



The Little Book of Data

November 2022

Foreword

Data is the new *oil*. Statements like this highlight how data has become a fast-evolving and highly valued commodity in the information age. From war zones to shopping malls, from rainfall statistics to electric grid usage, there are few places on Earth immune from its grasping tentacles.

Data on its own, however, is meaningless. It must be cleaned, sorted and processed effectively to become useful. Turning it into information and then into actionable insights requires judgement, a flair for design and a solid grasp of computing and statistics – not to mention ownership or access rights.

This is where data visualisation comes in. The ability to present data in clear and creative ways is becoming a valuable commodity in its own right. Doing it well saves time and confusion. And while data visualisation is often poorly defined, it can be as simple as marking a child's height on a door frame or as complex as a radial chart with multiple data inputs and variables. The crucial point is that it should be accurate, as free from bias as possible and draw you in to tell you something important or new.

As data journalist Jer Thorp wrote in his book *Living in Data*: “The core of data visualisation is . . . to take a number and turn it into a visual element. To take a measure and turn it into something that is differently understood.”

The world, including finance, is constantly changing and we are always looking for an edge. This is why we spend time each year curating and creating what we believe are some of the most relevant and thought-provoking charts and information graphics for our clients. We select the ones that catch our eyes and make us stop and think.

I hope you enjoy the fifth edition of *The Little Book of Data*.

Mark Versey

CEO, Aviva Investors

For any feedback or questions regarding this content, please contact the AIQ Editorial Team at InvestmentWritingContent@avivainvestors.com and visit us online at www.avivainvestors.com/aiq to see our full range of content.

Company names mentioned are for informational purposes only and not intended to be investment recommendations. Securities or company names herein do not constitute a solicitation to buy or sell. Past performance is not a reliable indicator of future performance.

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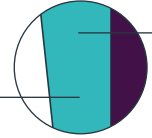
Prologue: Hold that thought











Human attention is decreasing in a data explosion

Humans process visuals 60 times faster than text, but however we access information, we are struggling to keep up. As the volume of data being shared and accessed has increased, our attention spans have diminished, meaning we are ill-equipped to process what's happening in our world. Clear and accurate data visualisation is becoming ever more important.

