-countries coordination)

- **Important to discuss how Climate Change affects financial and price stability**. That is, CC directly undermines central banks in fulfilling their mandates:
  - Financial stability – potentially severe effects (related to CC-risks, physical and transition risks); **also a concern of supervisors**
  - Price and macroeconomic stability: effects on inflation (heat), employment (CC-related real and financial crises)

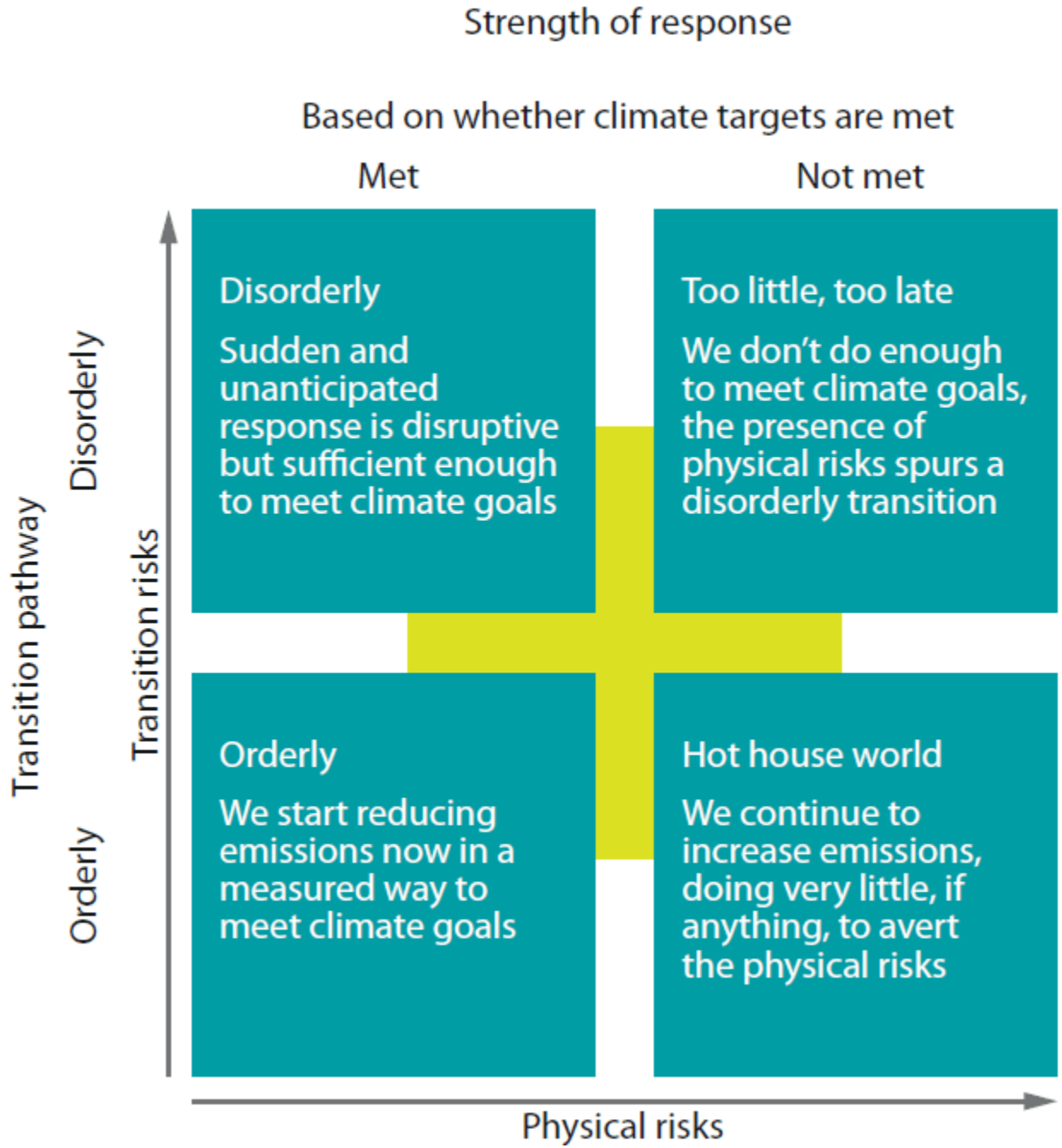
What can central banks do and are actually doing?
Provide public goods on CC-related risks and contribute to coordination

CBs are providing guiding frameworks for public and private financial sector, civil society. **The CB's Network for Greening the Financial System (NGFS) has been instrumental offering such public goods**

