Climate Finance

SDG & ESG

Risk Theory

Known knowns

- What we know

Known unknowns

- What we want to know…
  - … but don't yet know

Unknown unknowns

- What we don't yet know we need to know

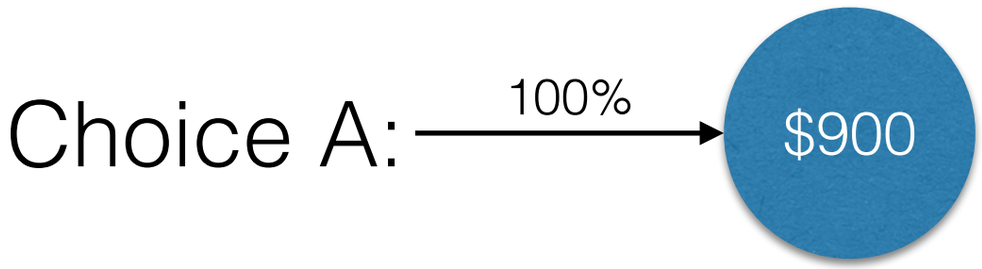
Decision under uncertainty

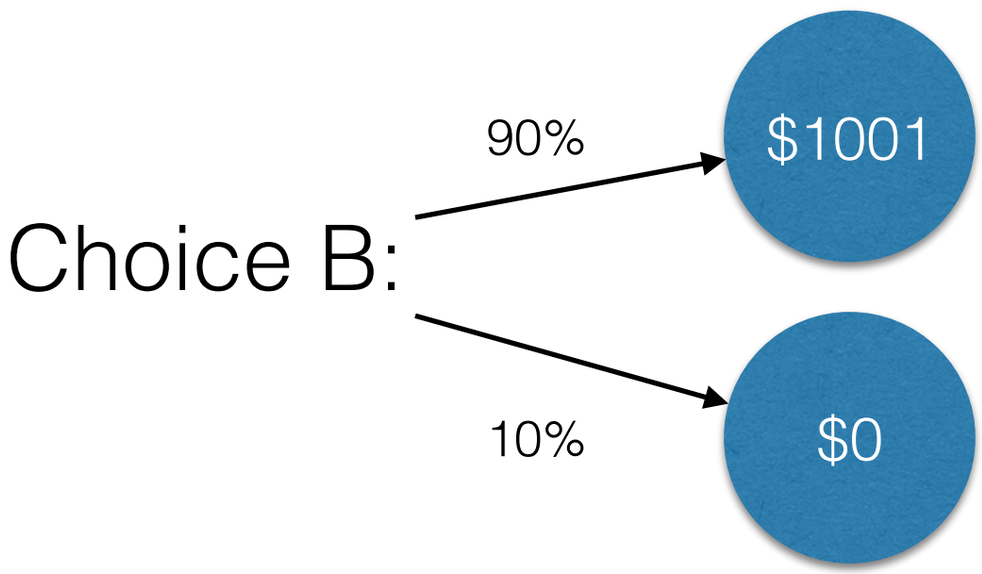
What to do

when you
don’t know
what will happen

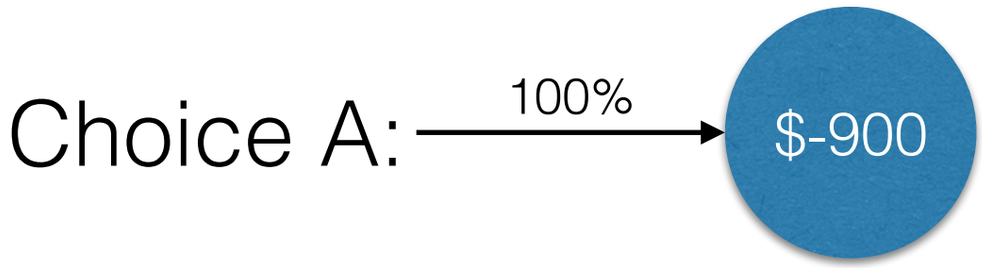
Behavioural bias

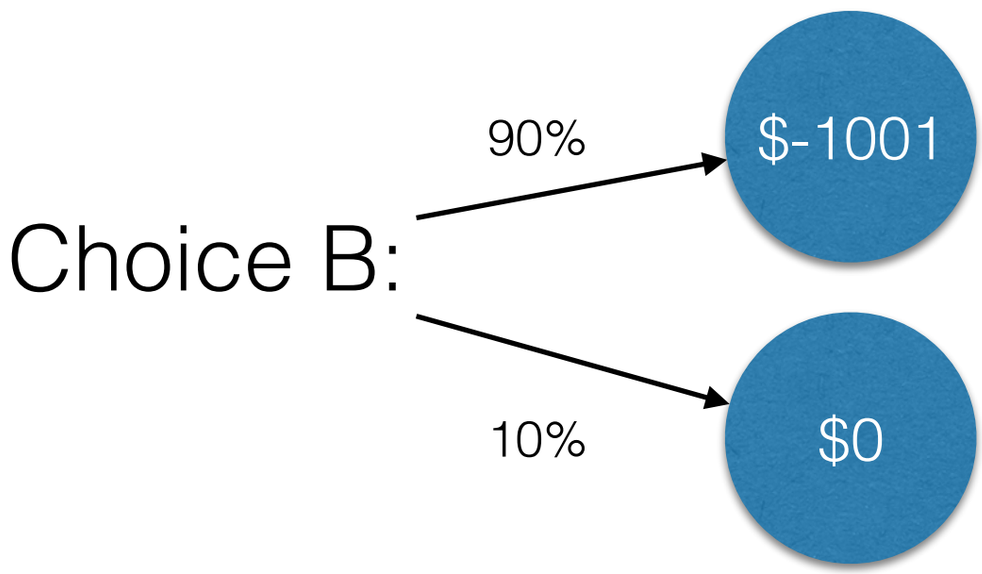
Game 1



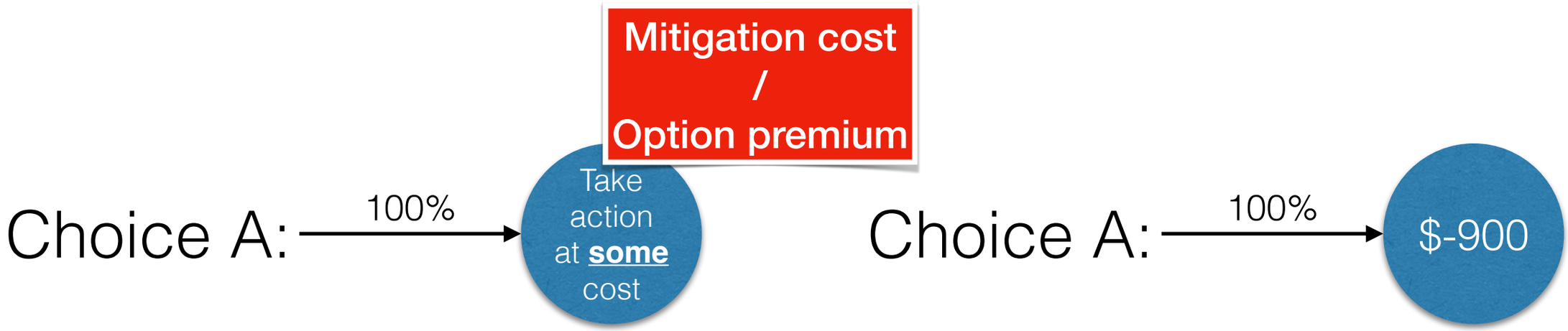


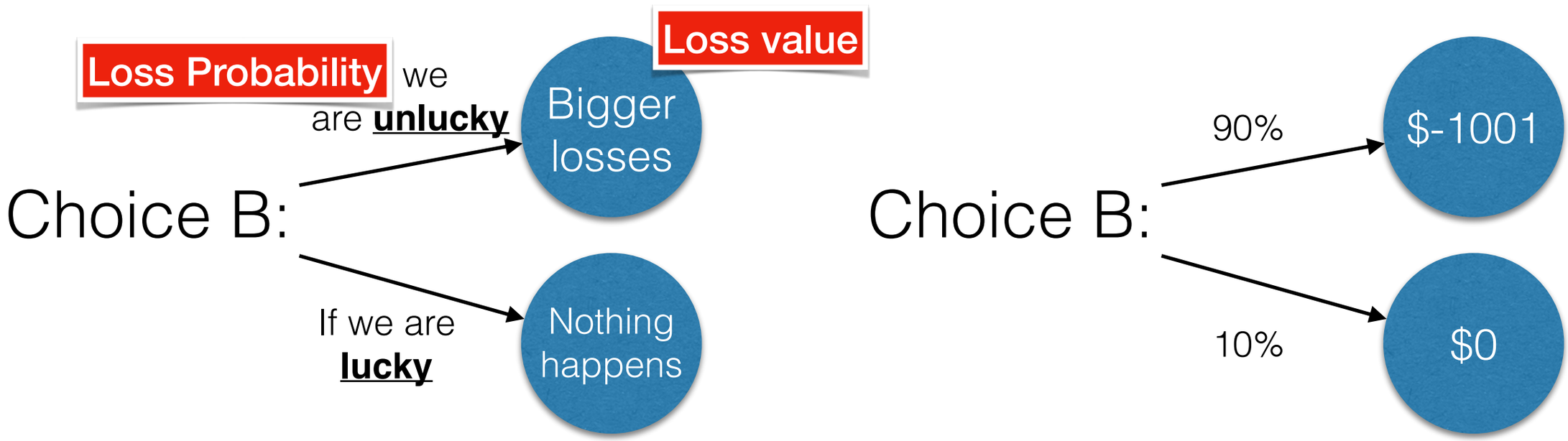
Game 2





Insurance premia





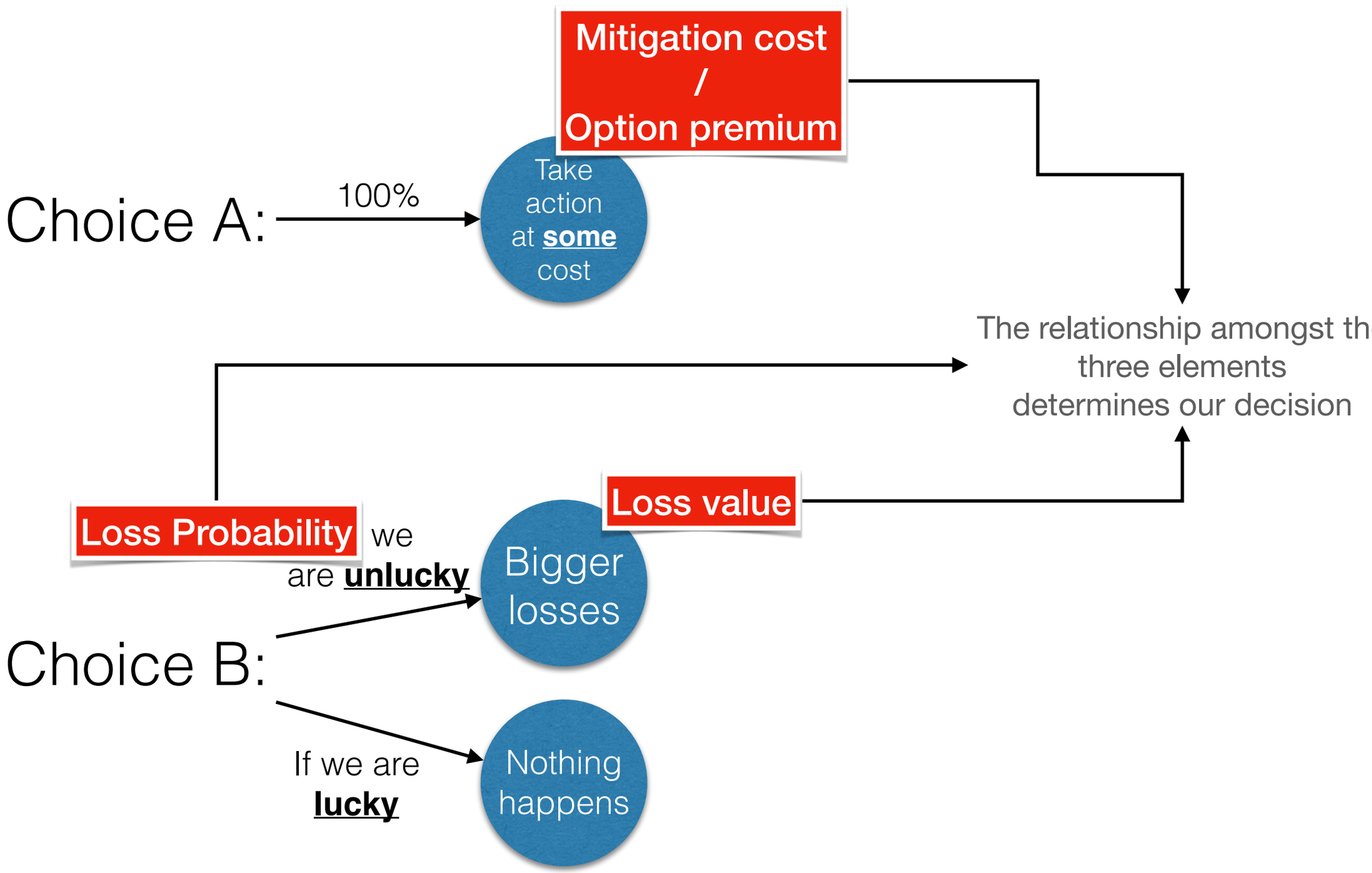
Hard-to-quantify risk behaviour

Miss your flight: —100%→ Take action at **some** cost

Board your flight:

- If we are **unlucky** → We die
- If we are **lucky** → Nothing happens

Insurance premia



Rational risk theory: basic facts

- One might think that

Insurance premia $\sim$ probability of loss $\times$ loss amount

---

- In reality, there are many scenarios x_i, with probabilities p_i, leading to losses L_i, different under each scenario.
- More generally, we will have a probability space (Ω, μ) of events and probabilities, and losses are random variables $L(\omega), \omega \in \Omega$.
- and one might think that

Insurance premia $\sim \mathbb{E}(L)$.

- This might be true when risks are **diversifiable**.
- When they are not diversifiable, this calculation **underestimates** insurance premia.
- A risk premium will typically be added.

Risk pricing example: auto insurance

Sample assumptions

- The expected value of an auto policy claim is $1,000,
- The probability of accident is 10%

No diversification

We sell a **single** policy.

The loss function is a Bernoulli with mean $1000 and standard deviation $300

- could we charge $1,000?
  - With 10% probability, we will go **out of business**.
- Could we charge $1,100?
  - With 9.999% probability, we will go **out of business**.

Good diversification

We sell a **million** policies

The loss function is a Bernoulli with mean $1Bn and standard deviation $300,000.

- can we charge $1,000?
  - With 50% probability we go **out of business**
- Could we charge $1,100?
  - The probability we go **out of business** is about 0.13%.

Pricing risk

- If we are seeking protection against losses
  - given by a random variable L,
- the cost we should expect should be of the order of

$$\mathbb{E}(L) \; + \; \alpha \cdot \sigma(L)$$

- In other words, the insurance premium contains
  - The expected loss $\mathbb{E}(L)$
  - and the unexpected loss, in this represented by the standard deviation of the loss function

$$\sigma(L) = \mathbb{E}(L^2) - \mathbb{E}^2(L)$$

  - the multiplier α expresses the unit price of risk

May 24, 1990

Harvard and CUNY Shedding Stocks in Tobacco

By TAMAR LEWIN

Harvard University and the City University of New York have decided to eliminate stocks of tobacco companies from their investment portfolios, in what may be harbingers of a new tactic to highlight the dangers of smoking.

The action by Harvard was disclosed by President Derek Bok in a letter dated May 18 to three students at the university's public health school. He said Harvard had decided on divestiture in September and completed the stock sale in March.

And on Monday the City University of New York's board of trustees voted 9 to 2 to divest itself of tobacco stock, representing about $3.5 million of the university's $60 million portfolio.

Harold Jacobs, a trustee at City University, said, "We didn't know anything about Harvard doing it, and this was the first meeting where tobacco divestiture appeared on the agenda, but our vice chairman, Edith Everett, argued very persuasively that cigarettes are unhealthy and we should not hold tobacco stock, so we passed it."

Ms. Everett and her husband, Henry, have long been active in opposing the tobacco industry, and they serve on the board of trustees of the Tobacco Divestment Project, a Boston-based nonprofit group formed earlier this month.

That group and others working against cigarette smoking say the two universities' moves may be the start of a far more widespread divestitute campaign, including a proposal in the Massachusetts Legislature to require state pension funds to sell their tobacco stocks. By some estimates, more than 60 percent of tobacco stock over all is held by institutional investors, primarily banks, pension funds and insurance companies.

"Harvard and CUNY are the two great victories so far, but this is just the beginning," said Brad Krever, ex-

Continued on Page B8, Column 3

Risk Thinking

1990

$

Profitability Today

Tobacco Companies

The price of risk

Law-suits Tomorrow

2020

The price of time

Impact Investing

Investing in Tobacco

BTI • NYSE

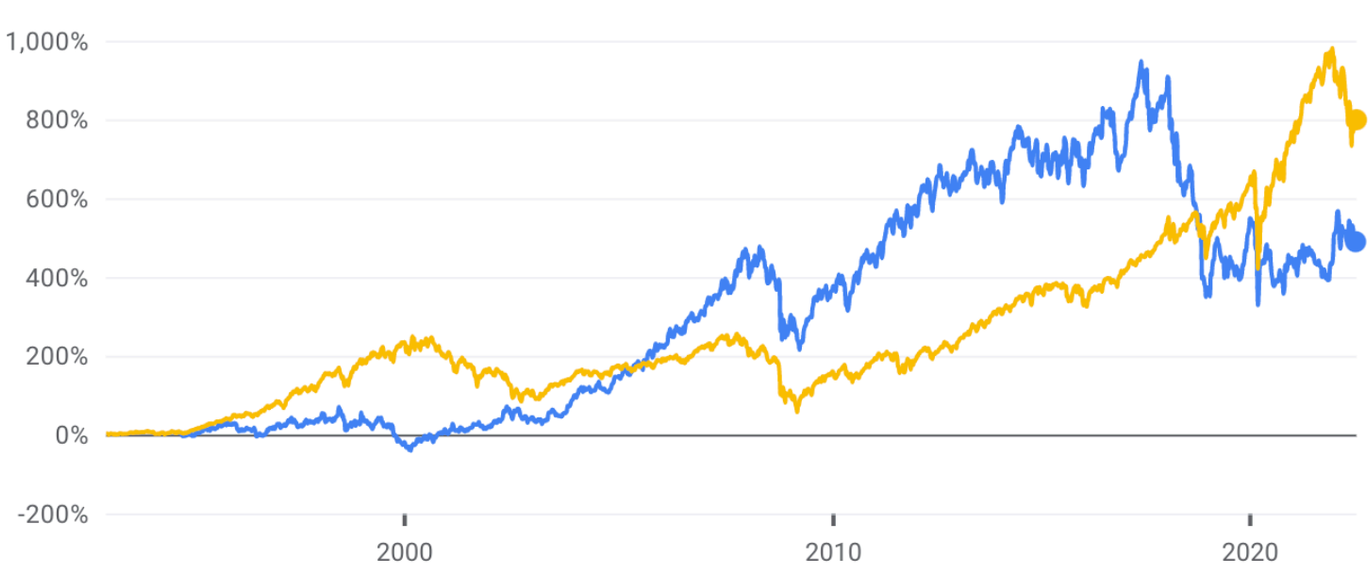
British American Tobacco PLC

$41.09 ↑489.53% +34.12 MAX

After Hours: $41.15 (↑0.15%) +0.060

Closed: Jul 22, 7:09:25 PM UTC-4 · USD · NYSE · Disclaimer

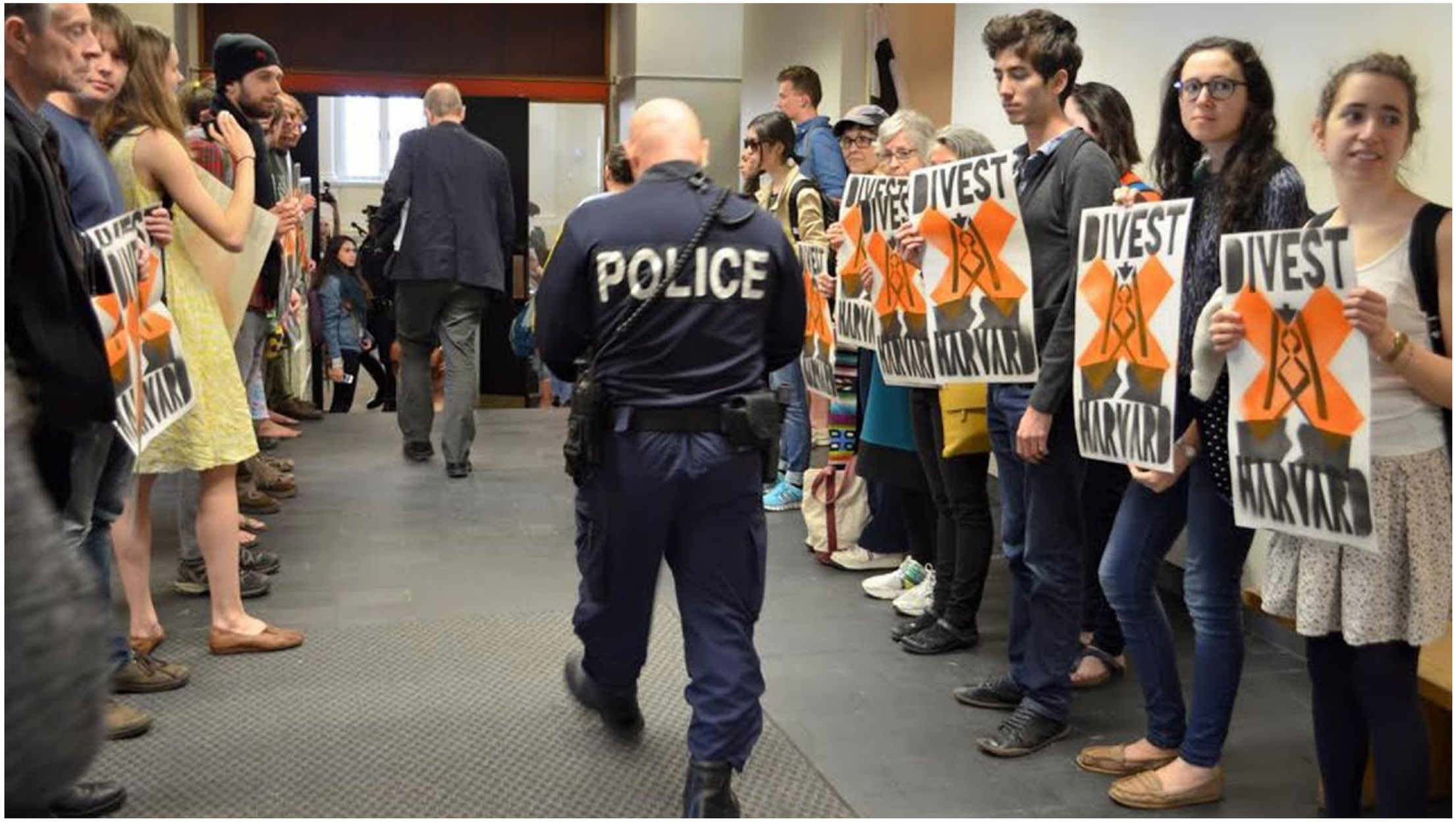
1D 5D 1M 6M YTD 1Y 5Y MAX



British American T...	$41.09	+$34.12	↑489.53%
SPDR S&P 500 ETF ...	$395.09	+$351.15	↑799.16%