Data production and human attention

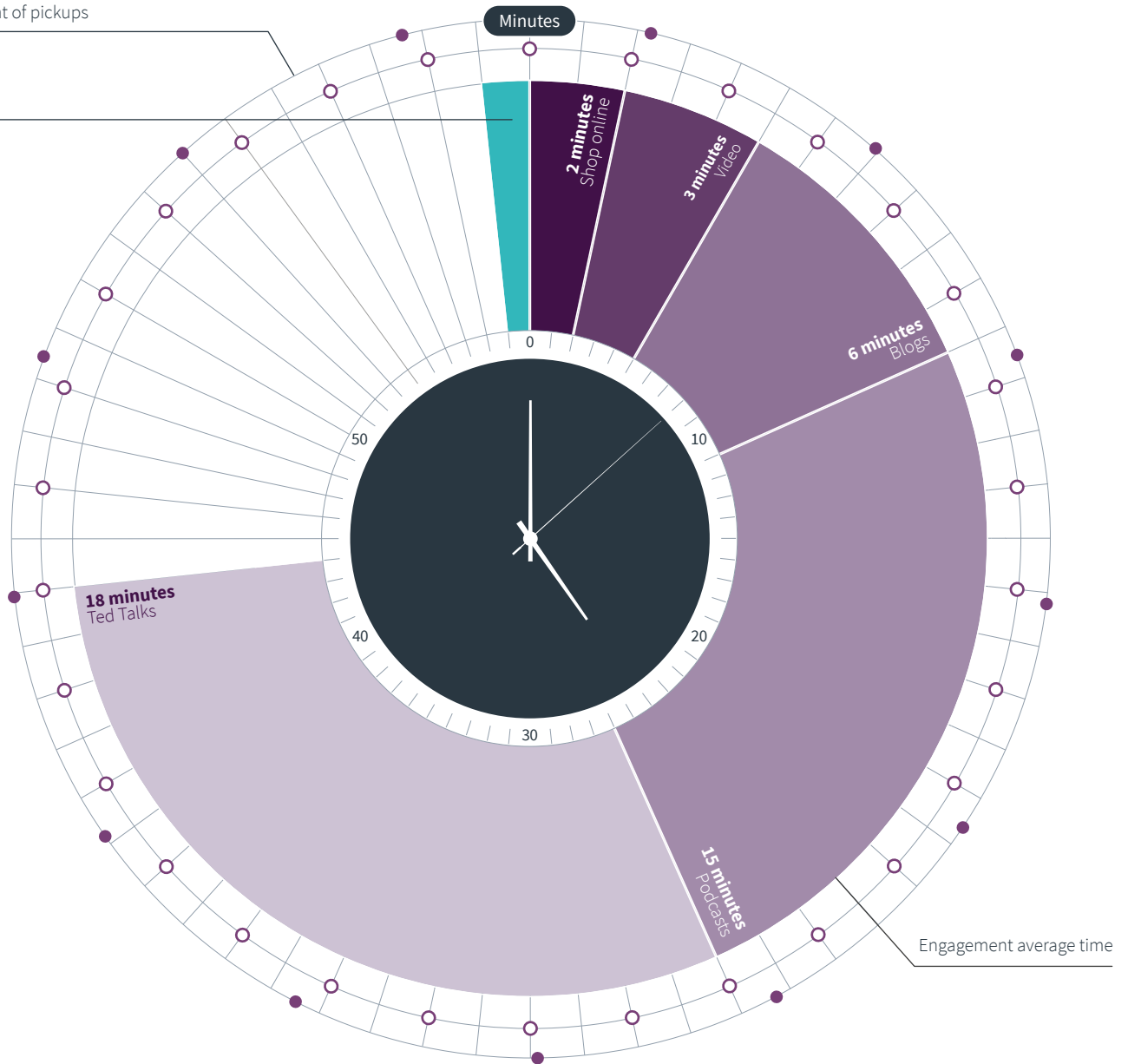
Amount of data produced every minute

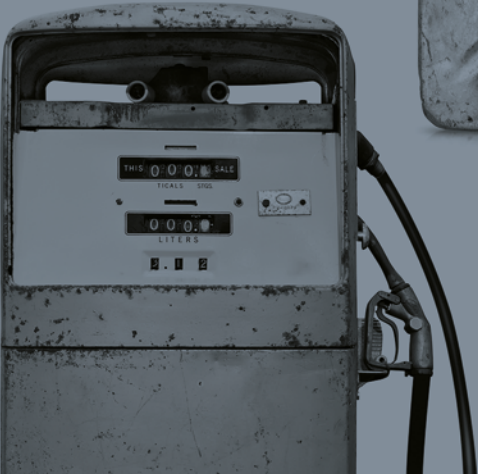
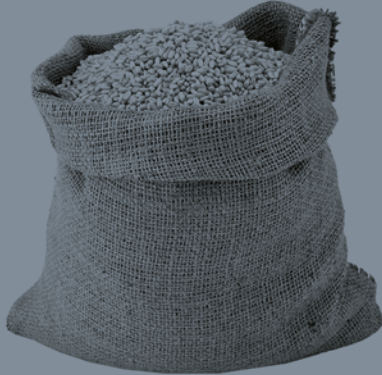
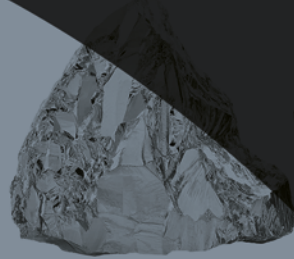


	3,877,140 searches
	973,000 logins
	12,986,111 texts sent
	49,380 photos posted
	481,000 tweets sent
	4,333,560 videos uploaded
	750,000 songs streamed
	2,083,333 snaps
	176,220 calls
	79,740 posts