- Continue improving **analytical tools to assess CC-risk and resilience of economy and financial sectors**
  - New macro models -beyond IAMs or DSGEs-, CC-risk metrics, CC-related stress tests
  - CC-scenarios for 1.5 with sustainable growth and contributions by agent (real & financial sectors)
- Continue discussing scope and role of **macropru** (BCBS working group) and **monetary policies** (collateral, APP); not a trivial issue ("market neutrality" vs shadow-asset pricing)
- **Disclosure and accounting standards** (FSB-TCFD, IFRS sustainability reporting) → better identify risk
- Consistent **taxonomy on green investment** products, for investors and civil society (comparable ESG criteria, PRI, Green bonds standards, construction of 1.5 portfolio, etc)
- Seek **"greening" own assets** (eg reserves, pension funds); offer investment options for CBs (BIS-green fund); favoring new "green finance" approaches and instruments

Recommendations by the NGFS and European initiatives with a focus on financial stability

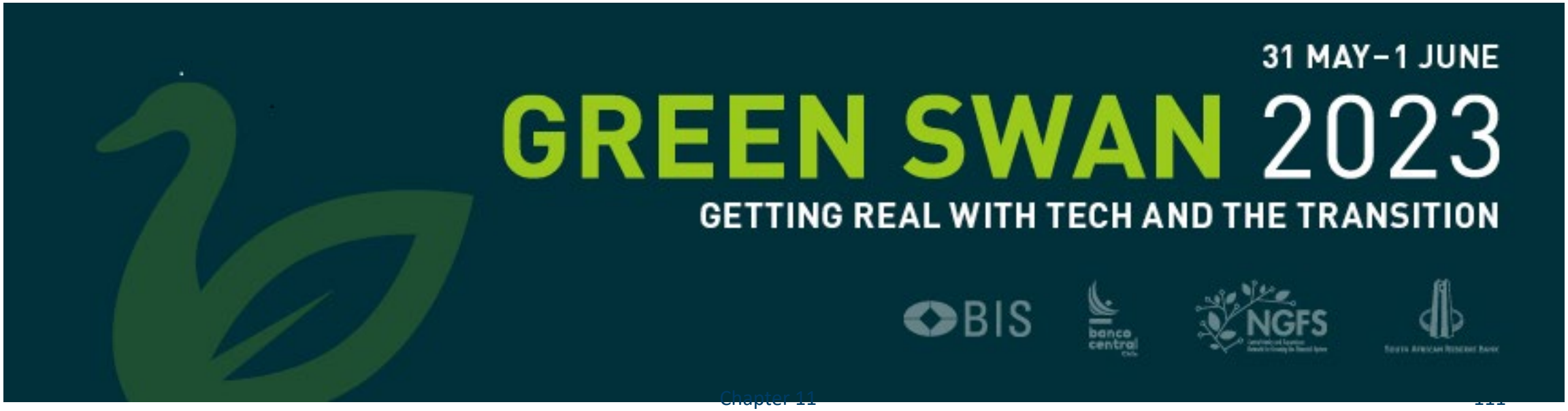
	2019 NGFS Recommendations	2018 EU Action Plan and regulatory proposals & ESRB proposals
Monitoring climate-related risks	Central banks and supervisors are encouraged to develop methodologies for measuring climate-related risks, including forward-looking scenario analysis and stress tests	The ESRB has proposed that the European Supervisory Authorities include climate risk scenarios in stress-test exercises, and is conducting analytical work on data and methodologies
Developing taxonomies	Regulators should develop taxonomies that aim to facilitate (i) financial institutions' climate risk management, (ii) assessment of the potential risk differentials between green and brown assets, and (iii) mobilisation of capital for green investments	The Commission has proposed a **regulation for an EU classification system of sustainable economic activity (taxonomy)**, which aims to help investors redirect capital towards green activities. This feeds into a Green Bond Standard and disclosure requirements, and could potentially be used in the context of low-carbon benchmarks and a "green supporting factor"
Promoting disclosures	Non-financial and financial institutions should adopt the FSB TCFD disclosure recommendations	The Commission has proposed a **disclosure regulation** and a **regulation for a low-carbon benchmark and a positive carbon impact benchmark**
Incorporating climate-related risks into prudential frameworks	Central banks and supervisors are encouraged to integrate climate-related risks into supervision, among other things, by (i) raising awareness and promoting climate risk assessment among institutions, (ii) setting supervisory expectations regarding governance and risk management, and (iii) potentially considering integrating climate risk into the prudential framework	In its Action Plan, the Commission states that it will explore the feasibility of the **inclusion of climate risks in institutions' risk management policies** and the **potential calibration of capital requirements for banks** as part of the CRR/CRD.