Harvard Today

To this date, the investment of Harvard Endowment and other universe endowments in Fossil Fuels is a contentious one



Impact Investing

Aims to generate specific beneficial social or environmental effects in addition to financial gains

Sustainability: the new liability

Sustainable Development Goals

1	NO POVERTY
2	ZERO HUNGER
3	GOOD HEALTH AND WELL-BEING
4	QUALITY EDUCATION
5	GENDER EQUALITY
6	CLEAN WATER AND SANITATION
7	AFFORDABLE AND CLEAN ENERGY
8	DECENT WORK AND ECONOMIC GROWTH
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE
10	REDUCED INEQUALITIES
11	SUSTAINABLE CITIES AND COMMUNITIES
12	RESPONSIBLE CONSUMPTION AND PRODUCTION
13	CLIMATE ACTION
14	LIFE BELOW WATER
15	LIFE ON LAND
16	PEACE, JUSTICE AND STRONG INSTITUTIONS
17	PARTNERSHIPS FOR THE GOALS

ESG

E pillar

- The use of or dependence on fossil fuels
- The use or management of water and other resources
- Pollution levels
- Climate change
- Hazardous materials and their disposal
- Carbon footprint
- renewable energy

S pillar

- Employment equality and gender diversity
- Product safety
- Employee health and safety
- Training and development
- Animal testing
- physical and mental health
- Supply chain transparency
- Human rights
- Privacy issues

G pillar

- Compensation of employees and executives
- Board and company diversity
- Tax strategy and accounting standards
- Bribery and corruption
- Fraud
- Ethics and values
- Transparency and anti-corruption
- Shareholder rights

“Climate change is setting in train a vicious cycle in which rising sea levels and more extreme weather are damaging property, forcing migration, impairing assets and reducing the productivity of work “

—- Mark Carney, 2021
former chair of the Central Bank of England (CBE)

Global climate policy groups

- Intergovernmental Panel on Climate Change (IPCC)
- Financial Stability Board (FSB),

Greenhouse gas (GhG) concentration levels must be urgently and radically reduced by every and all global constituents:

- market actors in all sectors of the economy which produce GhG from their own production processes,
- the energy systems they rely on
- from the products and services they produce

Emissions

- There are six emission gasses which are targets:
  - Carbon dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous oxide (N_2O)
  - Hydrofluorocarbons (HFCs)
  - Perfluorocarbons (PFCs)
  - Sulphur hexafluoride (SF_6)

GWP

Global Warming Potential

	Natural	Anthropogenic	Atmospheric lifetime (years)	GWP
CO2	decomposition, ocean release and respiration	cement production, deforestation as well as the burning of fossil fuels like coal, oil and natural gas	100-∞	1
Methane (CH4)	livestock, rice, termites, digestion, etc.	landfills, oil and natural gas systems, agricultural activities, coal mining, stationary and mobile combustion, wastewater treatment	10	80
Nitrous oxide (N2O)	Soil, oceans, volcanoes,…	Agriculture, from fertilizers	100	300
Hydrofluorocarbons (HFCs)	None	leakage of refrigerants used in vehicle air-conditioning systems	1-30	1000's
Perfluorocarbons (PFCs)	None	Aluminum production	1000's	10000
Sulphur hexafluoride (SF6)	None	electrical insulator and arc suppressant	3000	25000

Contributors to GhG emissions

- Organizations with emission-generating industrial process
- Environments which consume energy and heat
- Power producer groups which supply energy
- Food and agriculture industries which also produce emissions

Contributors to GhG emissions

#	Country	CO2 Emissions per capita (tons)	CO2 Emissions (tons, 2016)	Population (2016)
1	China	7.38	10,432,751,400	1,414,049,351
2	United States	15.52	5,011,686,600	323,015,995
3	India	1.91	2,533,638,100	1,324,517,249
4	Russia	11.44	1,661,899,300	145,275,383
5	Japan	9.70	1,239,592,060	127,763,265
6	Germany	9.44	775,752,190	82,193,768
7	Canada	18.58	675,918,610	36,382,944
8	Iran	8.08	642,560,030	79,563,989
9	South Korea	11.85	604,043,830	50,983,457
10	Indonesia	2.03	530,035,650	261,556,381
11	Saudi Arabia	15.94	517,079,407	32,443,447
12	Brazil	2.25	462,994,920	206,163,053
13	Mexico	3.58	441,412,750	123,333,376
14	Australia	17.10	414,988,700	24,262,712
15	South Africa	6.95	390,557,850	56,207,646
16	Turkey	4.61	368,122,740	79,827,871
17	United Kingdom	5.55	367,860,350	66,297,944
18	Italy	5.90	358,139,550	60,663,060
19	France	5.13	331,533,320	64,667,596

#	Country	CO2 Emissions per capita (tons)	CO2 Emissions (tons, 2016)	Population (2016)
40	Qatar	37.29	98,990,085	2,654,374
92	Montenegro	25.90	16,249,039	627,264
39	Kuwait	25.65	101,492,225	3,956,875
72	Trinidad and Tobago	25.39	34,974,263	1,377,560
28	United Arab Emirates	23.37	218,788,684	9,360,980
42	Oman	19.61	87,835,773	4,479,219
7	Canada	18.58	675,918,610	36,382,944
115	Brunei	18.28	7,672,127	419,800
99	Luxembourg	17.51	10,144,632	579,264
80	Bahrain	17.15	24,458,384	1,425,792
14	Australia	17.10	414,988,700	24,262,712
83	Estonia	17.02	22,402,414	1,316,510
177	Gibraltar	16.98	572,708	33,737
202	Falkland Islands	16.59	48,568	2,928
11	Saudi Arabia	15.94	517,079,407	32,443,447
2	United States	15.52	5,011,686,600	323,015,995
45	Turkmenistan	14.00	79,279,216	5,662,368
26	Kazakhstan	13.01	231,919,540	17,830,901

Investment and Insurance

Through portfolio engagement, the following sectors are exposed to climate risk:

- Investment parties which invest in carbon producing companies
  - private equity,
  - asset management firms,
- insurance companies
- lending institutions

Small companies

Small and mid-sized companies are not exempt from climate mitigation scrutiny:

- Many have carbon footprints of their own,
- Are suppliers to larger industrial groups with sizeable carbon footprints of their own

Business impact of climate risk

- Climate risk exposure pose major challenges for business because they are fundamentally different from other business risks.
- The transition companies will undertake will impact business through:
  - Alignment with evolving and stringent carbon reduction expectations
  - Formal climate risk regime requirements,

Risk response

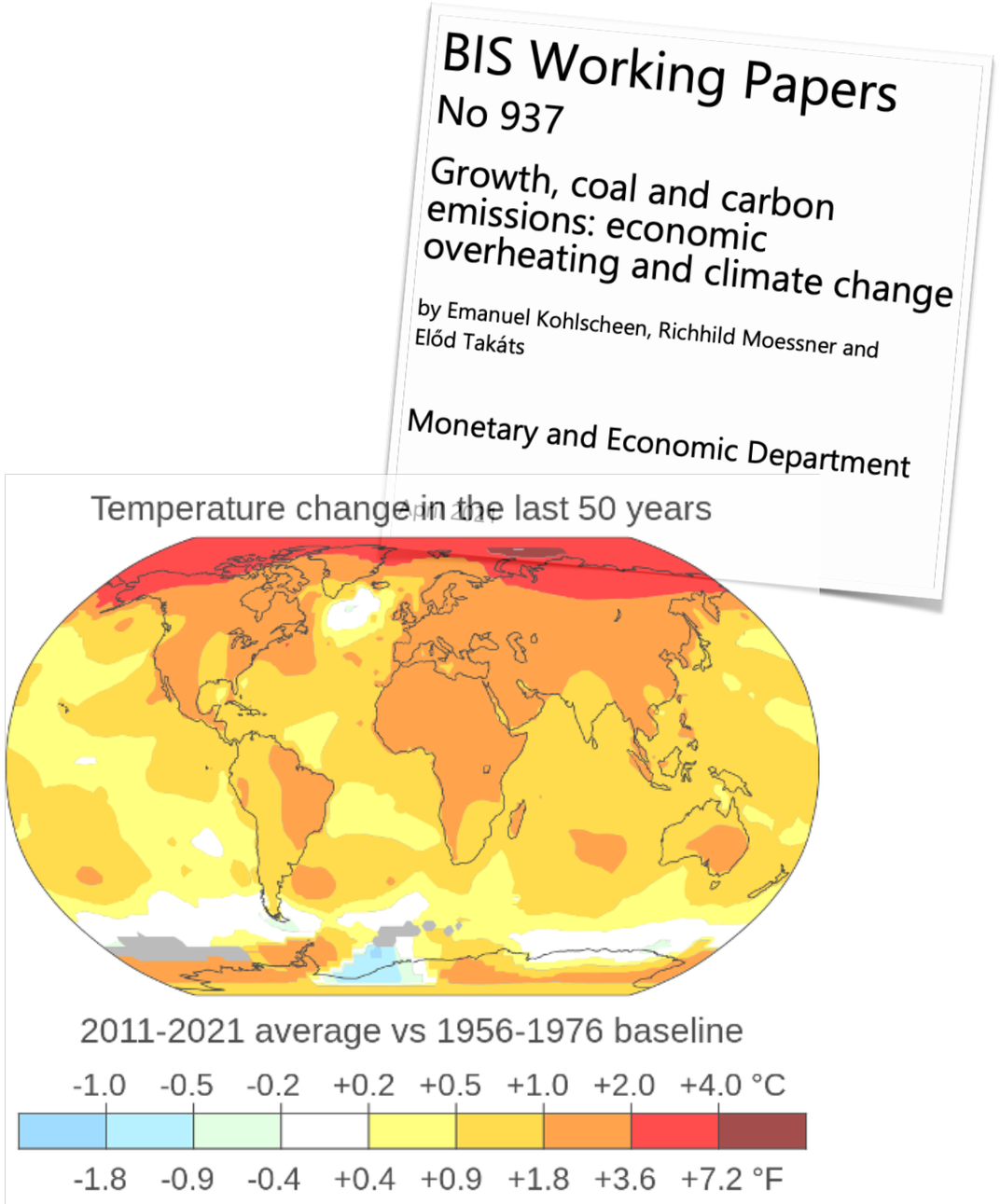
There are three proactive strategies for climate risk response

- mitigation
  - the efforts to reduce firm-level GhG emissions;
  - Favoured by IPCC
- adaptation
  - the efforts to increase organizational capacity to cope with changes in climate;
- geoengineering
  - the efforts to deliberately manipulate the earth system that is intended to counteract some of the impacts of GhG emissions (Stenhouse et al., 2014)
  - Long term - not a short term viable option

American Meteorological Society Recommendations (AMS)

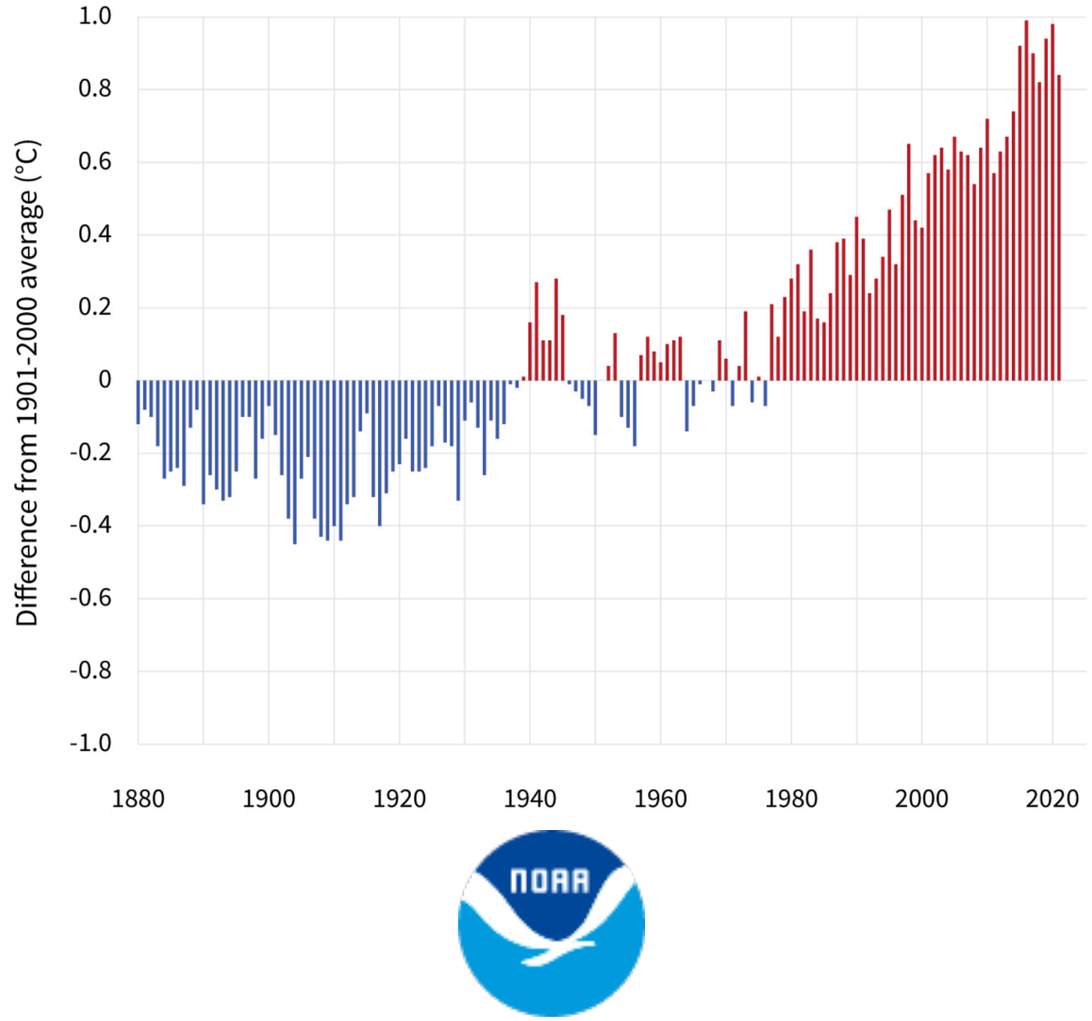
Economic overheating and climate change

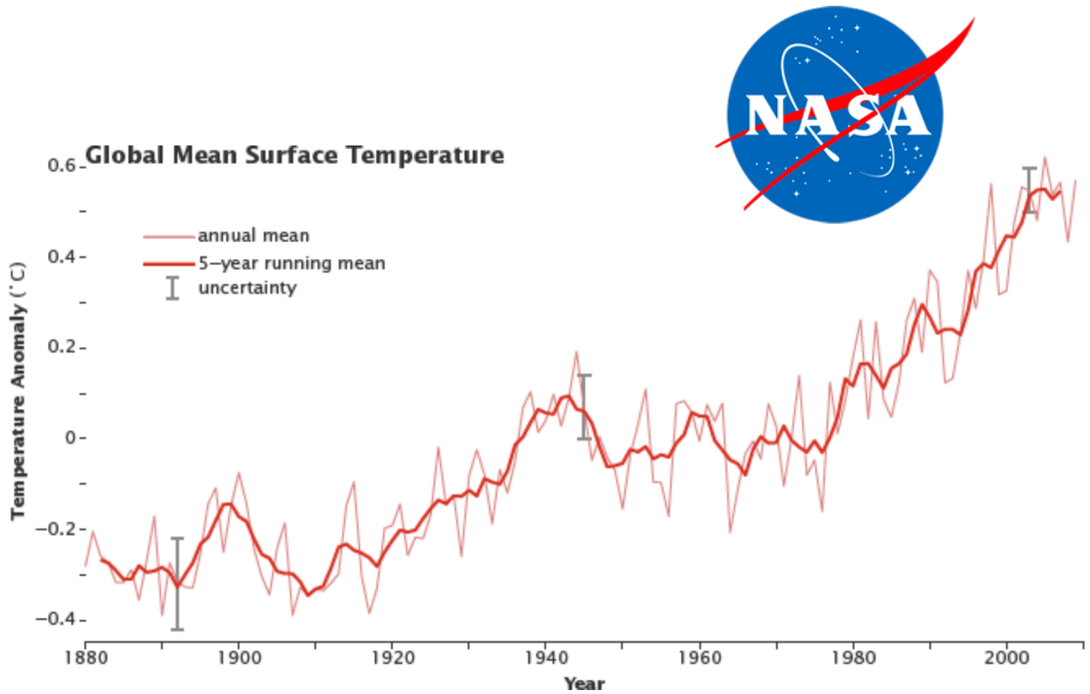
- Climate change is one of the most pressing challenge of our time
- The key driver of climate change is the emission of greenhouse gases, mainly carbon-dioxide (CO2)
- Current thinking:
  - our current economic development path is unsustainable.
  - Economic policy cannot avoid considering climate change anymore.



Surface temperature

National Oceanic and Atmospheric Administration





Despite ups and downs from year to year, global average surface temperature is rising. By the beginning of the 21st century, Earth's temperature was roughly 0.5 degrees Celsius above the long-term (1951–1980) average. (NASA figure adapted from Goddard Institute for Space Studies Surface Temperature Analysis.)

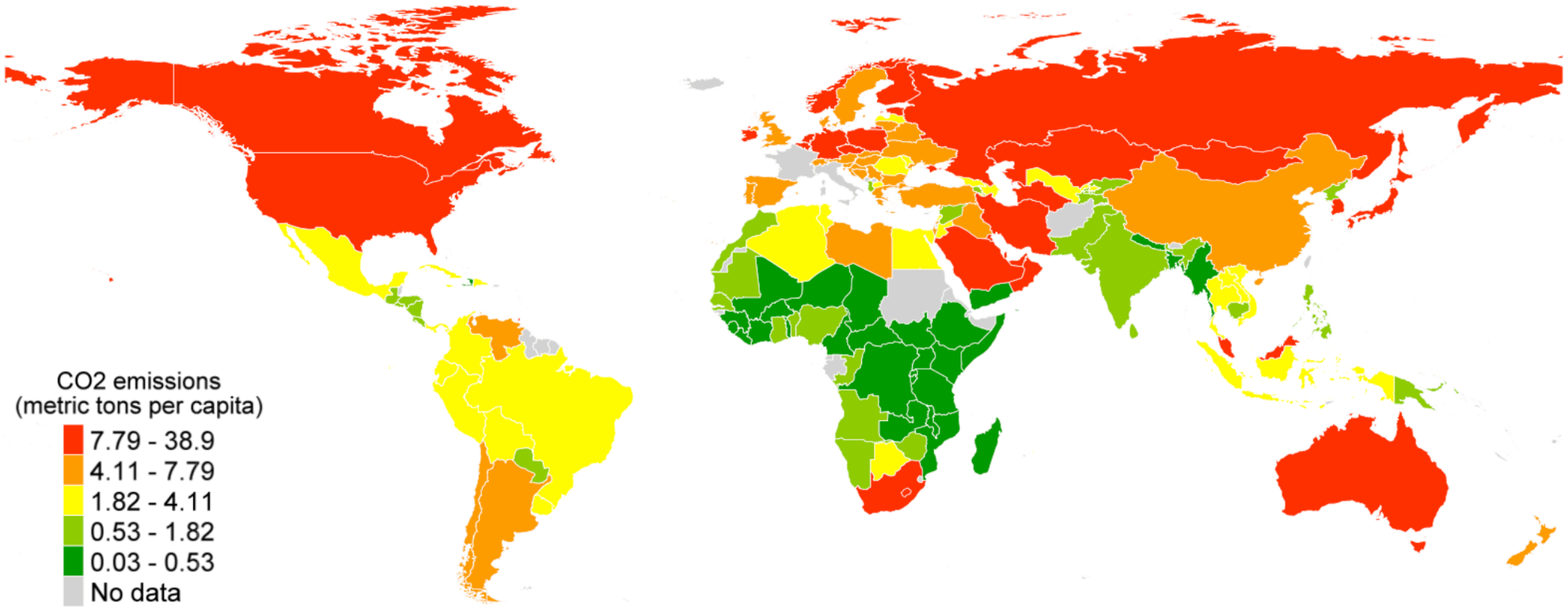
Global warming is the unusually rapid increase in Earth's average surface temperature over the past century primarily due to the greenhouse gases released as people burn fossil fuels. The global average surface temperature rose 0.6 to 0.9 degrees Celsius (1.1 to 1.6° F) between 1906 and 2005, and the rate of temperature increase has nearly doubled in the last 50 years.

Carbon emissions per capita

Carbon emissions per capita

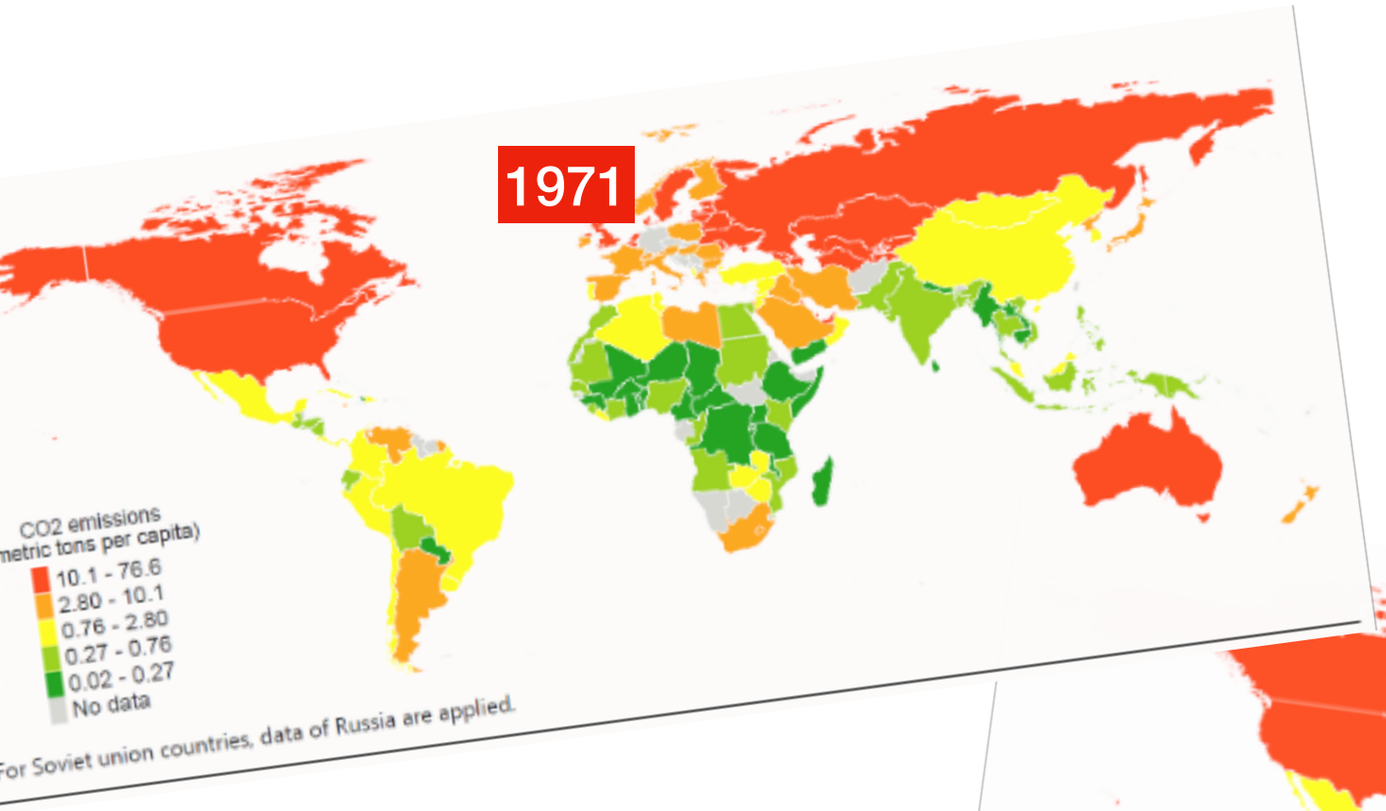
2016

Figure 1



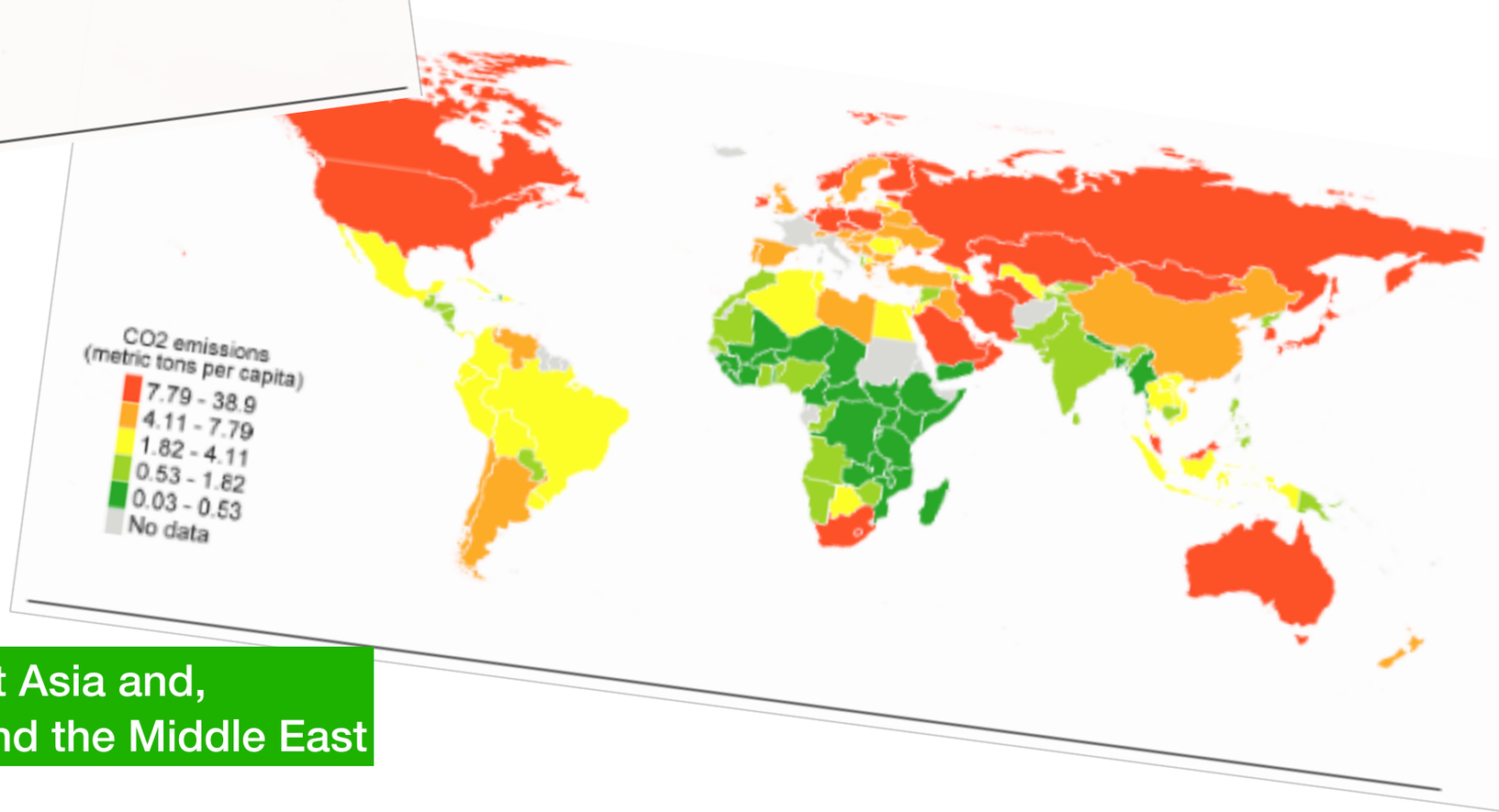
Carbon emissions per capita

1971



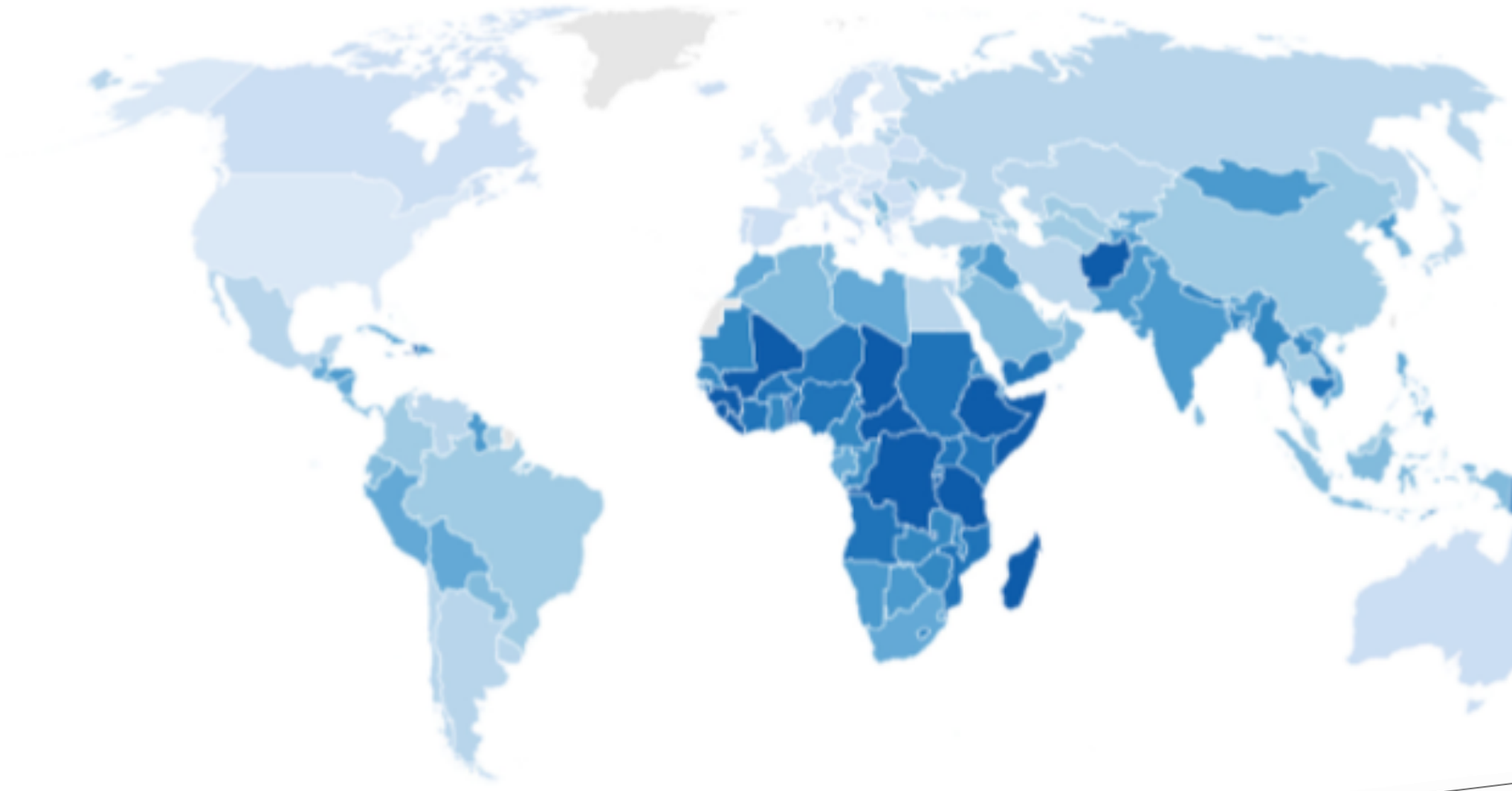
decreasing per capita carbon emissions in Europe
and, to lesser degree, in North America

2016



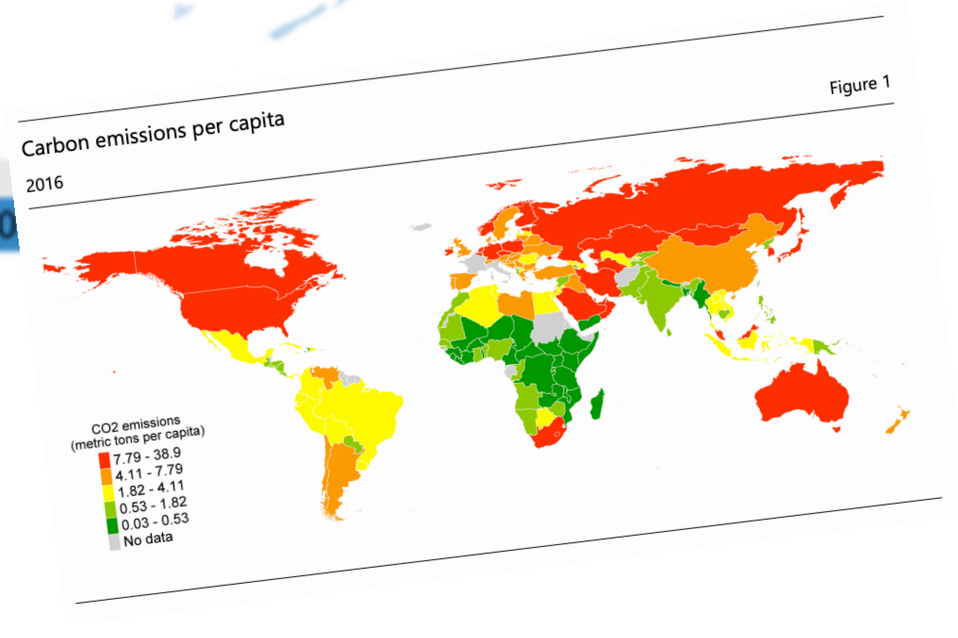
increasing emissions in East Asia and,
to a lesser degree, in North Africa and the Middle East

Climate impact and emissions



ND-GaIN Index of the vulnerability of countries to climate change

No Data	0.21	0.26	0.29	0.31	0.35	0.39	0.45	0



Facts

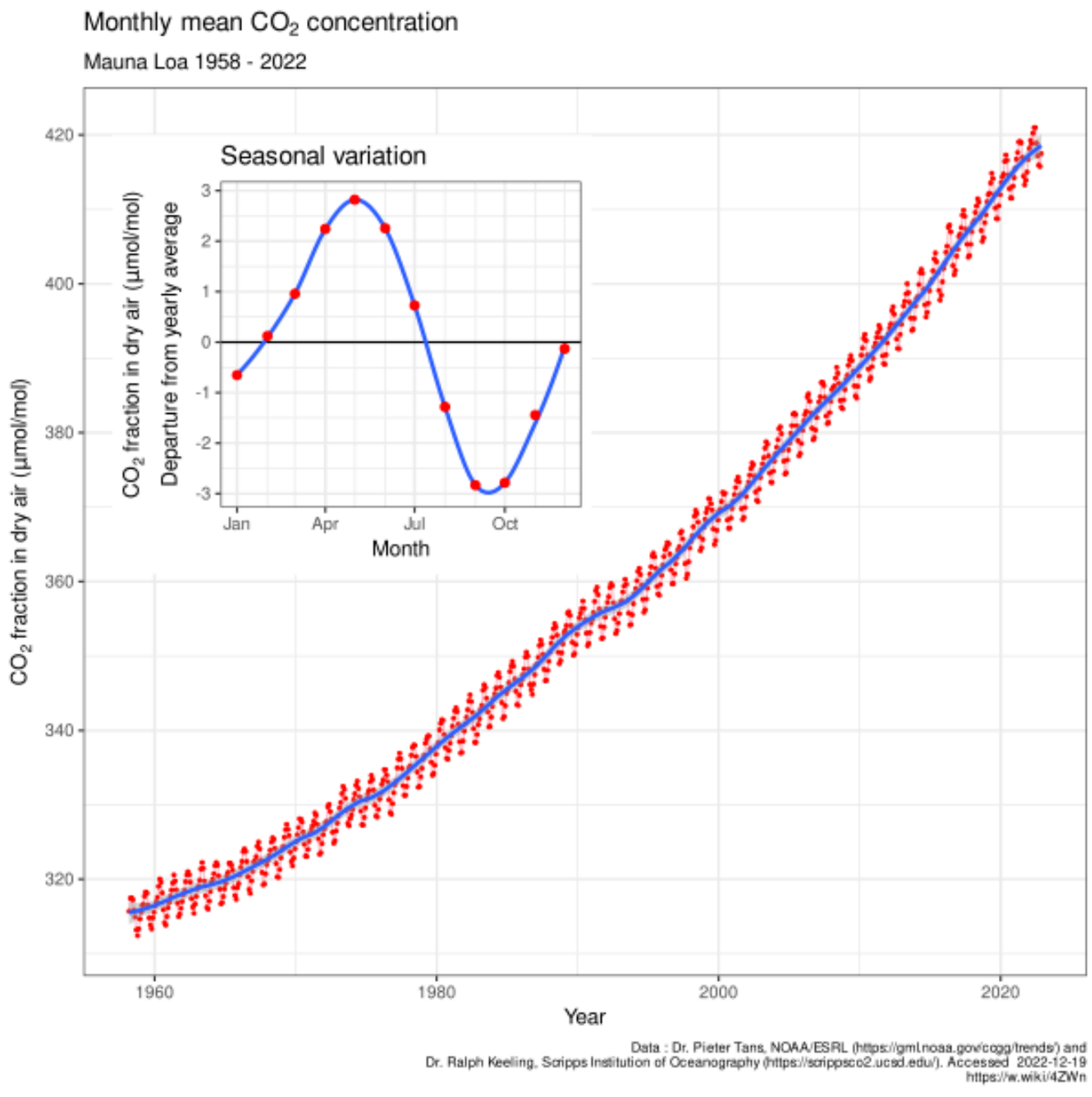
Since 1750 we have burnt 500Bn tons of CO_2
By 2050 we will have burnt another 500Bn tons of CO_2

concentration of CO_2 and other GhGs exceed 412 ppm

Increasing the concentration of CO_2 from 280 to 560 ppm is projected to increase average surface temperatures of the planet by around 3 °C,

CO2 over time

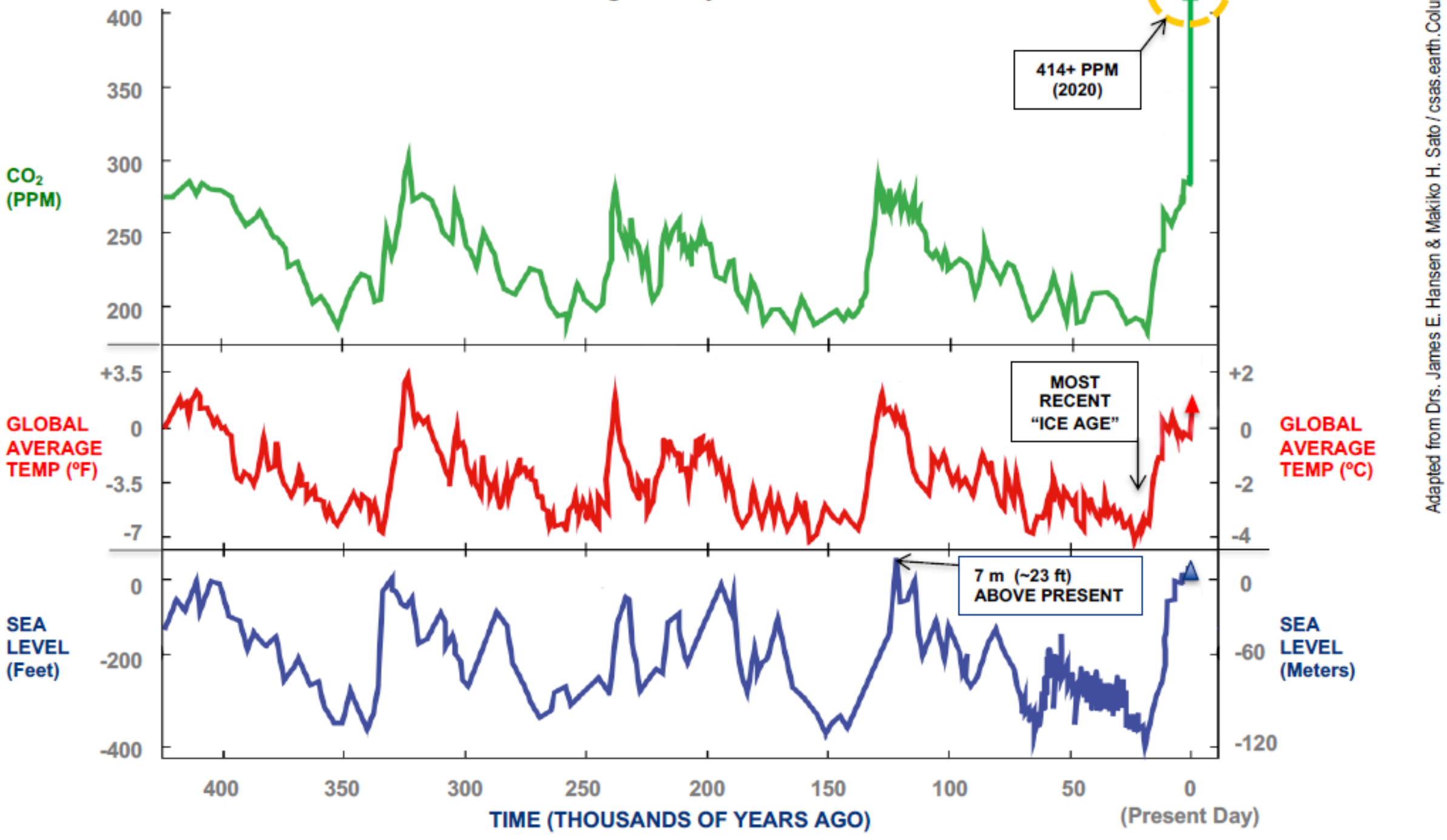
Year	CO2 Concentration (ppm)
1950	311 ppm
1960	316 ppm
1970	325 ppm
1980	338 ppm
1990	354 ppm
2000	369 ppm
2010	389 ppm
2020	414 ppm (estimated)
2021	416 ppm (estimated)



Carbon Dioxide (CO_2), Temperature, & Sea Level

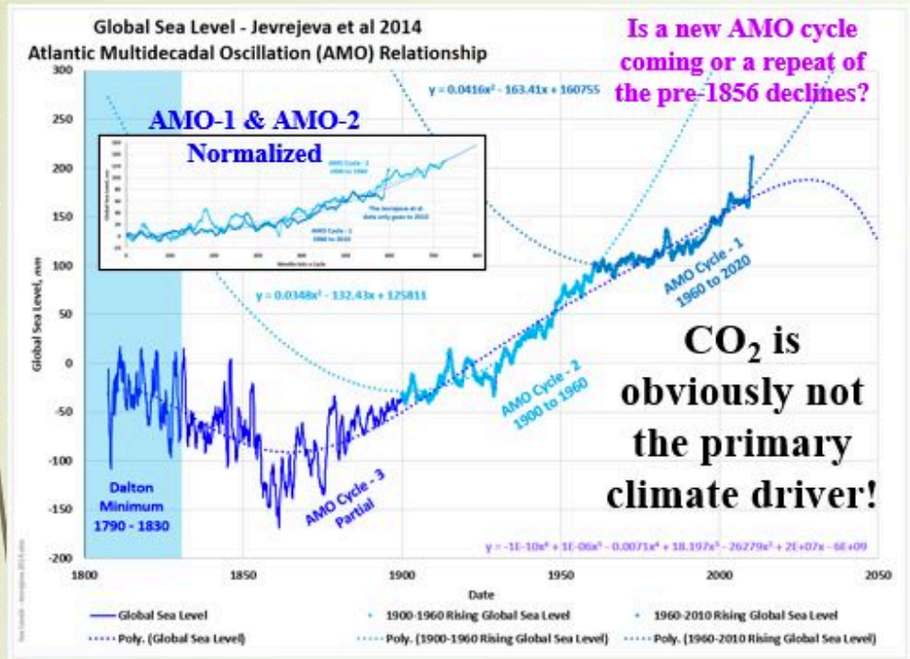
Move in Long-Term Synchronization

Four "Ice Age Cycles" Shown



Adapted from Drs. James E. Hansen & Makiko H. Sato / csas.earth.Columbia.edu

CSM – Grand Solar Minimum. The real "Climate Change" existential threat is right around the corner. Do the Research!