Strength of response
Based on whether climate targets are met
Met
Not met
Transition pathway
Disorderly
Orderly
Transition risks
Disorderly
Sudden and unanticipated response is disruptive but sufficient enough to meet climate goals
Too little, too late
We don't do enough to meet climate goals, the presence of physical risks spurs a disorderly transition
Orderly
We start reducing emissions now in a measured way to meet climate goals
Hot house world
We continue to increase emissions, doing very little, if anything, to avert the physical risks
Physical risks

Source: NGFS

BIS Green Swan Conference 2023 examined green technologies potential

- Critical areas (examples):
  - electrification, renewable energies for public infra and transportation
  - hydrogen, nuclear
  - bioenergy and
  - carbon capture, utilization and storage (CCUS)



Medium-long term consequences: inflation and r*

- While CB win the “last mile” battle against inflation of 2021-22, achieving their 2% inflation target, there are already cost-push pressure on headline and core inflation:
  - Extreme weather events affect food prices, damages in infrastructures, etc
  - Technological change toward NZ entail adaptation higher costs of inputs
  - This is compounded by other trends (re-shoring, changes in labor markets, etc)
- Structural changes to NZ will entail productivity gains, more investments to de-carbonize our economies
  - This will push the neutral rate r* up
  - This will be compounded by demographic trends; Artificial Intelligence (AI) radically changing the production and consumption processes of various types of goods and services. Increased productivity improves investment prospects, profitability and tends to increase r*. It could be a way out of secular stagnation. If accompanied by appropriate monetary and fiscal policies, it can bring disinflationary relief with an increase in potential output, cost reduction, etc. But it could also result in more demand pressure and more inflation

S 11.10. Policy implication (5): A New Green and Fair Bretton Woods for Net Zero

S 11 Conclusions: Policies to mitigate climate change need coordination, work on systemic risk, demand & supply, locally but also globally

- The evidence about CC in the IPCC reports is overwhelming
- Characteristics of a new systemic risk, **Green Swans** as opposed to the GFC's Black Swan: irreversible, non-linear, life threatening; financial consequences of physical and transition risks
- **Why should central banks bother**? Their financial stability objective; should they ask for a new explicit mandate?
- **Policy responses**: from awareness, regulation, collateral and asset purchase programs up to direct credit interventions; no silver bullet: need for coordination with other actors and policies (mainly Governments)
- **Financing the transition to net zero** (green financial products, green taxonomies for mobilization of resources, financing new technologies and innovation)

- **Cooperation/coordination with all stakeholders** (globally, locally, Governments, CBs, private sector, IFIs, regulators, standard-settings, ratings agencies, etc); the NGFS (*Network for Greening the Financial System*) playing important role for CBs;
- **Work on systemic risk** in the financial system (new risk models, transmission of CC to "financial crisis", portfolio asset "temperature", disclosure of exposures – FSB-Task Force); **stress-testing resilience** of financial system to scenarios of CC shocks (assessment of potential losses v-a-v available capital for insurance cies and banks, etc);
- **Demand side: Fostering diversification** to lower carbon economy (public awareness, carbon pricing, GHG emission taxation & certificates, paying attention to distributional effects, "pragmatism" in policy responses, etc);
- **Supply side: Financing the transition** "green" research" R&D, new technologies, carbon capture, new "green" financial instruments, green infrastructure, "global funds" for MICs and LICs, etc.
- **Distributional consequences of CC policies and transition** are important; political economy of CC is obvious; compensation & transfers can be important elements to gather support and efficiency

80 years later we need a “New Green and Fair Bretton Woods”

- First, we need to construct a consensus around a narrative for fighting Climate Change:
- 1) it requires a global, multilateral, urgent collective action; it is a global negative externality (Green Swan) a recognized market failure that no single region, country, actor in society can address alone;
- 2) it needs a significant amount of financial resources (eg., around 2% of global GDP in investment for the transition);
- 3) it requires helping developing countries that do not have these resources to finance their transition;
- 4) it needs regional and multilateral agreements to use both existing funding (public and private) but also new innovative sources of global financing; and
- 5) it can be organized into a global framework (eg., the principles of the Paris Accord in the COPs, the actions of the G20).

80 years later we need a “New Green and Fair Bretton Woods”

- Second, we need a road map laying out the concrete elements of such a new Bretton Woods.
- An Institutional framework.
  - Start using existing institutions (eg., the IMF, the World Bank, the system of regional multilateral development banks or MDBs, the alliance of public banks under the Finance In Common initiative or FICs, the many regional monetary, trade and financial agreements and arrangements among group of countries;
  - And then, also agree on creating a special fit-for-purpose agency or institutional framework, a vehicle for channeling resources and guaranteeing their sustainability and value over the medium long term.
- Financing.
  - Start using existing resources and existing commitments (eg., the MDBs, the private alliances such as the Glasgow Financial Alliance for Net Zero to begin implementing existing plans,
  - And then, enlarge the scope of resources that can be mobilized to leverage more (eg., international taxation, new issuances of SDRs, enhance the issuance of green financing and bonds).

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