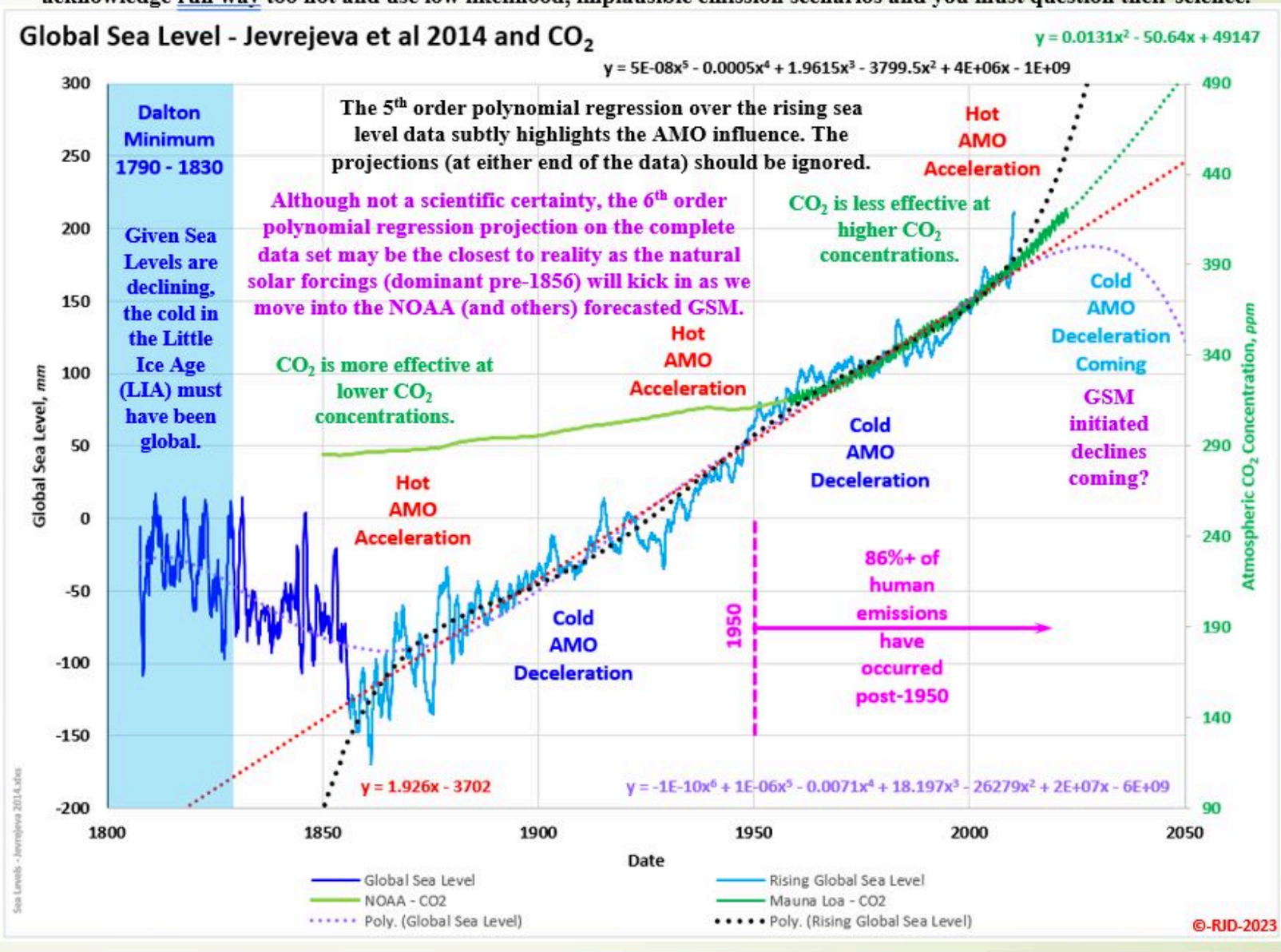
The plot to the right obliterates the CAGW alarmist narrative. Sea levels are tied closely to global temperatures. The responses are muted (due to the sheer size of the oceans) but they are there. If CO_2 is responsible for virtually all the warming since the pre-industrial period, CO_2 should correlate to this entire seal level dataset. Obviously, that is not the case. The CO_2 data has been correlated to the post-1950 period since 86% of humanity's emissions occurred over that period. Just because the CO_2 correlates does not mean that CO_2 was responsible for all the warming/ sea level rise. There are accelerations and decelerations throughout the sea level data, but the long-term trend (since 1856) is linear. The 60-year acceleration/deceleration cycle is most likely due to ocean cycles (primarily the AMO), not CO_2 and will decelerate sea level rise again bringing the sea levels back to the linear trend. The pre-1856 declining sea levels are a major problem for the alarmist narrative, given that CO_2 levels were virtually flat over that period. Ocean cycles can affect sea level, but they cannot change the direction sea levels are trending on these time scales. That leaves other natural forcings (i.e.: solar related activity). Strange how the sea level declines began during the Dalton Minimum. CO_2 has little effect on sea level.

No CO_2 Sea Level Correlation

OPS-74 CO_2 and Sea Level – 1807 to 2010

More detail, climatechangeandmusic.com

The Catastrophic Anthropogenic Global Warming (CAGW) alarmist narrative is simple (and insidious). The basic premise tells us that we (humanity) are responsible for virtually all the warming since the pre-industrial period (primarily through our CO_2 emissions) and continued CO_2 emissions will lead to dangerously high temperatures and accelerated extreme weather events. Regardless of what they tell us, they have no empirical CO_2/Temperature datasets that show CO_2 driving the climate on any statistically significant historical time scale. Combine that with their computer model projections that they self-acknowledge run way too hot and use low likelihood, implausible emission scenarios and you must question their science.



Carbon neutrality

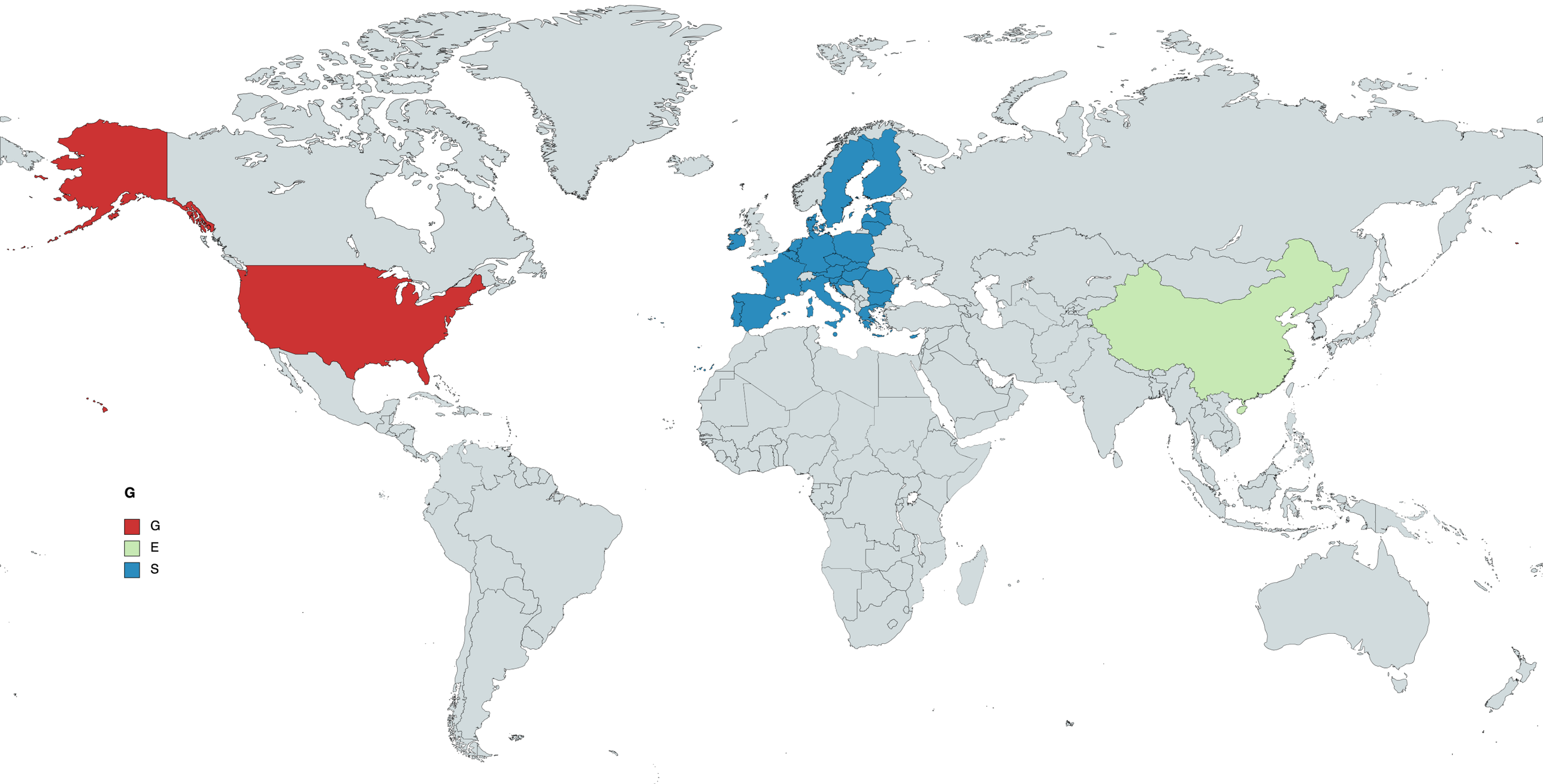
- Carbon neutrality is to limit anthropogenic GhG production to the level that is removed from the atmosphere.
- Limit temperature increase to 1.5 ℃ from pre-industrial levels prevents an intractable feedback loop


The Economist
What 3°C of global warming looks like

Sustainability

- **Climate Change**: The concentration of carbon dioxide (CO2) in the atmosphere has increased from 280 parts per million (ppm) in pre-industrial times to over 410 ppm in 2021. (Source: NASA)
- **Biodiversity**: Around one million plant and animal species are at risk of extinction, with the current rate of extinction estimated to be tens to hundreds of times higher than the average over the past 10 million years. (Source: IPBES)
- **Food Waste**: Approximately one-third of all food produced globally is wasted, which amounts to 1.3 billion tons of food each year. (Source: FAO)
- **Plastic Pollution**: There will be more plastic than fish in the ocean by weight by 2050 if current trends continue, with an estimated eight million tons of plastic entering the ocean each year. (Source: World Economic Forum)
- **Energy Consumption**: The global energy consumption is expected to increase by 50% by 2050, with renewable energy sources expected to provide 70% of the additional energy demand. (Source: IEA)
- **Water Scarcity**: Two-thirds of the global population could face water scarcity by 2025, and over 4 billion people already face severe water scarcity at least one month per year. (Source: UN)
- **Sustainable Finance**: Sustainable investment funds have grown 96% since 2019, and sustainable debt issuance reached a record high of $732 billion in 2020. (Source: BloombergNEF)
- **Circular Economy**: Less than 10% of the world's materials are currently reused or recycled, and the global waste generation is expected to increase by 70% by 2050. (Source: World Bank)

FIT



Created with mapchart.net


EARTH5R
www.earth5r.org
5 GENDER EQUALITY

Environment

- Green Power stocks
- Water supply
- Renewable energy
- Pollution control
- Green transportation
- Waste reduction

Social

- Community impact
- Minorities
- Diversity

Governance

- Principles
- Processes
- Ethics
- Regulation
- Compliance

ESG Pillars

E Pillar

- Its use of or dependence on fossil fuels
- Its use or management of water and other resources
- Pollution levels
- Climate change
- Hazardous materials and their disposal
- Carbon footprint and whether it uses renewable energy

title

- Employment equality and gender diversity
- Product safety concerns and liability
- Employee health and safety
- Training and development
- Animal testing
- Stance on physical and mental health-related issues
- Supply chain transparency
- Human rights
- Privacy issues

title

- Compensation of employees and board executives
- Board and company diversity
- Tax strategy and accounting standards
- Bribery and corruption
- Fraud
- Ethics and values
- Transparency and anti-corruption
- Shareholder rights


7
8 DECENT WORK AND ECONOMIC GROWTH
9
10 REDUCED INEQUALITIES
11
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15
17 PARTNERSHIPS FOR THE GOALS
THE GLOBAL GOALS
TED

Business Case:

The Nyaliga Fire Project

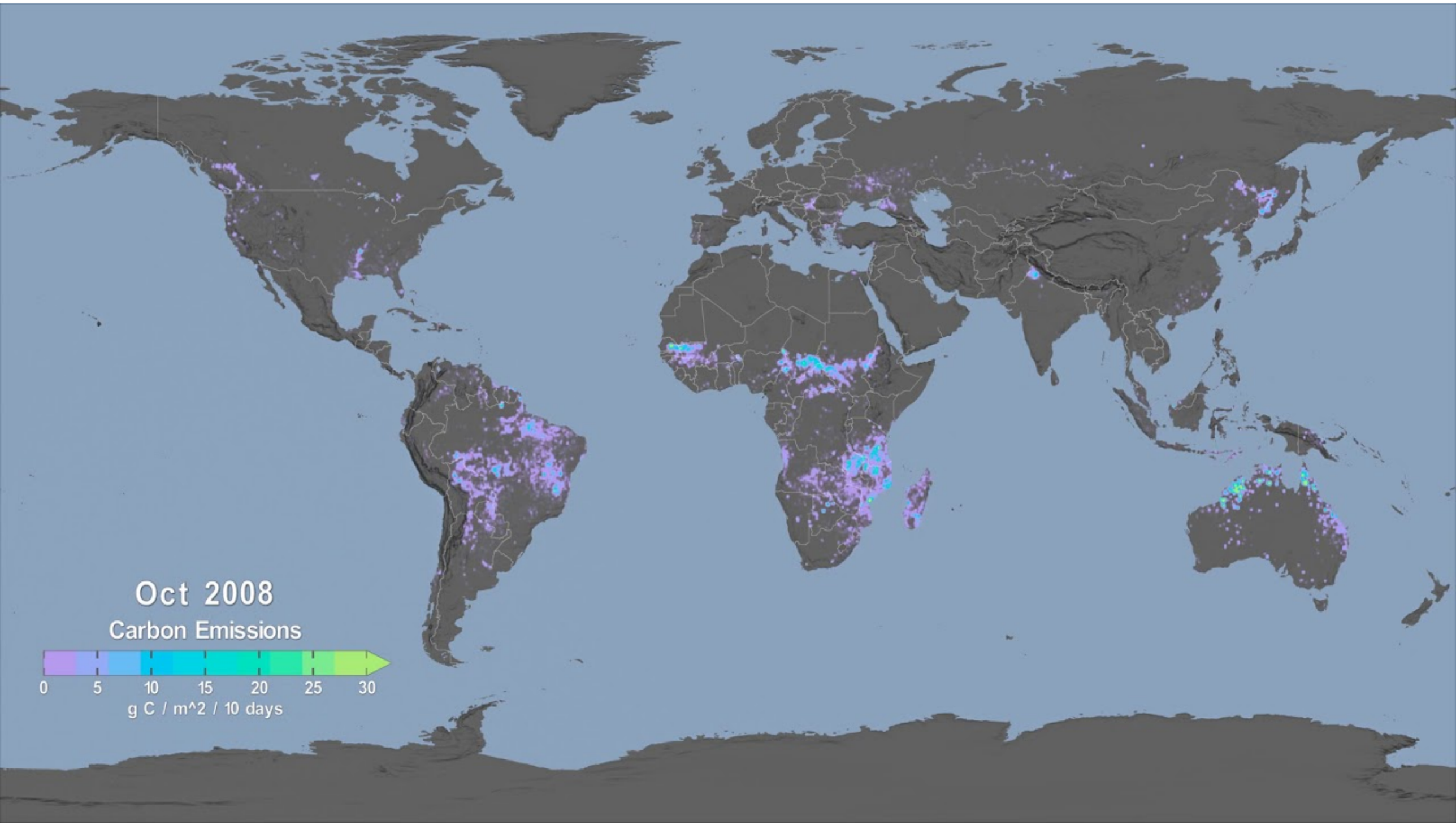
Savanna fire management

- The Nyaliga Aboriginal Corporation
  - manages a savanna carbon project
  - 6,400 square kilometres
  - Eastern Kimberley (AUS)
- Controlled savanna burning in the early dry season (March to July):
  - traditional Indigenous knowledge
  - modern technologies,

Savanna facts

- Northern Australia's savanna wildfires occur during the late dry season (usually August to December).
- If the land isn't managed to reduce these wildfires, they can burn intensely, at scale, over long periods of time.
- Aug–Dec fires release substantially more greenhouse gas than early dry season fires which are cooler and patchier, burning less extensively and intensely.
- ERF funds, since 2017, the controlled savanna fire management in the early dry season (March to July) as a carbon abatement method.
- In 2020–21, the majority of carbon credits generated by registered Emissions Reduction Fund savanna fire management projects were from projects managed or carried out by Indigenous Australians. Elder Kathleen O'Reeri states that:
  - It protects their sacred places
  - makes areas for food gathering and hunting.
  - It looks after their food resources, culture, and way of living.
  - They call it 'right way' burning

Forest fires



Savanna results

Compared to pre-2017:

- the amount of their Country burned has reduced by one third,
- the area burnt late in the season by two-thirds,
- annual emissions have reduced against baseline averages by over 40% on average:
  - The carbon credits earned can be sold back to the Australian Government or to businesses to offset their GhG emissions
- The trees are better, the grass and wildlife are coming back

Carbon credits

Their annual carbon credit income is being used to:

- Run the fire management project, including to help employ Nyaliga people as casuals,
- to provide fire training opportunities,
- and to ensure the sustainability of the work being done by their new team of six local rangers and Ranger Coordinator.

Social impact

- "It also caters for our elders to take our young people back on Country to teach them about our land, law and culture".
- "Our elders go out with the rangers and kids during the school holidays - we call them 'Back to Country' trips. We teach about our way of living and our culture, and how to protect our sacred places.

Factsheet

Savanna fire management projects reduce the size, intensity and frequency of savanna wildfires in northern Australia to decrease the amount of greenhouse gases released into the atmosphere. This reduction in emissions earns Australian carbon credit units (carbon credits).

Undertaking controlled savanna burning has a range of other environmental, economic, social and cultural benefits:

Diversified revenue
Carbon credits provide an additional income stream for savanna land managers.

Cultural benefits
Indigenous savanna projects use traditional knowledge and provide on-country economic opportunities for Indigenous communities.

Farm benefits
Controlled burns improve pastoral productivity by stimulating grass regrowth and inhibiting woody weeds.

Property protection
Reduced wildfire intensity decreases threat to property, livestock and infrastructure.

Disclosure and audit

Methodology determination

Project Register

dun & bradstreet

Dun & Bradstreet's ESG Rankings Dataset:

Context, Methodology, and Applications

EXECUTIVE SUMMARY

Environmental, social and governance metrics — or ESG — have become mainstream with the emergence of more and better data, as well as an increased understanding of the environmental and social pressures of modernity. Dun & Bradstreet is committed to contributing meaningful and consistent ESG data on public and private businesses. Our new Dun & Bradstreet ESG Rankings dataset covers over 11 million public and private companies, and is constantly expanding in company coverage.

To compose an ESG score, Dun & Bradstreet has built on efforts present in the current ESG landscape and added our own unique data assets to provide transparency around ESG performance across public and private companies. The dataset will contribute to the ESG data landscape as follows:

- Wide coverage of both public and private companies using a consistent approach.
- Scores that are informed by real data, the majority of which is verified information.
- Emphasis on the importance of metrics to company stability and financial performance.
- Updated data provided monthly.

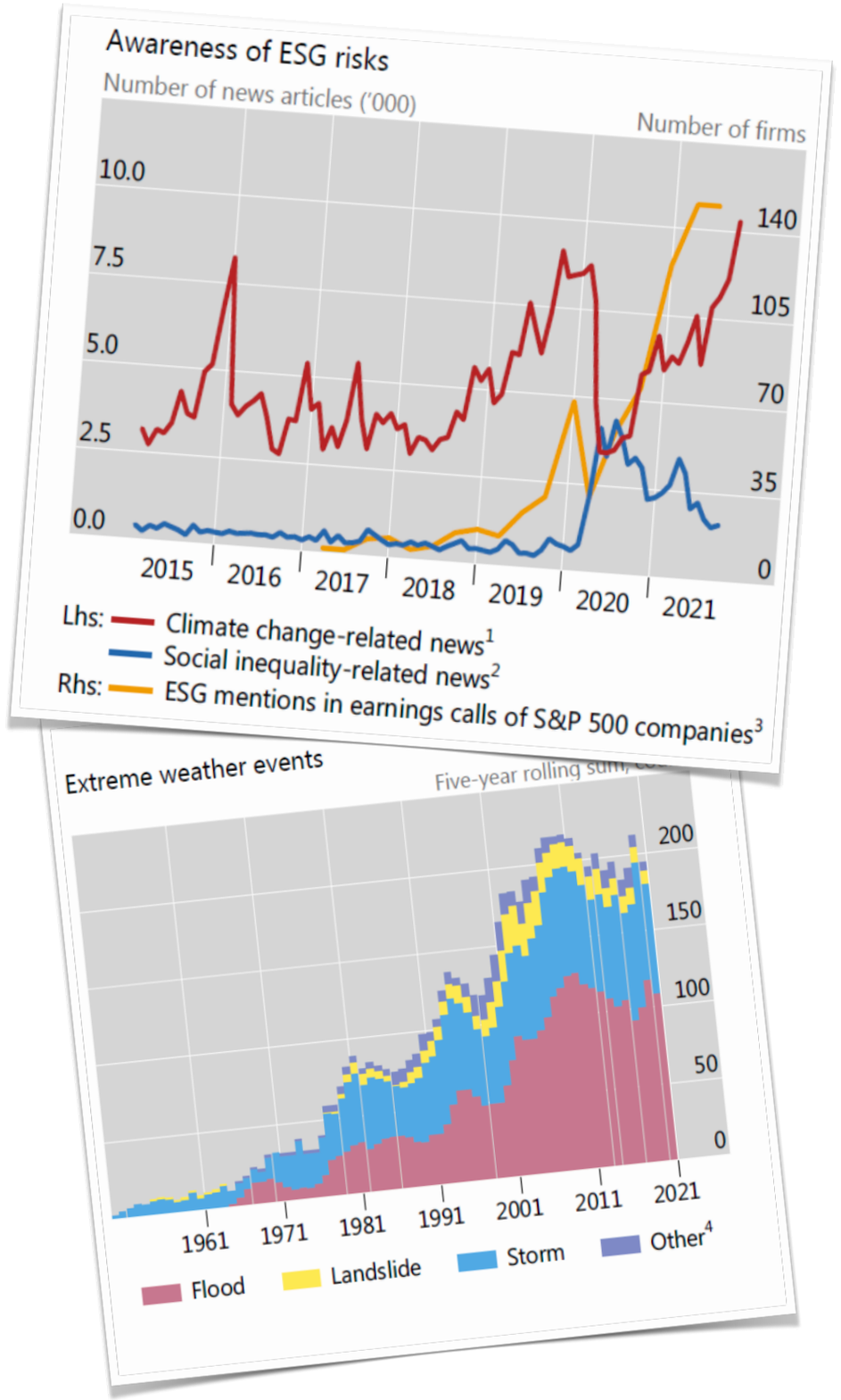
The ESG Rankings dataset's topic architecture was created by referencing several of the leading ESG standards; data is sourced, collected, and quality-checked through various processes. In preparation for analytical modeling and calculations, data is further normalized, processed, and weighted. The outputs are various ESG-related rankings as well as overall scores. The ESG outputs are calculated in a straightforward, mathematical manner to create data that is normally distributed between 1, indicating low risk or best performance, and 5, indicating high risk or worst performance.

The Dun & Bradstreet ESG Rankings dataset offers a decision-useful set of metrics that can be used in multiple applications, such as supply chain management, investing, lending and credit evaluation, insurance inputs, and even sales and marketing segmentation. Aggregating a massive array of ESG-related data into manageable indicators that are decision-useful has been one of the long-term goals of the sustainability field, and one that Dun & Bradstreet supports and contributes to.

Dun & Bradstreet has tested our ESG Rankings dataset for robustness, but recognizes there are areas of refinement. These areas are the focus of existing workstreams that increase data availability through more granular and broad data acquisition as well as further use of modeling, where appropriate; refinement of natural language processing (NLP) libraries and analysis to filter out "greenwashing"; and harmonizing of local ESG data availability in an ESG dataset with global coverage. Developing ESG products that provide depth around specific risks or trends, such as climate impact or emerging regulations, is also part of providing a wide range of useful and valuable intel on the ESG metrics for public and private companies.

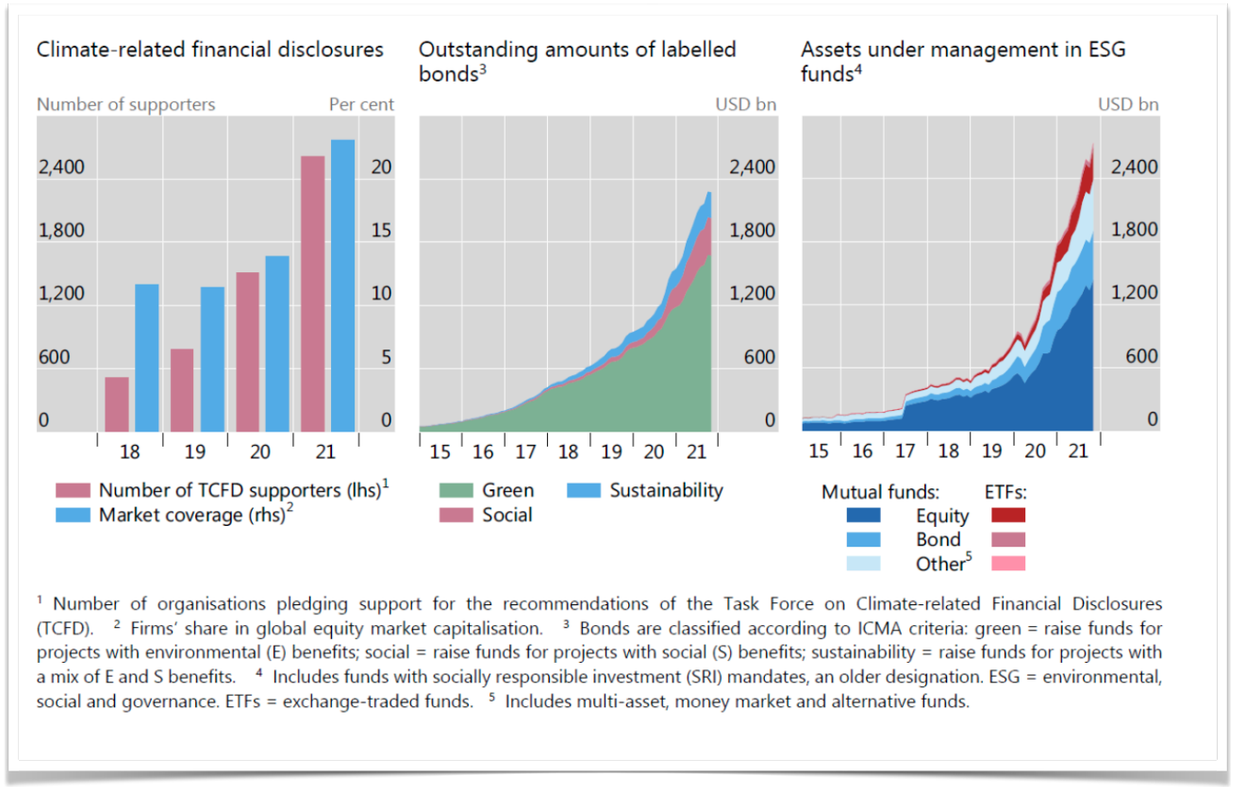
ESG awareness

- ESG increasingly considered by news media, governments and companies
- Increased pressure to governments to consider ESG in their political agenda
- More corporations now disclose their ESG plans and goals
- Investors are now considering ESG risk as part of their investment criteria



Size of ESG markets

- $2 Tn in ESG-labelled bonds
  - Bond issuances to fund ESG initiatives.
  - Green bonds dominate
  - Increase in social bonds during COVID- 19
- $2.4 Tn AUM in ESG funds
  - Retail and institutional



[1] Number of organisations pledging support for the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). [2] Firms' share in global equity market capitalisation. [3] Bonds are classified according to ICMA criteria: green = raise funds for projects with environmental (E) benefits; social = raise funds for projects with social (S) benefits; sustainability = raise funds for projects with a mix of E and S benefits. [4] Includes funds with socially responsible investment (SRI) mandates, an older designation. ESG = environmental, social and governance. ETFs = exchange-traded funds. [5] Includes multi-asset, money market and alternative funds.

Macroeconomic variables and carbon emissions

- Devise the right structural and cyclical policies towards a more sustainable economy through mapping macroeconomic variables into carbon emissions

- They map key macroeconomic variables and carbon emissions using comprehensive data from a panel of 121 countries over the 1971–2016 period to establish the link between per capita carbon emissions and macroeconomic variables

- The find linear and non-linear **policy relevant** relations, the study also uncovers a non-linear link between economic activity and carbon emissions

BIS Working Papers No 937
Growth, coal and carbon emissions: economic overheating and climate change
by Emanuel Kohlscheen, Richhild Moessner and Előd Takáts

- Advanced and emerging economies
- Different time periods

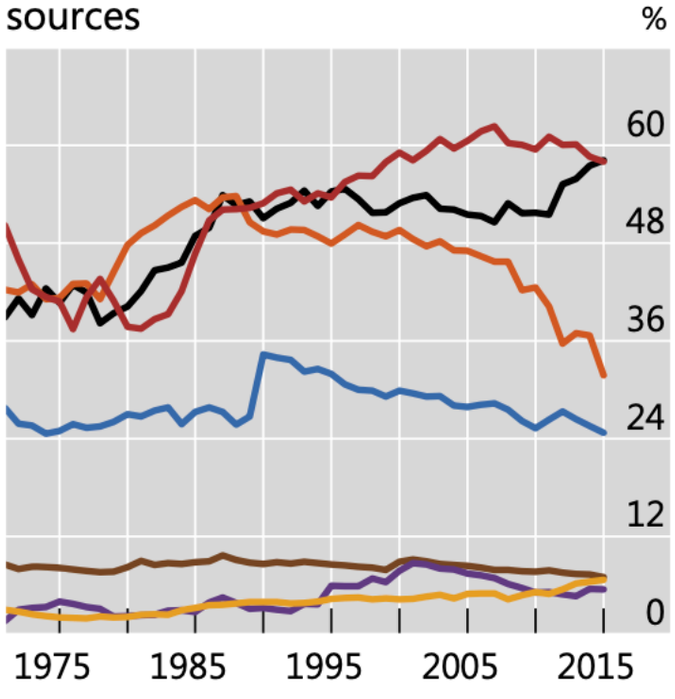
Electricity production

Electricity production

In percent of total[1]

Figure 2

Electricity production from coal sources



[1] Population-weighted averages. [2] Excluding hydroelectric power. Source: IEA Statistics.

Linear model for CO2 emissions

Country

GDP per capita

Real GDP growth

$$\mathrm{CO}_{2_{i,t}} = \alpha_i + \beta_t + \delta \cdot \mathrm{CO}_{2_{i,t-1}} + \gamma \cdot \mathrm{GDP}_{\mathrm{pc}_{i,t}} + \theta \cdot \mathrm{growth}_{i,t}$$
$$+ \omega \cdot \mathrm{urbanization}_{i,t} + \vartheta \cdot \mathrm{manufacturing}_{i,t}$$
$$+ \mu_1 \cdot \mathrm{share}_{\mathrm{oil}_{i,t}} + \mu_2 \cdot \mathrm{share}_{\mathrm{coal}_{i,t}} + \mu_3 \cdot \mathrm{share}_{\mathrm{renewables}_{i,t}}$$
$$+ \varepsilon_{i,t}$$

Manufacturing/GDP ratio

Beef cattle herd management

- Australia's cattle producers are reducing their environmental impact.
- The Emissions Reduction Fund recognises the benefits of by managing large herds in ways that reduce the emissions per kilogram of beef produced.

Beef Cattle Trade

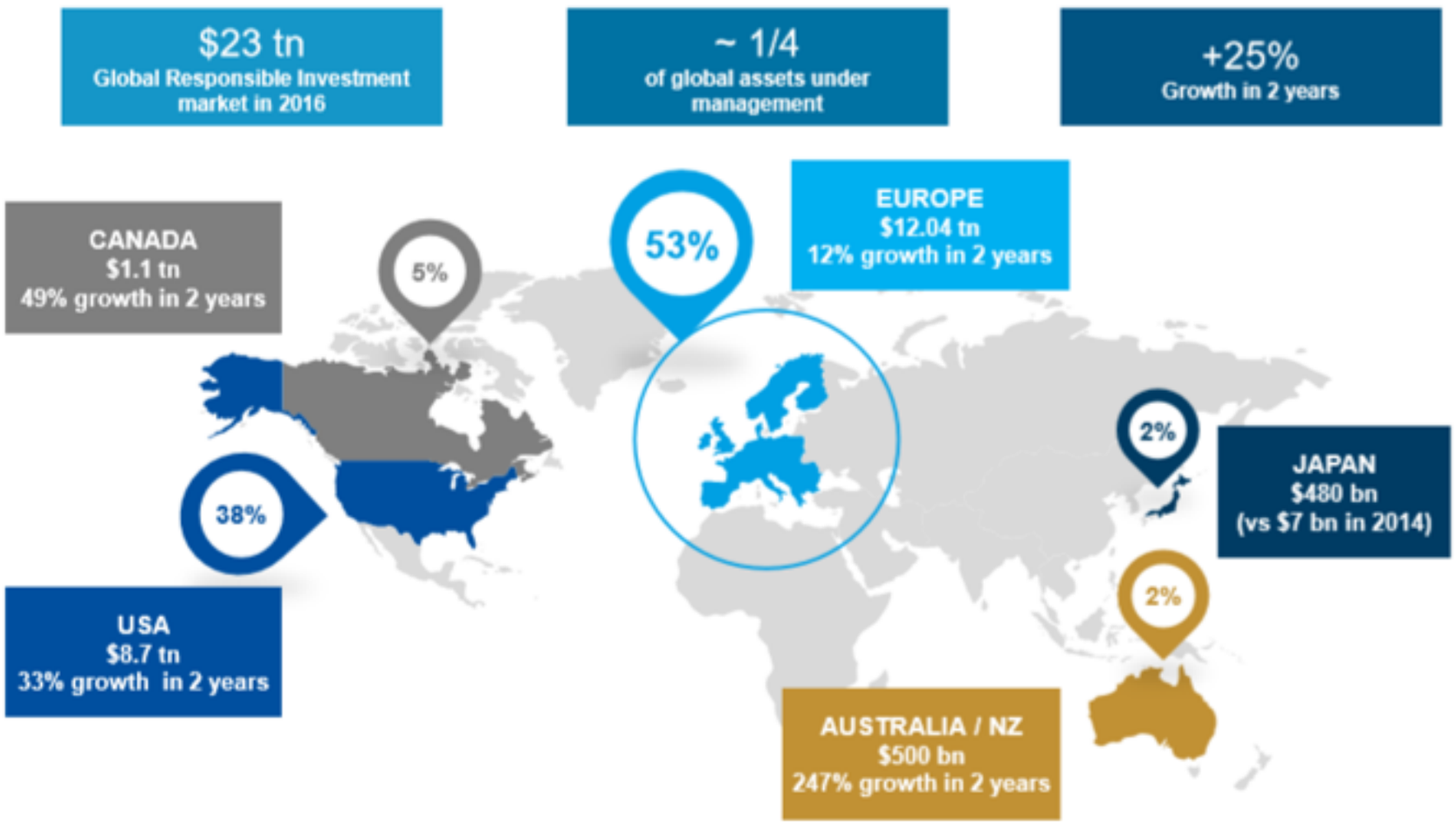
Business Impact of Climate Change

- Understand cognitive challenges
- Develop a “Risk Thinking” methodology
- Business development:
  - Urban design
  - Carbon trading
  - Green finance

For millennials, social issues matter most

Most important factor in deciding to do business with a company:

Source: Allianz ESG Investor Sentiment Study, 2018



Source: Global Sustainable Investment Alliance (2017).

Bloomberg Climate Risk Analytics Survey 2022

Survey ended May 2022, reported July 2022

Financial Firms See Climate Risks as a Top Priority

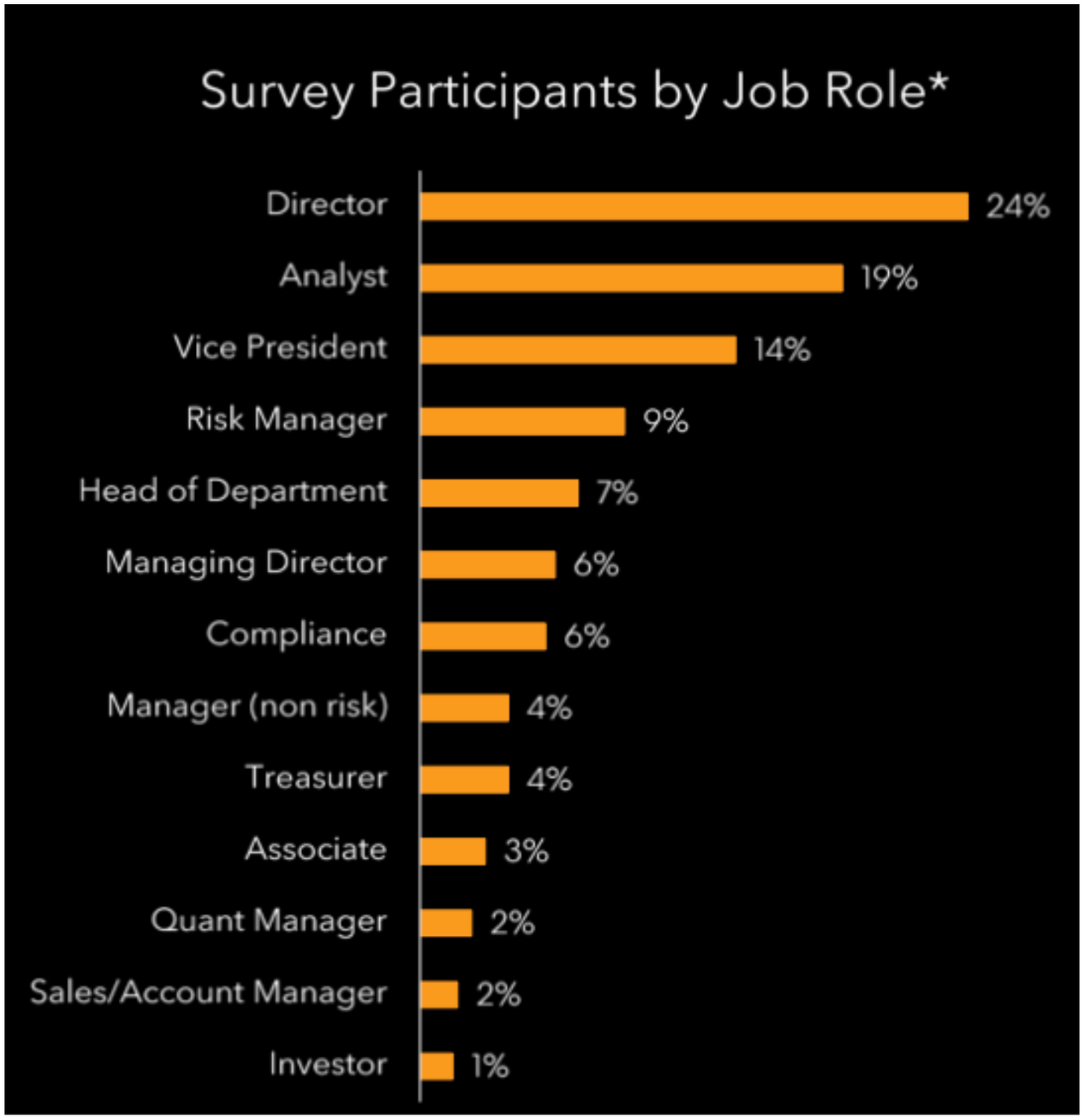
but Lack Consensus on How to Effectively Analyze Climate Concerns

85% of firms have started assessing climate risk

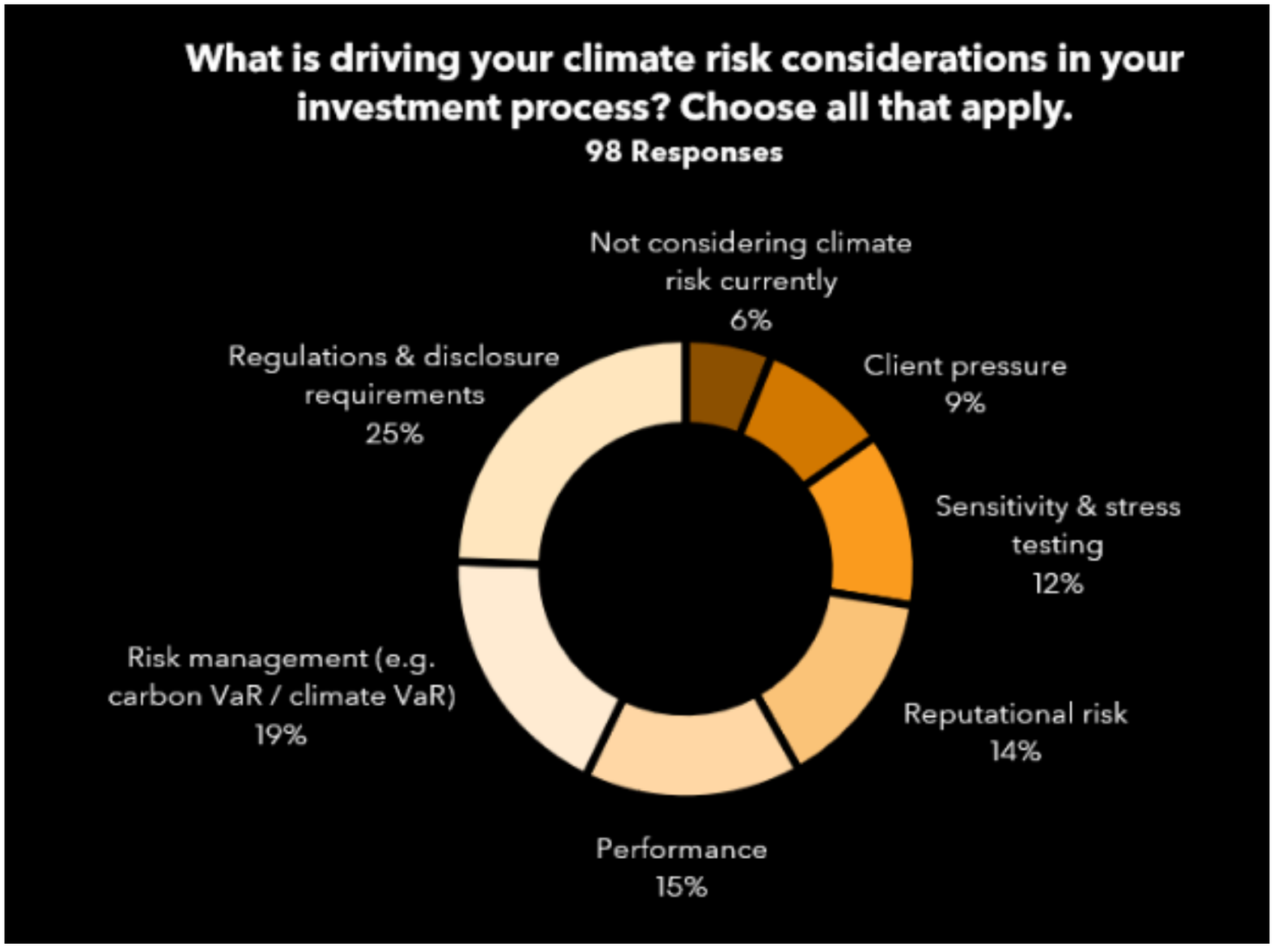
however there is still a way to go with embedding climate into risk management frameworks

Bloomberg

Survey respondents



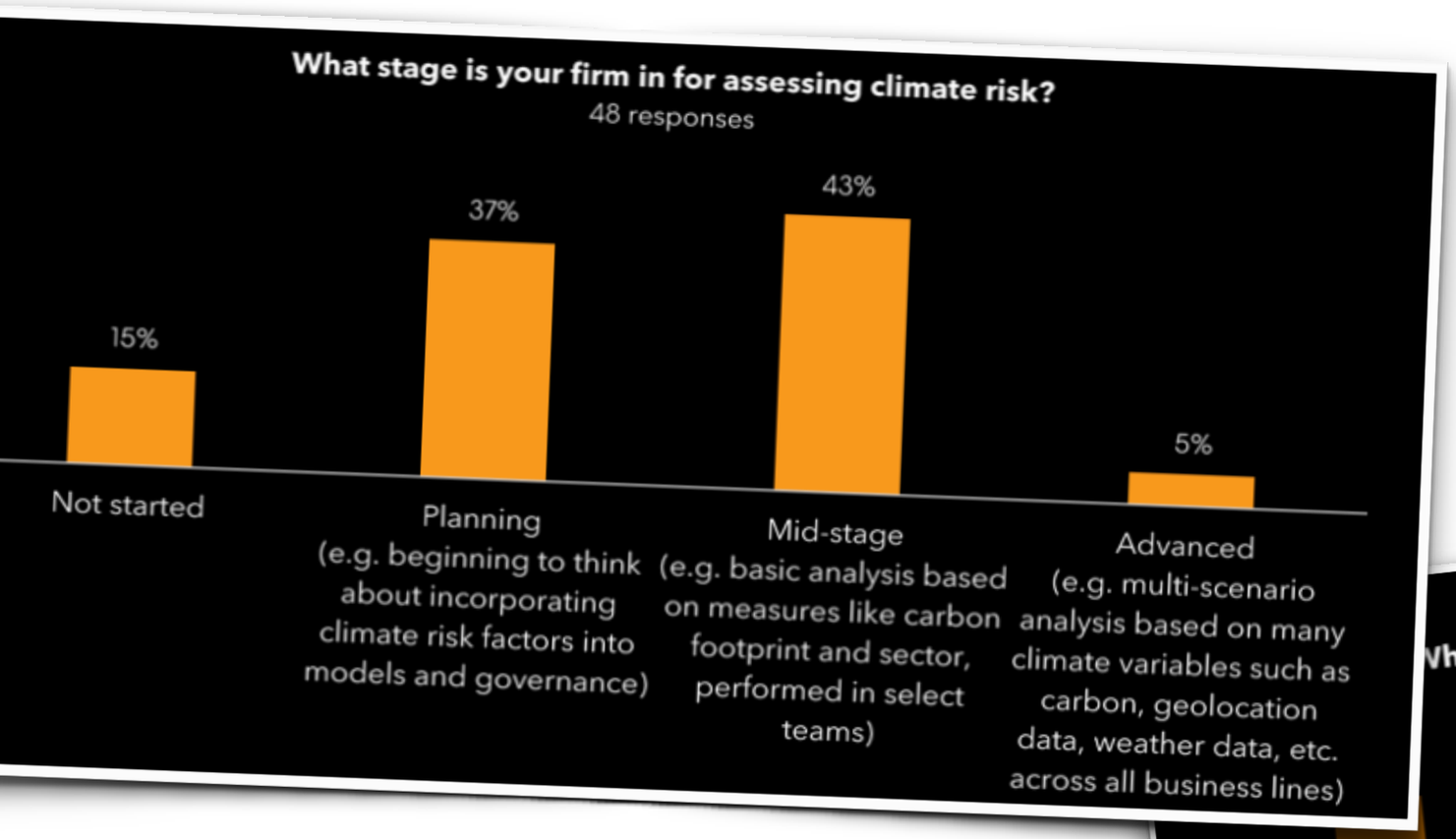
Drivers

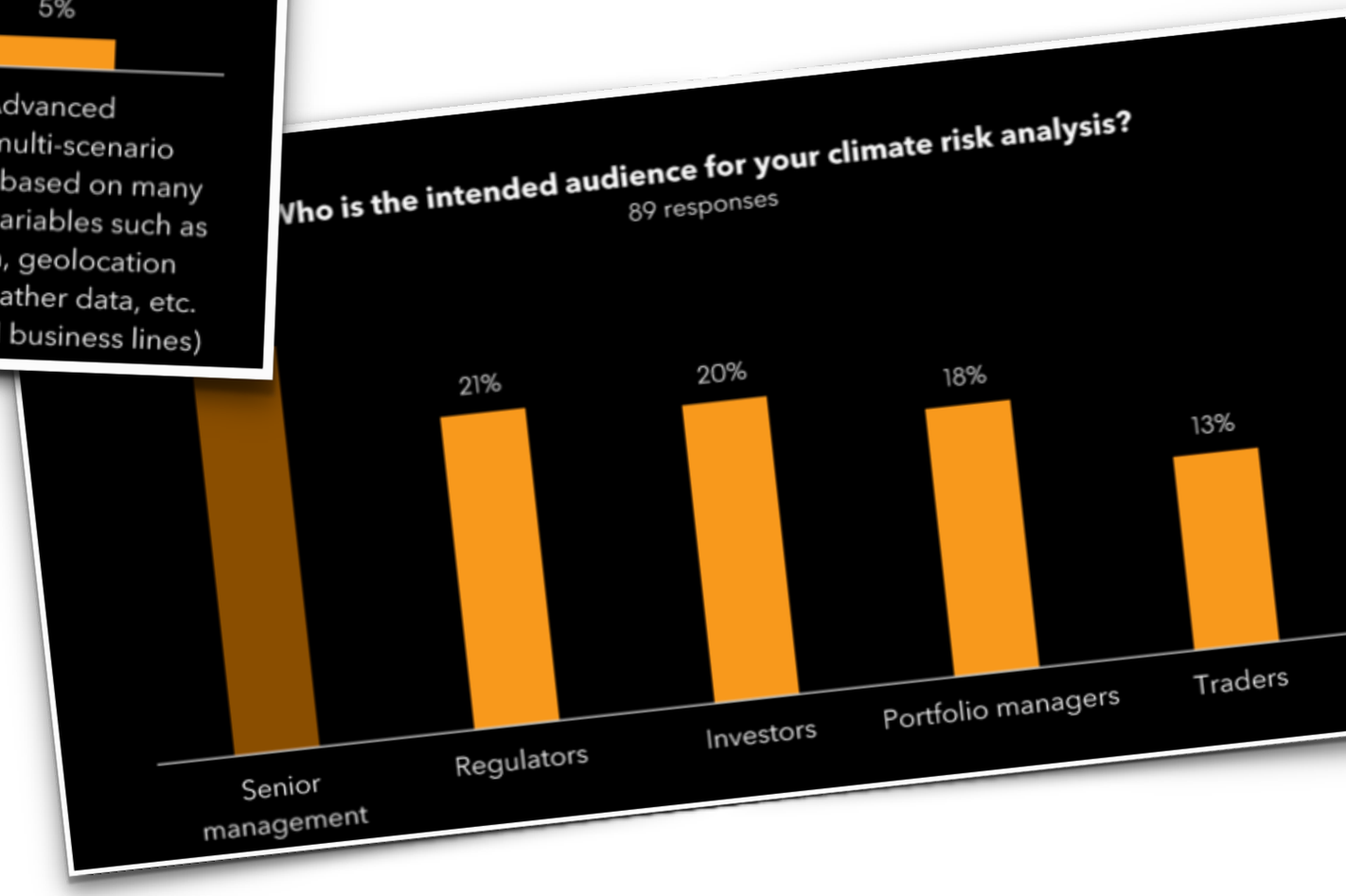

What is driving your climate risk considerations in your investment process? Choose all that apply.
98 Responses
Not considering climate risk currently 6%
Client pressure 9%
Sensitivity & stress testing 12%
Reputational risk 14%
Performance 15%
Risk management (e.g. carbon VaR / climate VaR) 19%
Regulations & disclosure requirements 25%

What & Why

- 85% indicated that their firms have started assessing climate risk but of that group,
- 37% are in the early stages of planning how to incorporate climate risk into models and governance,
- 43% are in the mid-stage of incorporating climate into risk management and governance analysis based on measures like carbon emissions.
- Only 5% of respondents indicated that they are in the advanced stage of having comprehensive data and multi-scenario analysis based on a variety of climate variables like carbon emissions, geolocation data, and extreme weather events.
- Regulators are increasingly focused on better understanding the financial risks arising from climate change,
- 21% of respondents said regulators are the intended top audience for their climate risk analysis.
- 27% listed senior management as their top audience
- 20% Investors
- 18% portfolio managers
- 13% traders (13%).
- This indicates that climate risk is not just a compliance exercise, but instead a priority to incorporate into proper risk management frameworks.

Graphs


What stage is your firm in for assessing climate risk?
48 responses
15%
37%
43%
5%
Not started
Planning (e.g. beginning to think about incorporating climate risk factors into models and governance)
Mid-stage (e.g. basic analysis based on measures like carbon footprint and sector, performed in select teams)
Advanced (e.g. multi-scenario analysis based on many climate variables such as carbon, geolocation data, weather data, etc. across all business lines)

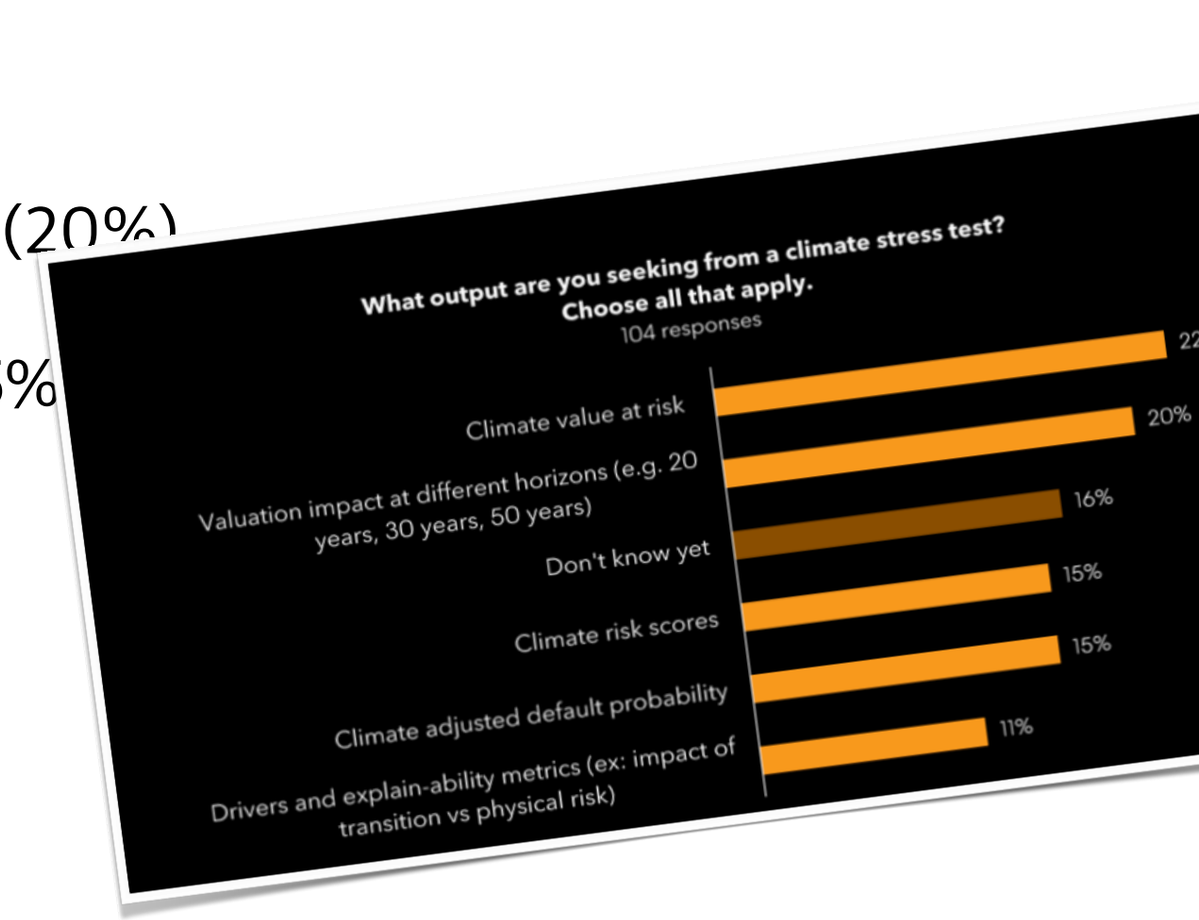

Who is the intended audience for your climate risk analysis?
89 responses
21%
20%
18%
13%
Senior management
Regulators
Investors
Portfolio managers
Traders

Lack of Consensus

There is a a significant lack of consensus on how to evaluate and report on climate risk.

Respondents were quite varied in what they are seeking from a climate stress test

- 16% of respondents did not know what they want.
- Climate value at risk (22%),
- Valuation impact at different timelines (20%)
- Climate adjusted default probability (15%
- Climate risk scores (15%)
- Other 18%



Climate impact on Credit

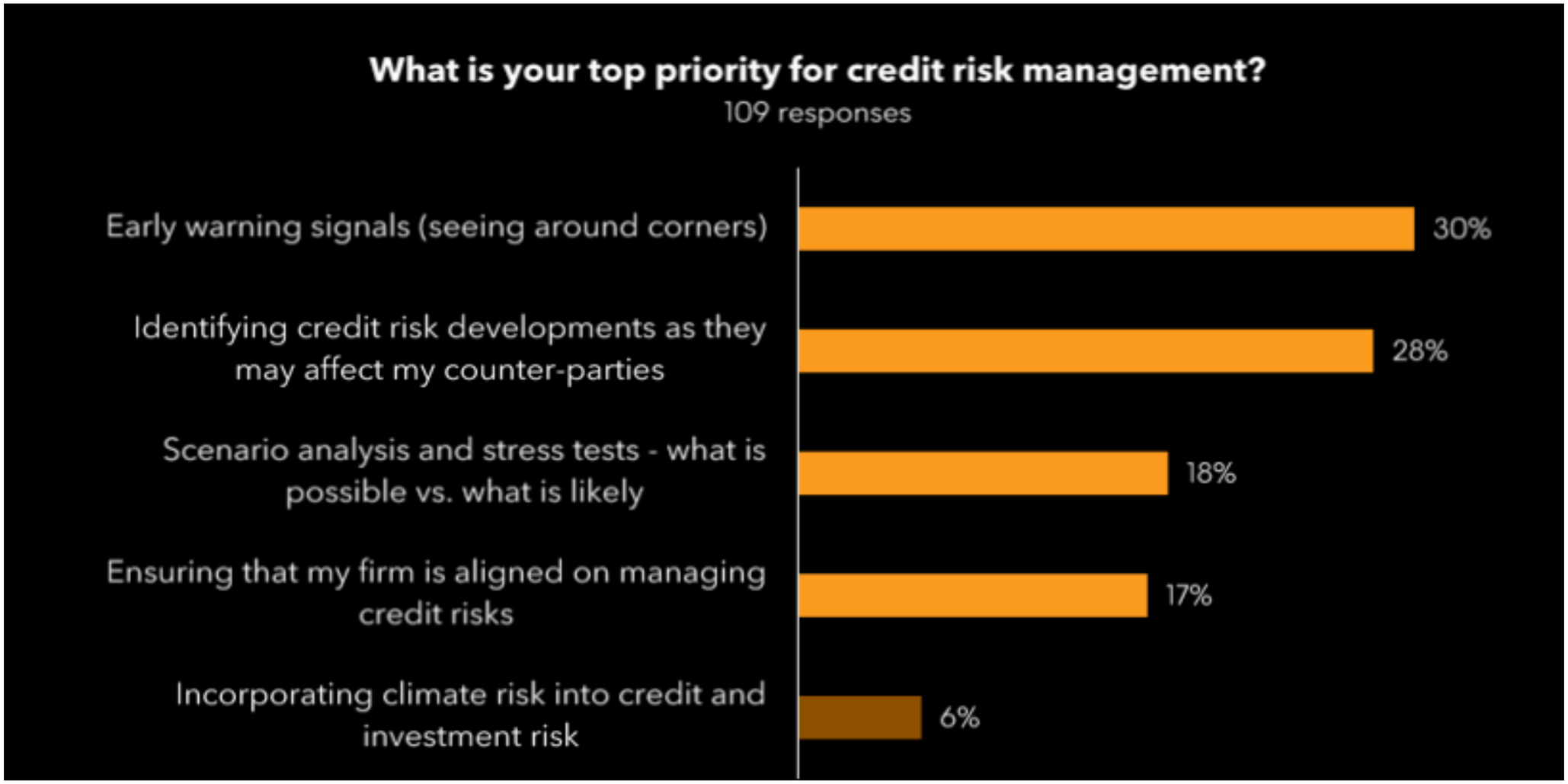
- climate risk impact on credit is currently the lowest priority (6%).

The top priorities for credit risk management were

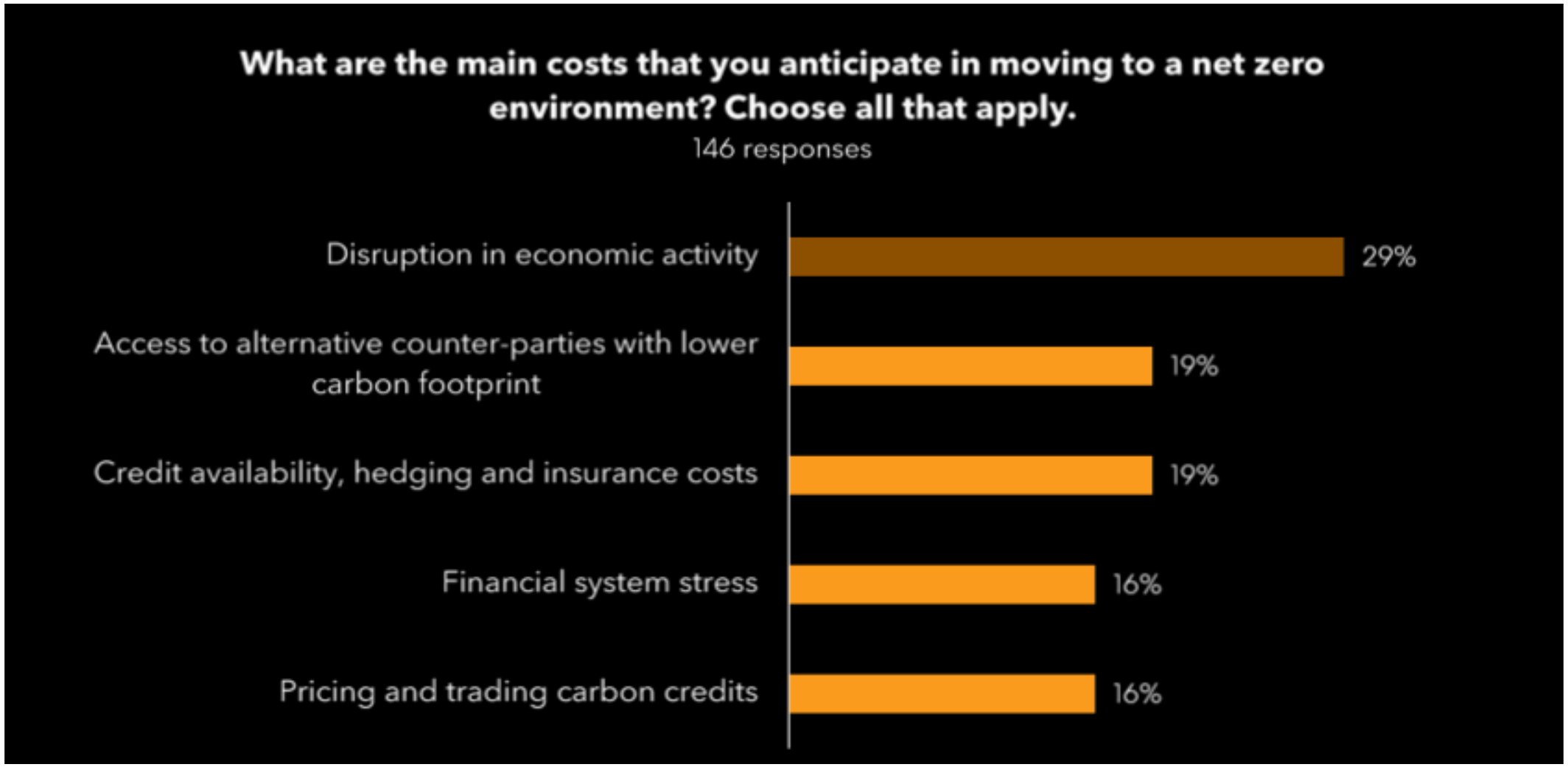
- generating early warning signals (30%),
- identifying credit risk developments as they may affect counterparties (28%),
- scenario analysis and stress tests (18%),
- and firm alignment on managing credit risks (17%),

Firms continue to prioritize other factors over climate in their credit risk frameworks.

Credit


What is your top priority for credit risk management?
109 responses
Early warning signals (seeing around corners)
30%
Identifying credit risk developments as they may affect my counter-parties
28%
Scenario analysis and stress tests - what is possible vs. what is likely
18%
Ensuring that my firm is aligned on managing credit risks
17%
Incorporating climate risk into credit and investment risk
6%

Costs


What are the main costs that you anticipate in moving to a net zero environment? Choose all that apply.
146 responses
Disruption in economic activity
29%
Access to alternative counter-parties with lower carbon footprint
19%
Credit availability, hedging and insurance costs
19%
Financial system stress
16%
Pricing and trading carbon credits
16%

ESG scores: Traditional approach

- Rules-based scoring systems:
  - Human implementation
  - Slow, subjective, questionable
  - No evidence of sustainability

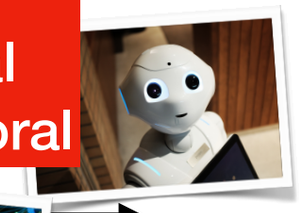
100 years of quantitative methods

1930 1950 2000 2020

Harry Markowitz realized
no value was given to
RISK

"Portfolio Selection," *Journal of Finance*. 1952
languished on dusty library shelves
only four of the 14 pages contained text

ML
AI
ESG
NLP
Social
Behavioral



John Burr Williams,
The Theory of Investment Value
value of a stock given by
current value of future dividends.

A plethora of quant methods
started with the ubiquity of the PC

Find a good stock
buy it at the best price.

100 years of input data

1930

1950

2000

2020

Portfolio theory

Numerical methods

Computer

PC

Company accounting information

Time series analysis

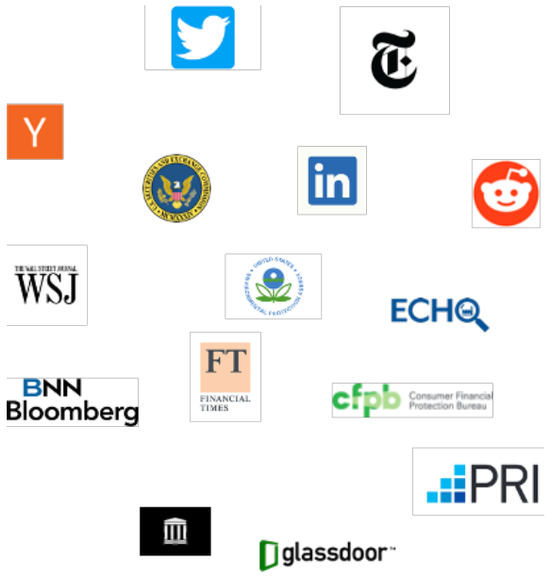
Value investing

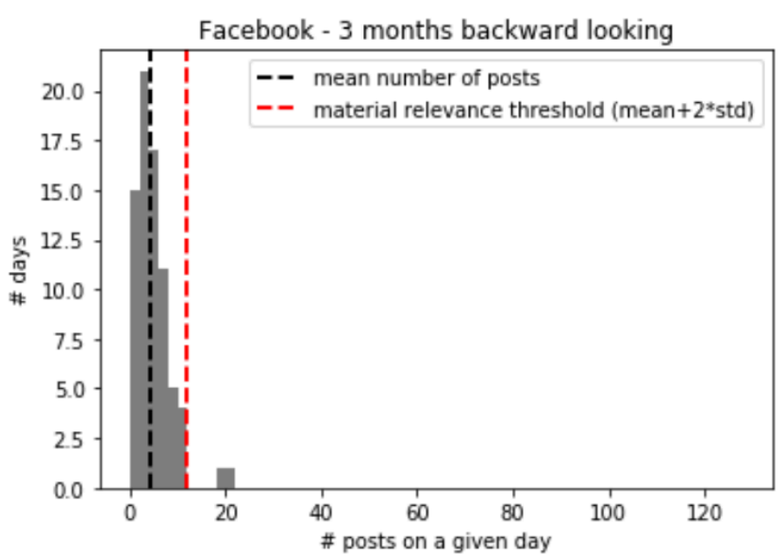
Textual data NLP. LLM, etc.

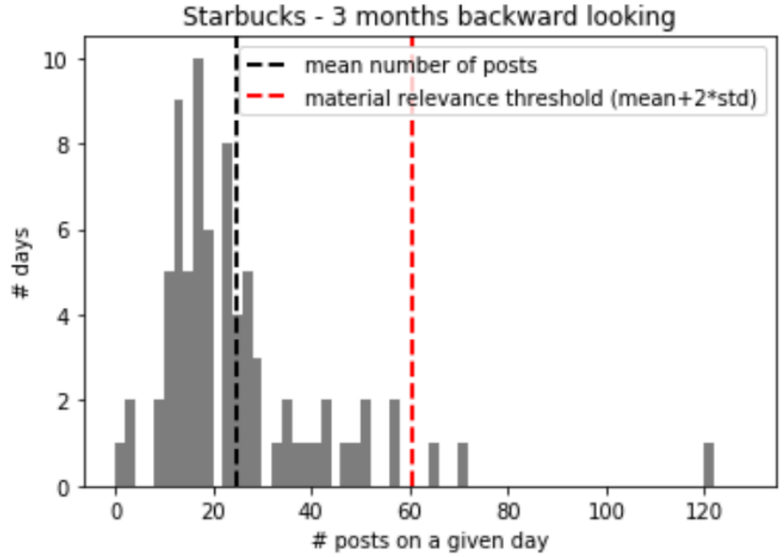
AI

News
Web
Social media
Documents
Filings
...

- Data sources
- Analyze via NLP
- Determine materiality







Interpreting the data

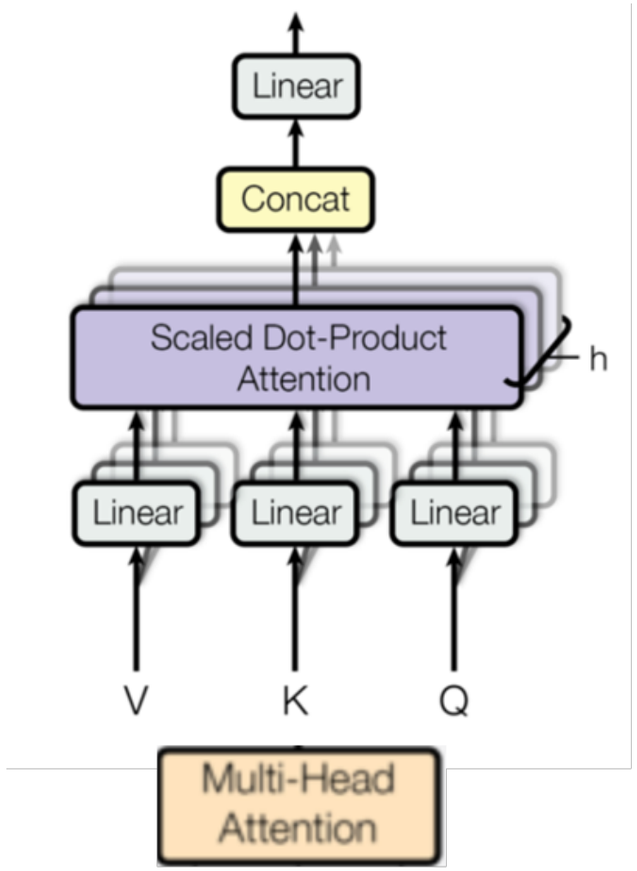
Category	#Tweets
Environment	380
Social Capital	772
Human Capital	491
Business Model & Innovation	80
Leadership & Governance	724
None	2,776
Total	5,223

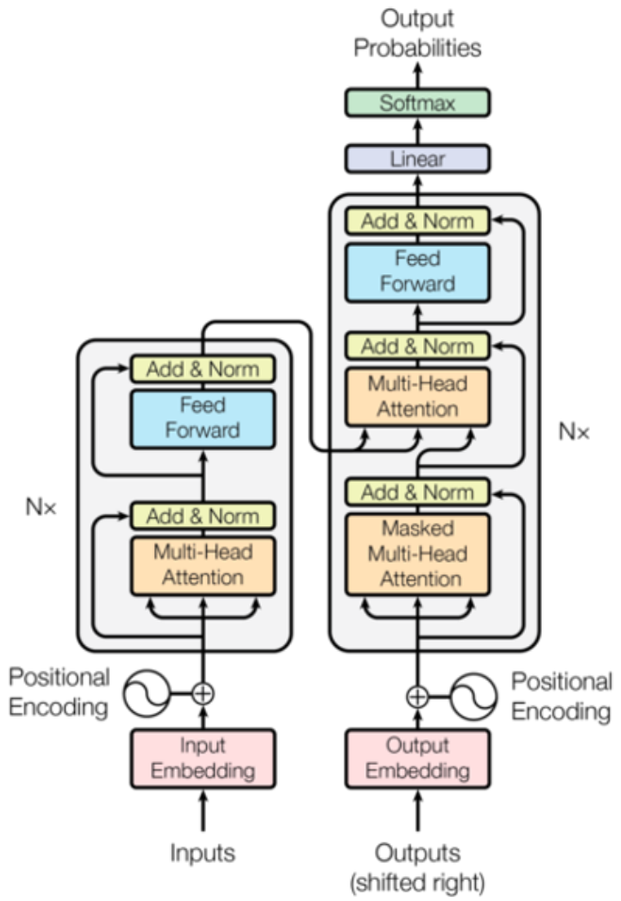
Category	#Tweets
Negative	1,279
Positive	331
Total	1,610

BERT

- Bidirectional Encoder Representations from Transformers
- A neural network-based technique for natural language processing pre-training: discern the context of words
  - Spam filters, search engines, etc.

State-of-the-art natural language processing allows for high-performing NLP models, even for complex subject matter areas, and even under weak supervision





For BERT, we need **encoder only** blocks

Source: Attention is All You Need, Vaswani et. Al.

Facebook business case

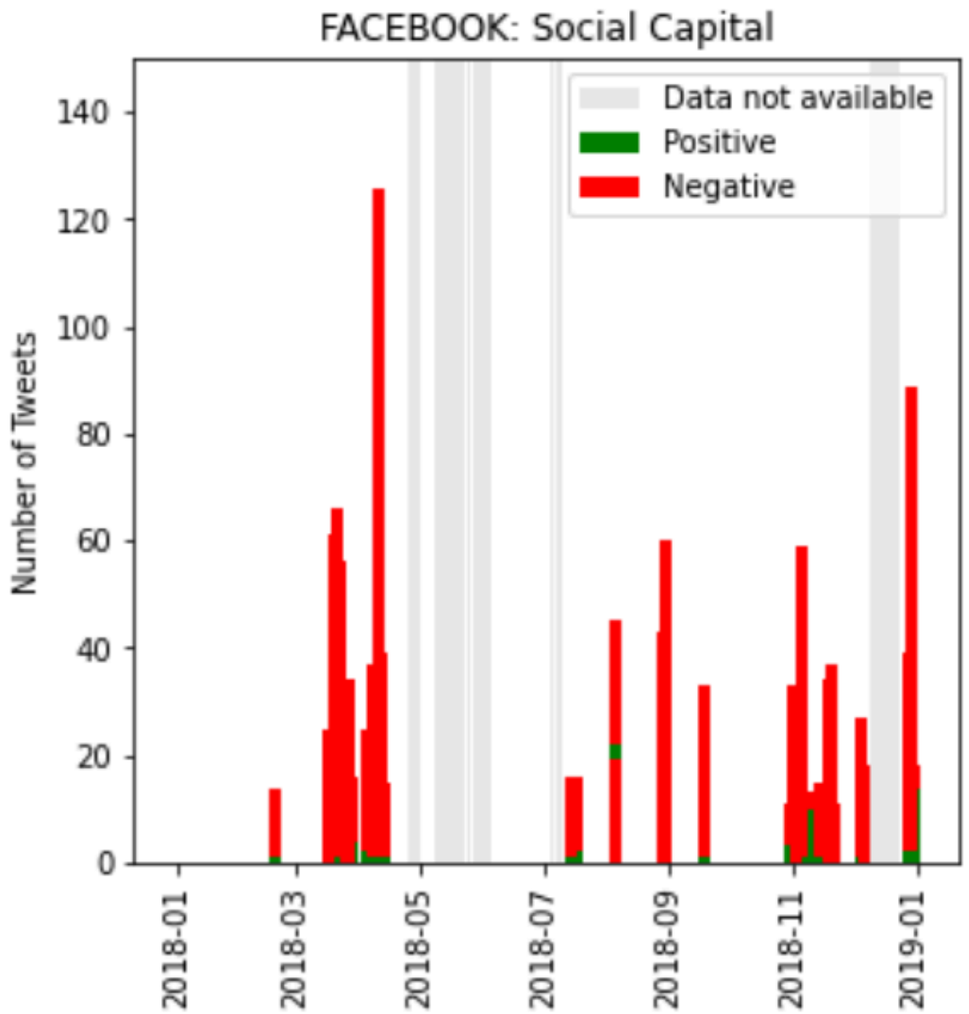


Figure 6: Facebook Social Capital Tweets

Facebook business case

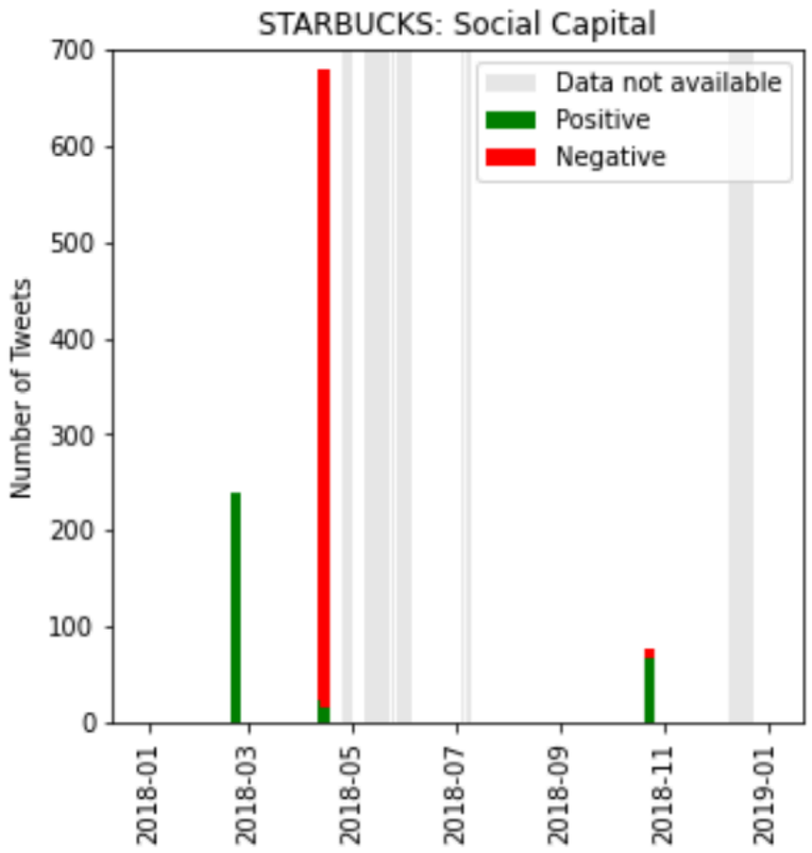


Figure 3: Starbucks Social Capital Tweets

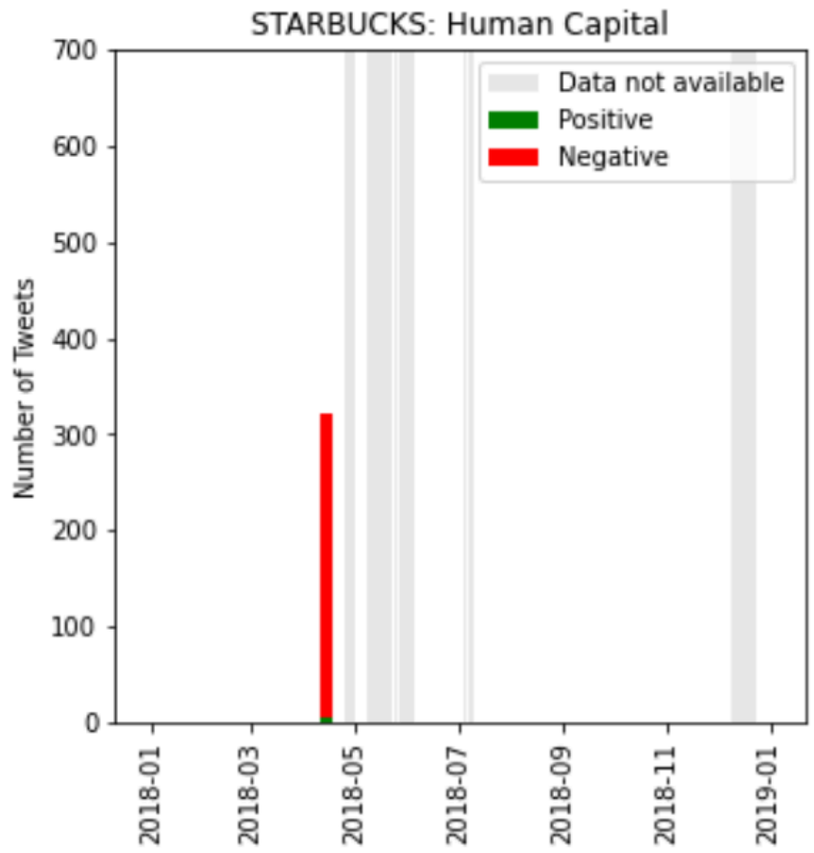


Figure 4: Starbucks Human Capital Tweets

Facebook business case

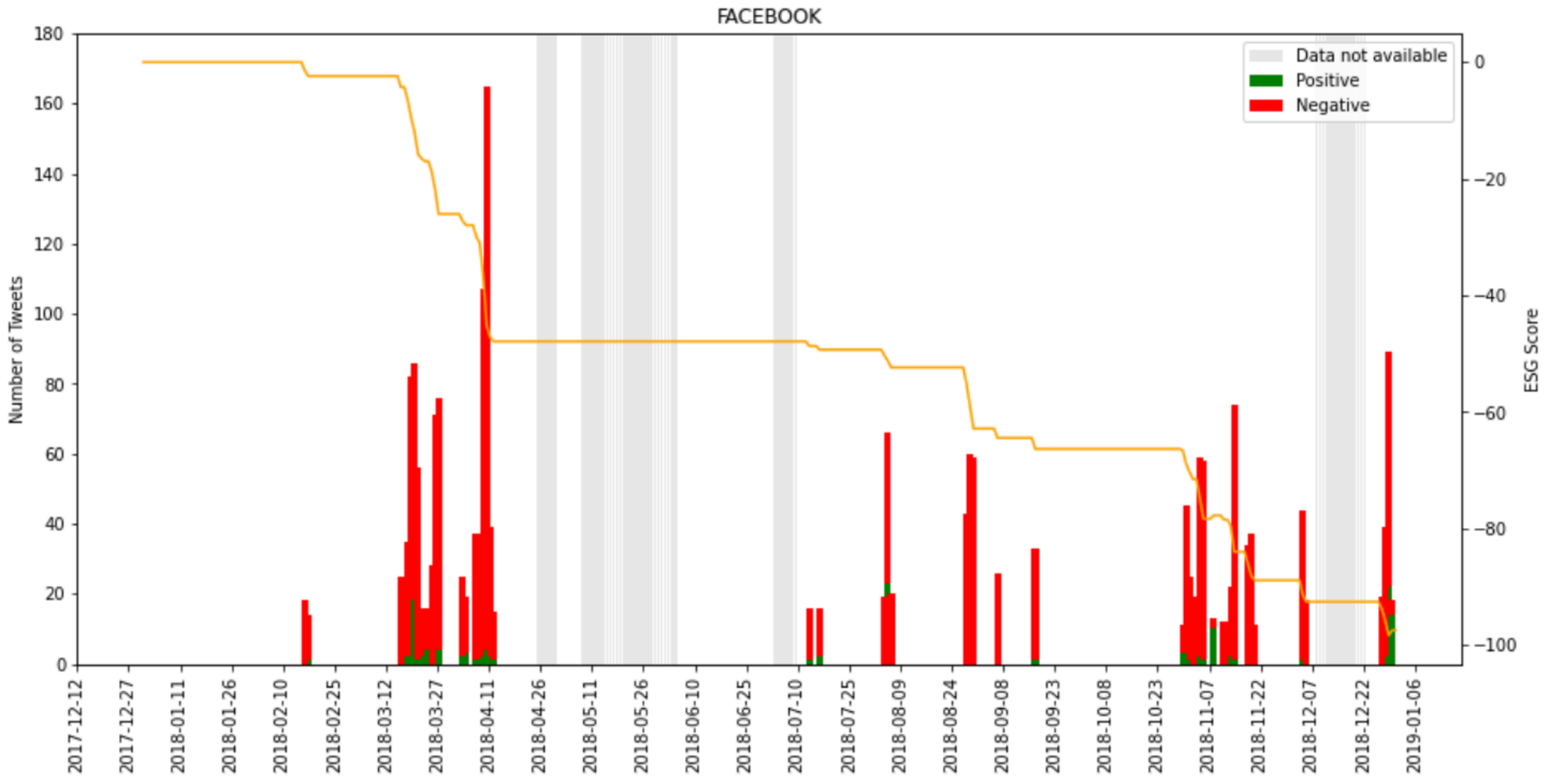


Figure 5: Facebook Tweet-based ESG Score

Sibli

Company Search

Boeing Type to search...

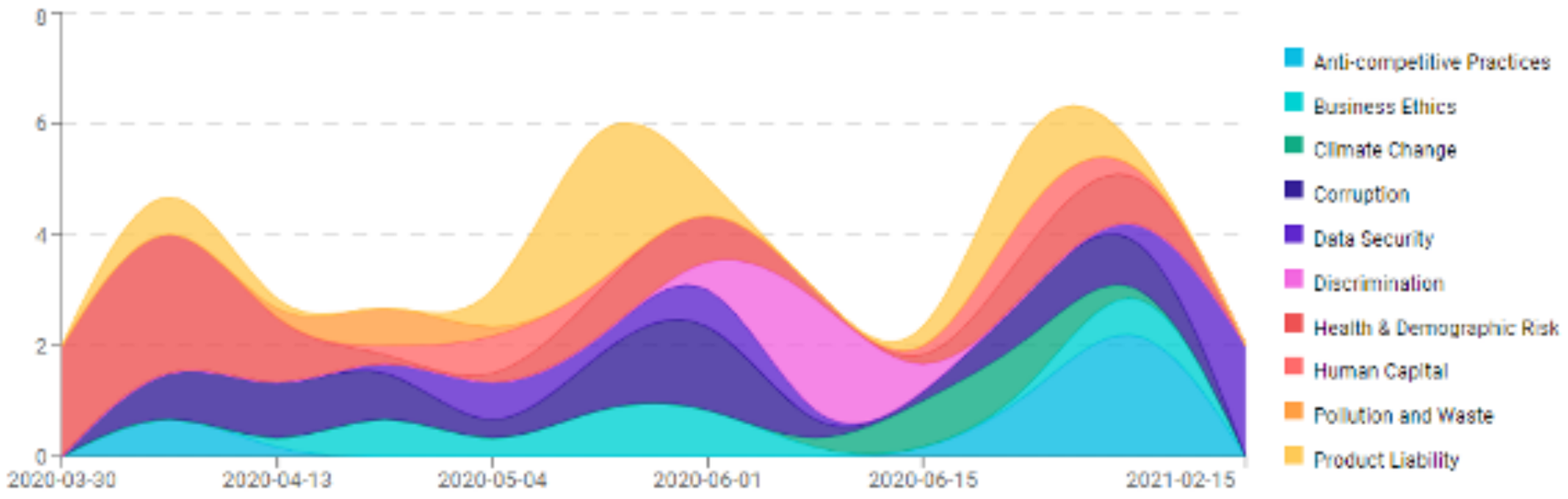
Issue Summary

1,804
The New York Times

17
Reddit

5,901
Twitter

49
Y Combinator



Documents

Artificial Intelligence in “scoring”

- Construct ESG scores using web-resident, text data sources
  - Company document centres
  - Sentiment analysis sourced in real time
  - News sources

Building Machine Learning Systems to Automate ESG Index Construction

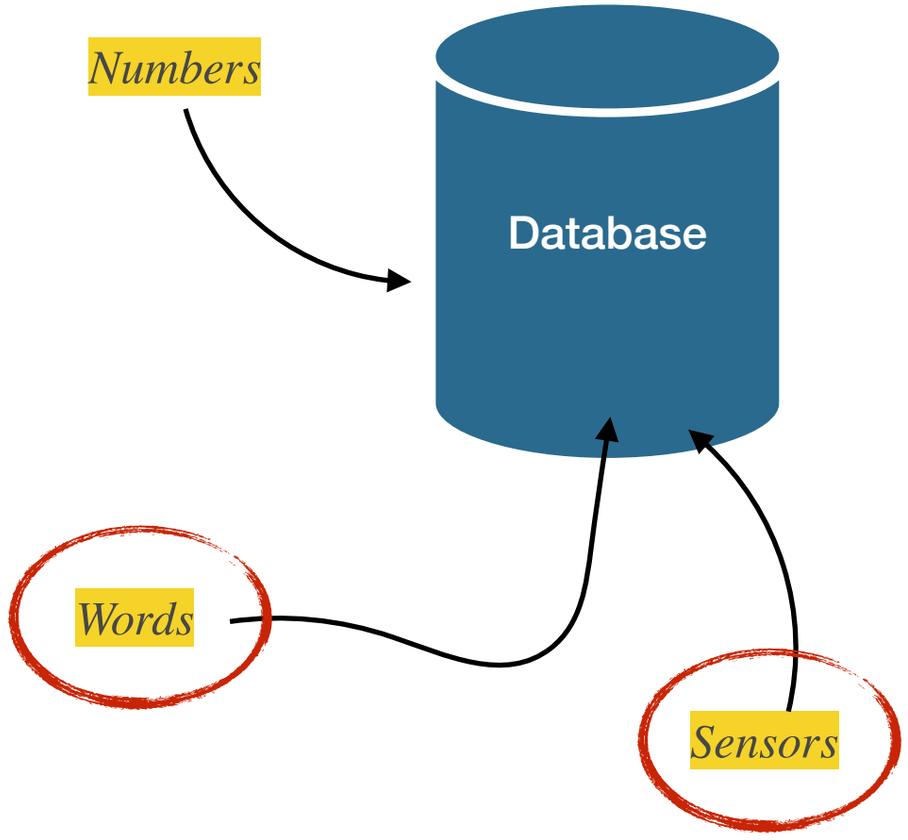
May 19, 2020

Alik Sokolov, Jonathan Mostovoy, Jack Ding, Luis Seco

AI

Traditional data sources are being replaced by unstructured data sources

- Numerical data
- Textual data
- Sensor data
- Images, satellite, video, etc.



Kyoto

- In 1997, the Kyoto Protocol was adopted as an international agreement under the UNFCCC and entered into force in February 2005.
- As at June 2013, there are 192 parties to the Protocol.
- The major feature of the Protocol is that it sets binding targets for 37 industrialized countries (the “Annex I” parties)
- The European Community to reduce their emissions of six specified types of greenhouse gases
- For the purposes of standardizing the measurements, the emissions of these other gases are converted into the equivalent “global warming potential” of CO2.
  - methane (CH4) has 80 times the global warming potential of carbon dioxide
  - Therefore the emission of 1 tonne of methane is considered to be equivalent to the emission of 80 tonnes of carbon dioxide.

Australia's Emissions Reduction Fund

- The Government of Australia has set up a fund to purchase Australian carbon credit units
- The intent is to proactively reduce their emissions

Australia's Emissions Reduction Fund

How the Emissions Reduction Fund works

The Emissions Reduction Fund offers landholders, communities and businesses the opportunity to run new projects that reduce or remove greenhouse gas emissions from the atmosphere.

In running an Emissions Reduction Fund project, you can earn carbon credits and sell them to the Australian Government, or to companies and other private buyers. Each carbon credit represents one tonne of carbon dioxide equivalent greenhouse gas emissions stored or avoided.

How to participate

Emissions Reduction Fund project lifecycle

Annual register

Reports on total number of Australian carbon credit units issued

Financial year	Kyoto-ACCUs	Non-Kyoto ACCUs (eligible)	Non-Kyoto ACCUs (voluntary)	Total ACCUs issued	Kyoto ACCUs relinquished	Non-Kyoto ACCUs relinquished	Total ACCUs relinquished
2021–22	16,508,527	0	0	16,508,527	0	0	0
2020–21	16,456,794	0	9,481	16,466,275	96,991	0	96,991
2019–20	15,471,477	0	4,981	15,476,458	34,379	0	34,379
2018–19	13,659,926	0	3,483	13,663,409	661	0	661
2017–18	12,191,462	0	16,441	12,207,903	14,779	0	14,779
2016–17	12,893,770	0	258,221	13,151,991	0	20,450	20,450
2015–16	10,578,114	0	141,621	10,719,735	16,881	4,292	21,173
2014–15	9,228,763	0	89,343	9,318,106	0	0	0
2013–14	4,380,473	0	0	4,380,473	22,941	0	22,941
2012–13	851,680	898,499	0	1,750,179	0	0	0
2011–12	0	0	0	0	0	0	0

Soil Carbon

- More and more farmers are turning to new technologies to better manage their land.

- Nathan Simpson of Binginbar farms in New South Wales (AUS) saw his farm deteriorating through years of overgrazing

- Turned to increasing soil carbon levels as the solution

Carbon in soil

- More carbon in soil
  - increase productivity
  - drought tolerance
  - reducing farm input costs
- When carbon levels become depleted
  - health declines,
  - Production declines.

Binginbar Farm Case

- They changed the seed mix to include
  - two different grasses,
  - three types of clover,
  - two lucernes
  - a chicory
- It'll provide feed through the whole season; something's always growing.
- Assisted by **satellite** data, they will keep a suitable level of grass cover to allow soil carbon sequestration to occur.
- Target: a minimum 600 kg of dry matter per hectare at any point in time"

Service providers

- AgriProve: helps farmers access the Emissions Reduction Fund and run soil carbon projects
- They do:
  - monitoring,
  - reporting,
  - number crunching,
  - verification requirements
  - remove any administrative burden
- they have over 100 projects funded by the ERF

Soil Carbon: Olsen Farm

Kyoto

- While the Kyoto Protocol requires signatory countries to meet their targets primarily through domestic measures, it also provides for a number of flexible mechanisms that allows them to offset their emissions by purchasing reductions made in other countries.

- This is done by purchasing “units”, each unit being equivalent to one tonne of CO2 (emissions of other greenhouse gases being converted to the equivalent number of tonnes of CO2).

- Through the trading of these units to offset emissions of greenhouse gases, a new commodity has been created in the form of emission reductions or removals.

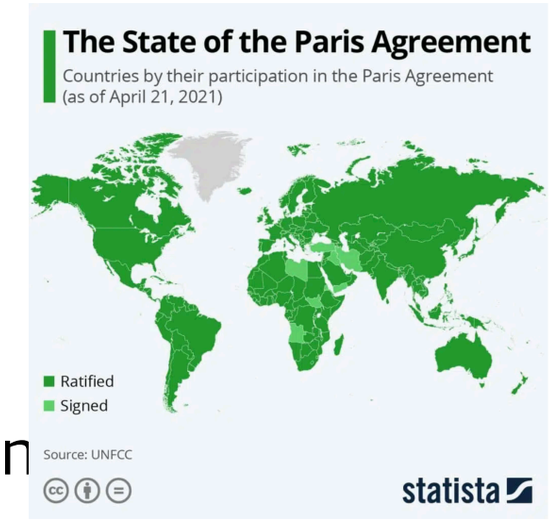
- Since carbon dioxide (CO2) is the principal greenhouse gas, this market is widely referred to as the “carbon market”, with each of the units traded commonly referred to as “carbon credits”.

Carbon sequestration

- Refers to the **long-term** storage of carbon in plants, soils, geologic formations, and the ocean.
- Carbon sequestration occurs both naturally and as a result of anthropogenic activities
- and typically refers to the storage of carbon that has the immediate potential to become carbon dioxide gas.

Carbon credits

- A carbon market allows investors and corporations to trade both carbon credits and carbon offsets simultaneously:
  - It helps mitigate the environmental crisis
  - Creates a new market.
- Created around since the 1997 Kyoto Protocols
- Surge of activity thanks to the emergence of new region
- The Paris agreement of 2015 -ratified by all but six countries- will increase demand
- In the United States, no national carbon market exists, and only one state - California - has a formal cap-and-trade program.



Credits vs. Offsets

- Carbon credits, (i.e. carbon allowances): When a company buys a carbon credit, usually from the government, they gain permission to generate one ton of CO2 emissions. With carbon credits, carbon revenue flows vertically from companies to regulators, though companies who end up with excess credits can sell them to other companies.

- Offsets flow horizontally, trading carbon revenue between companies. When one company removes a unit of carbon from the atmosphere as part of their normal business activity, they can generate a carbon offset. Other companies can then purchase that carbon offset to reduce their own carbon footprint.

- Unit traded: CO_2e

Regulatory caps

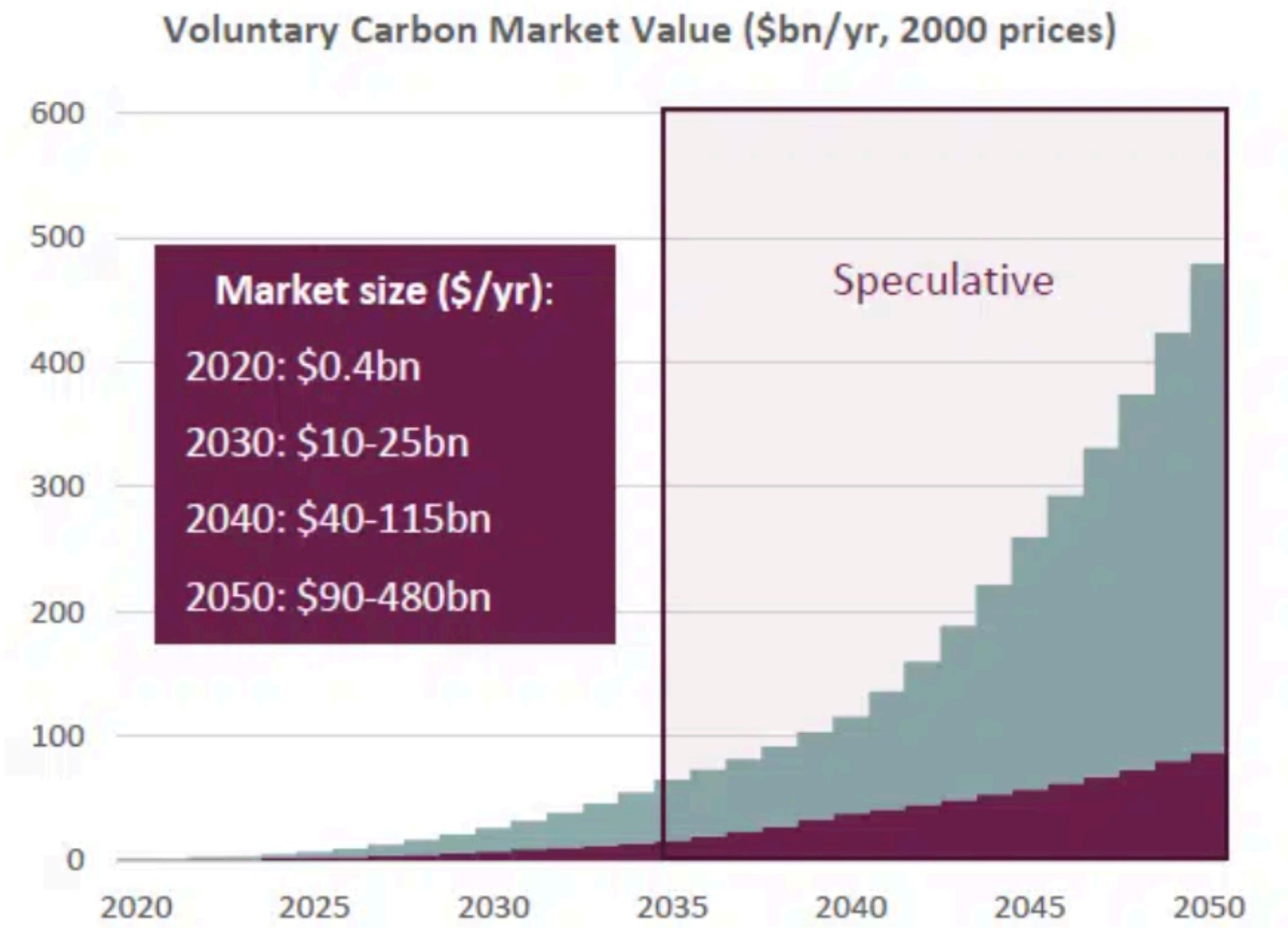
- Emisions targets determine the number of credits issued each year.
- “cap-and-trade” program: Regulators set a limit on carbon emissions - the cap, which decreases over time.
  - Canada, the EU, the UK, China, New Zealand, Japan, and South Korea

Voluntary carbon market

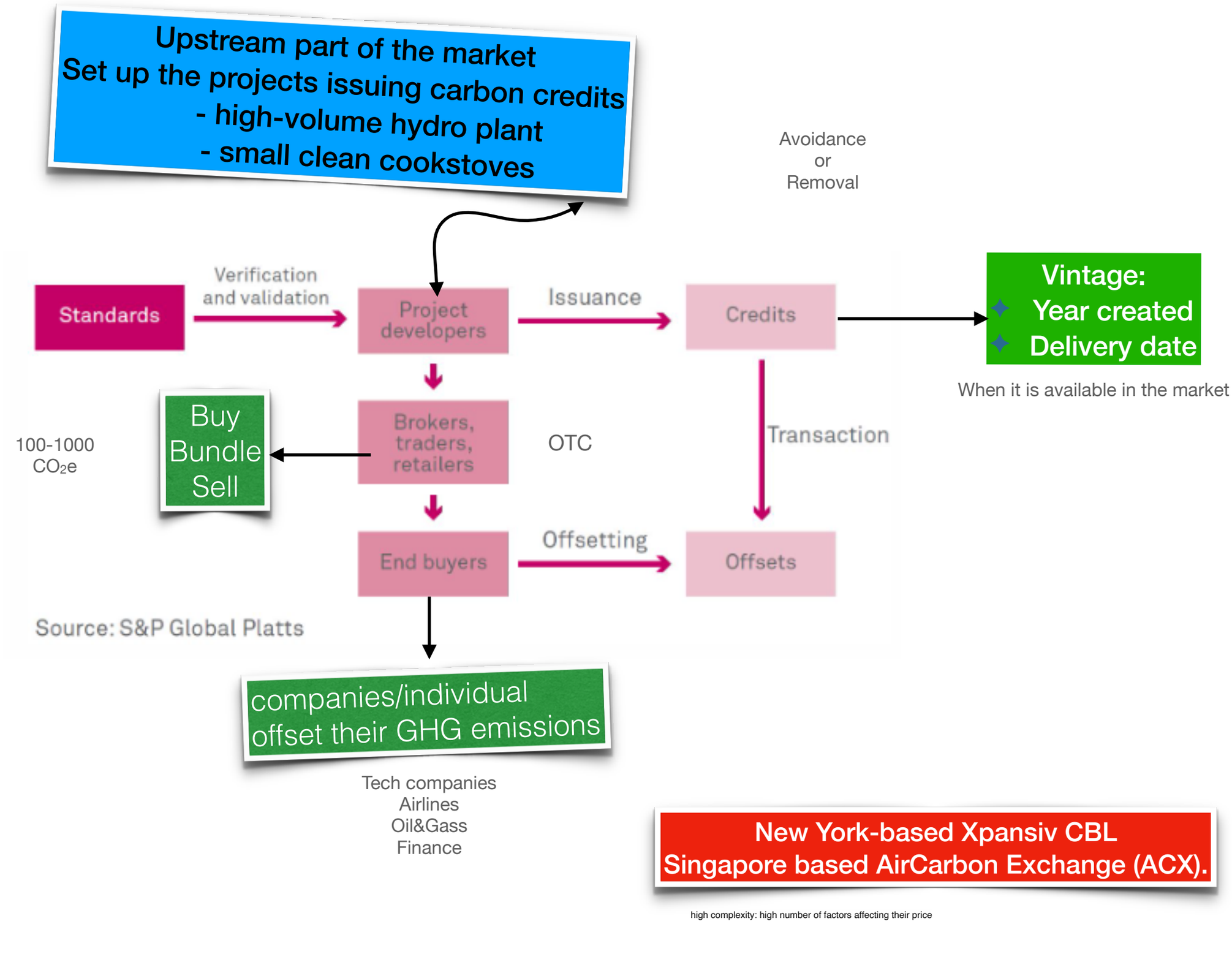
- New mandatory emissions trading programs and growing consumer pressure have driven companies to turn to the voluntary market for carbon

- Organizations with operations that reduce the amount of carbon already in the atmosphere can issue carbon offsets. The purchase of these offsets is voluntary, which is why carbon offsets form what's known as the "Voluntary Carbon Market"

- Example: For example: in 2021, Shell announced the company aims to offset 120 million tonnes of emissions by 2030


Voluntary Carbon Market Value ($bn/yr, 2000 prices)
600
500
400
300
200
100
0
2020
2025
2030
2035
2040
2045
2050
Market size ($/yr):
2020: $0.4bn
2030: $10-25bn
2040: $40-115bn
2050: $90-480bn
Speculative

Structure of the voluntary carbon market



Voluntary carbon buyers

- Traders & Financial players prefer Exchanges' standard products
- End buyers prefer to purchase credit offset to determine the characteristics of each underlying project to avoid **greenwashing**
- Often, the exchanges are used to **settle** large bilateral **OTC** deals. In a market note shared in May.

  - CBL said that an even larger number of bilateral deals negotiated offscreen were being brought by traders to be settled on the CBL platform.

Standards providers

- There is a fifth player unique to carbon markets. Standards are organizations, usually NGOs, which certify that a particular project meets its stated objectives and its stated volume of emissions.

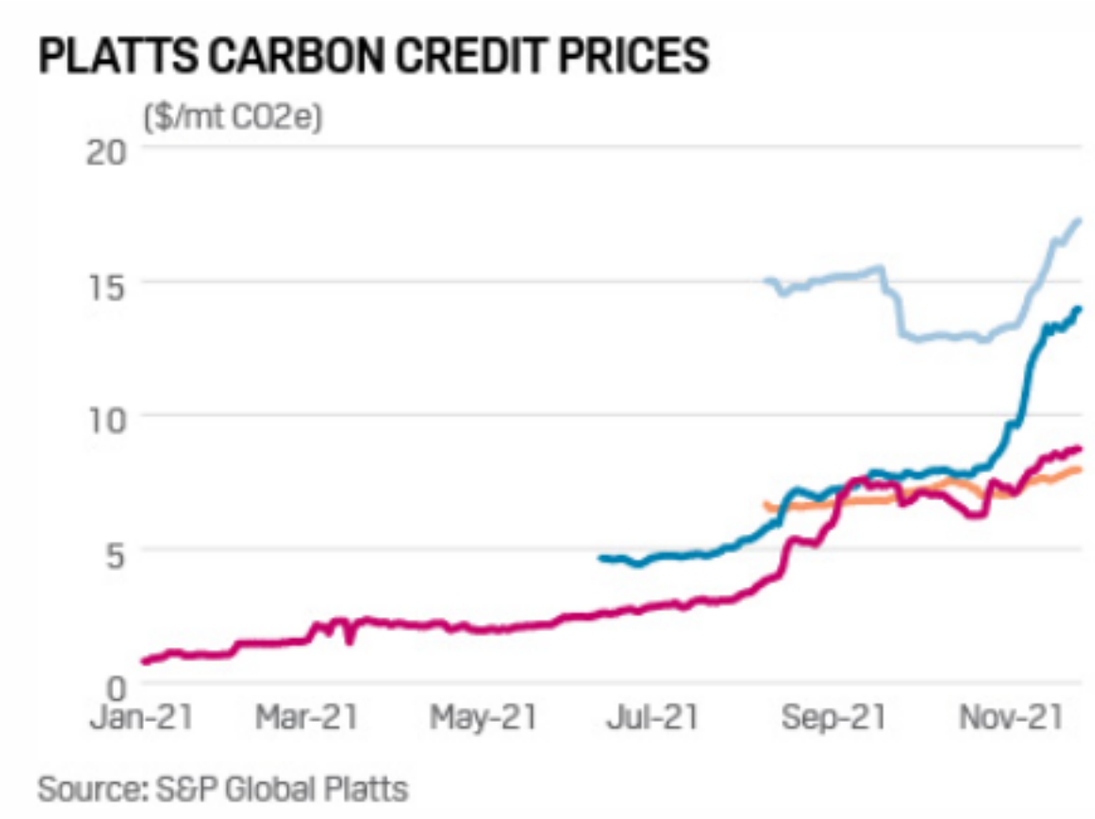
- Standards have a series of methodologies, or requirements, for each type of carbon project. For example, a reforestation project will follow specific rules when calculating the level of CO2 absorption of the planned forest and therefore the number of carbon credits it produces over time.

- A renewable energy project will have a different set of specific rules to follow when calculating the benefit in terms of avoided CO2 emissions and carbon credits generated over time.

Requirements

- The project should not be legally required, common practice, or financially attractive in the absence of credit revenues.
- No overestimation: CO2 emissions reduction should match the number of offset credits issued for the project and should take account for any unintended GHG emissions caused by the project.
- Permanence: The impact of the GHG emission reduction should not be at risk of reversal and should result in a permanent drop in emissions.
- Exclusive claim: Each metric ton of CO2 can only be claimed once and must include proof of the credit retirement upon project maturation. A credit becomes an offset at retirement.
- Provide additional social and environmental co-benefits in line with the UN's SDGs.

Carbon Credit Price (S&P)



Platts CRC is a basket assessment that reflects the most competitive of the Platts Natural Carbon Capture and Platts Technological Carbon Capture assessments.

nature-based solutions
vintage of each of the past five years
including both avoidance and removal credits

CORSIA eligible
Carbon Offsetting and Reduction Scheme for International Aviation

Platts CAC is a basket assessment that reflects
the most competitive of the Platts Household Devices,
Platts Industrial Pollutants and Platts Nature-Based Avoidance assessments.
Platts publishes individual assessments for
both current delivery and delivery one year forward.

Carbon markets

There are two significant, separate carbon markets to choose.

- One is a regulated market, set by “cap-and-trade” regulations at the regional and state levels.
- The other is a voluntary market where businesses and individuals buy credits (of their own accord) to offset their carbon emissions.

Creating credits

- Renewable energy projects,
- Improving energy efficiency,
- Carbon and methane capture and sequestration
- Land use and reforestation.

Renewable energy

- Renewable energy projects have already existed long before carbon credit markets came into vogue.
- Many countries in the world are blessed with a natural wealth of renewable energy resources:
  - Brazil, Canada have many lakes and rivers,
  - Denmark and Germany with lots of windy regions.
- For countries like these:
  - renewable energy was already an attractive and low-cost source of power generation,
  - and they now provide the added benefit of carbon offset creation.

Energy efficiency

- Energy efficiency improvements complement renewable energy projects by reducing the energy demands of current buildings and infrastructure.
- Simple everyday changes (swapping incandescent to LED) can benefit the environment by reducing power consumption.
- On a larger scale, this can involve things like renovating buildings or optimizing industrial processes to make them more efficient, or distributing more efficient appliances to the needy.

Carbon capture

- Carbon and methane capture involves implementing practices that remove CO2 and methane (which is over 80 times more harmful to the environment than CO2) from the atmosphere.

- Methane is simpler to deal with, as it can simply be burned off to create CO_2. While this sounds counterproductive at first, since methane is over 80 times more harmful to the atmosphere than CO_2, converting one molecule of methane to one molecule of CO_2 through combustion still reduces net emissions by more than 95%.

- For carbon, capture often happens directly at the source, such as from chemical plants or power plants. While the injection of this captured carbon underground has been used for various purposes like enhanced oil recovery for decades already, the idea of storing this carbon long-term, treating it much like nuclear waste, is a newer concept.

Land & reforestation

- Land use and reforestation projects use Mother Nature's carbon sinks, the trees and soil, to absorb carbon from the atmosphere. This includes protecting and restoring old forests, creating new forests, and soil management.

- Plants convert CO_2 from the atmosphere into organic matter through photosynthesis, which eventually ends up in the ground as dead plant matter. Once absorbed, the CO_2 enriched soil helps restore the soil's natural qualities - enhancing crop production while reducing pollution.

Carbon capture

- Investing in renewable energy by funding wind, hydro, geothermal, and solar power generation projects, or switching to such power sources wherever possible.
- Improving energy efficiency across the world, for instance by providing more efficient cookstoves to those living in rural or more impoverished regions.
- Capturing carbon from the atmosphere and using it to create biofuel, which makes it a carbon-neutral fuel source.
- Returning biomass to the soil as mulch after harvest instead of removing or burning. This practice reduces evaporation from the soil surface, which helps to preserve water. The biomass also helps feed soil microbes and earthworms, allowing nutrients to cycle and strengthen soil structure.
- Promoting forest regrowth through tree-planting and reforestation projects.
- Switching to alternate fuel types, such as lower-carbon biofuels like corn and biomass-derived ethanol and biodiesel.

Land & reforestation

third-party auditors who verify, collect, and analyze data to confirm the validity of each offset project.

Köszönöm

תודה

Спасибі

Thanks

ありがとう

ευχαριστώ

감사해요

Gracias

cảm ơn

Kösz

Dankon

Teşekkürler

Danke

متشكرم

Merci

Grazie

tack

rahmat

Takk

谢谢

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Gratias

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