- Users pick up their phones 13 times in one hour
- Office workers check their emails 30 times in one hour
- Information related to the data production field
- Information related to the human attention field

Amount of pickups







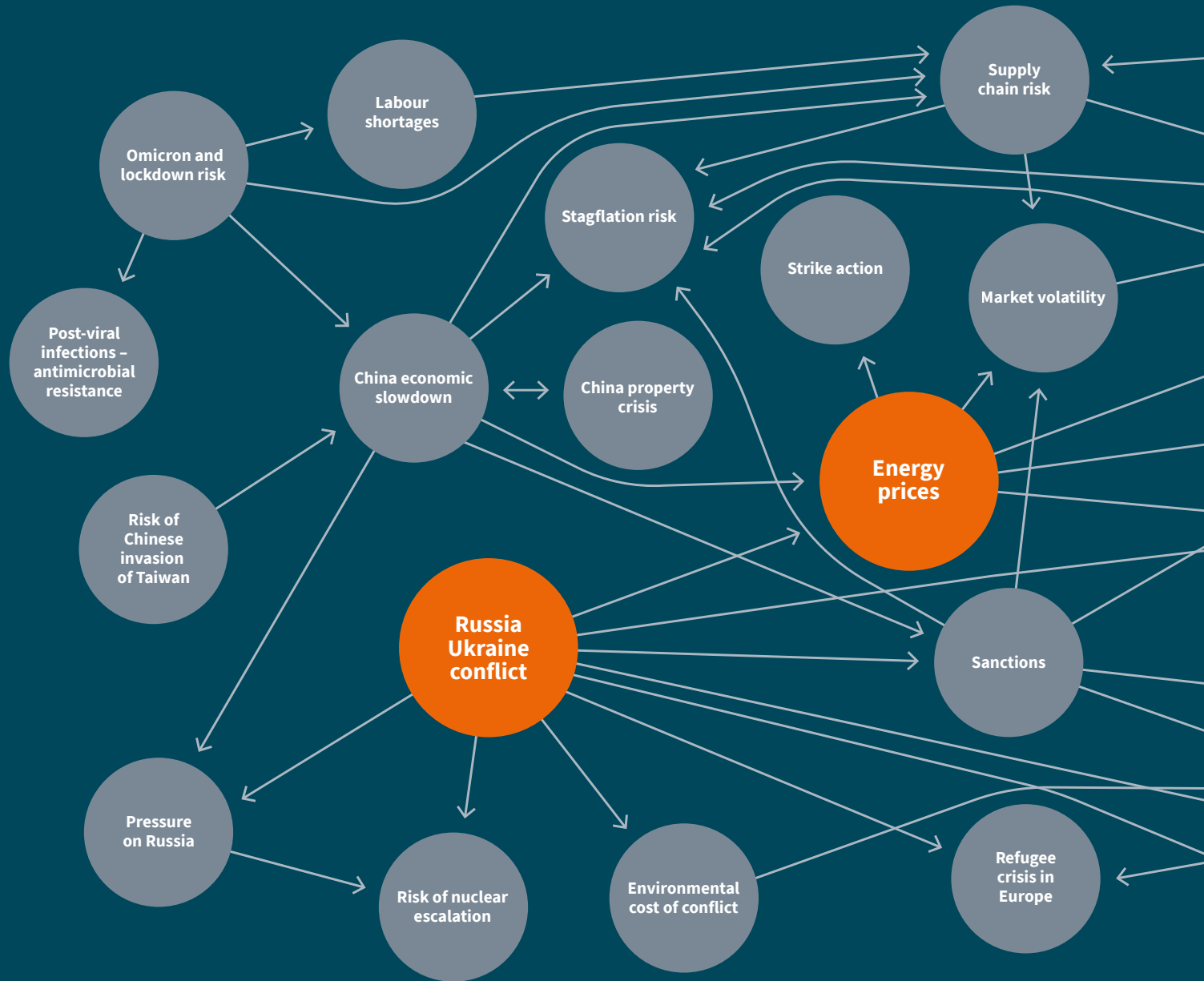
The bigger picture

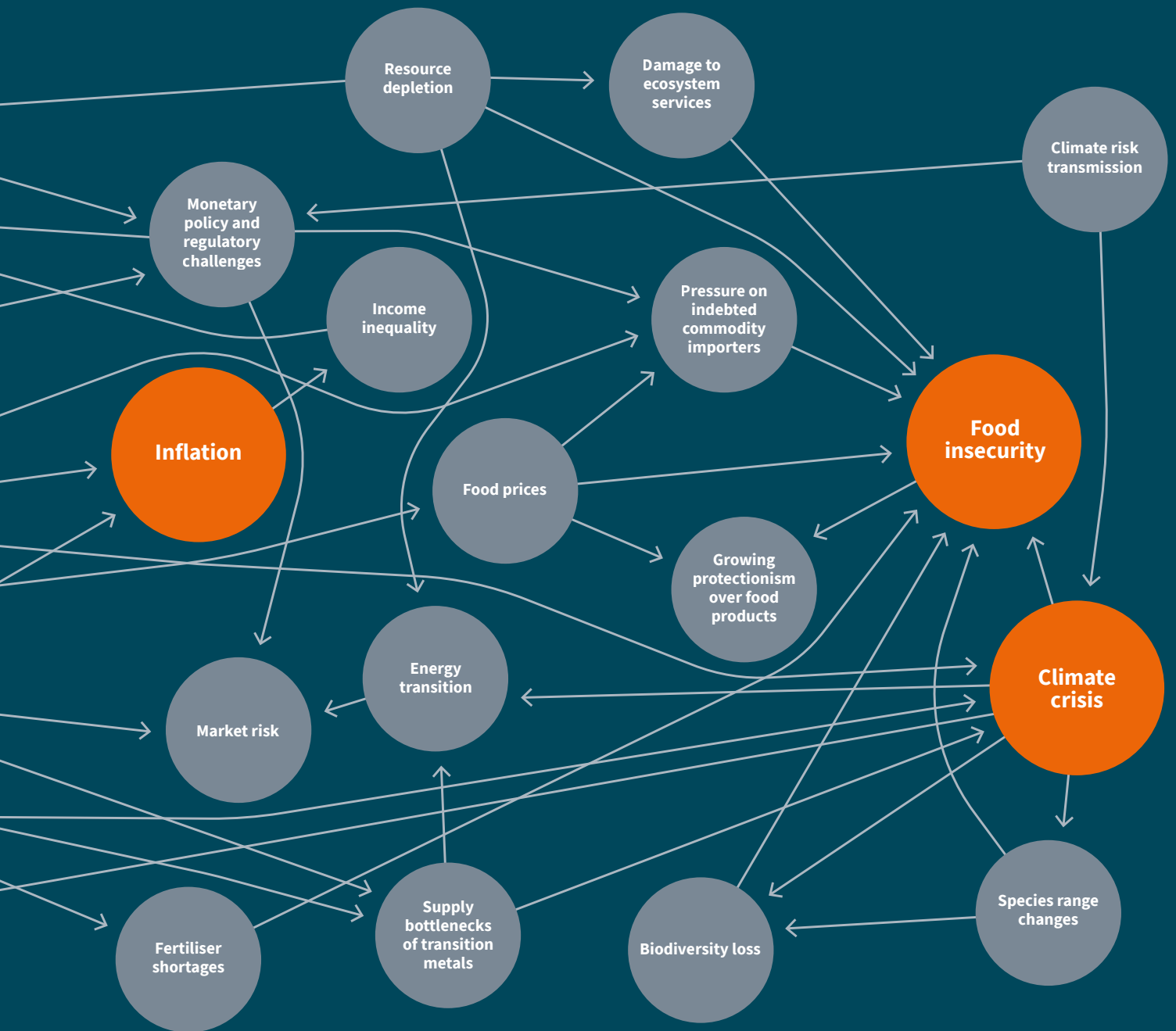
Major macro and market developments



Multiple systemic shocks

Connections and feedbacks

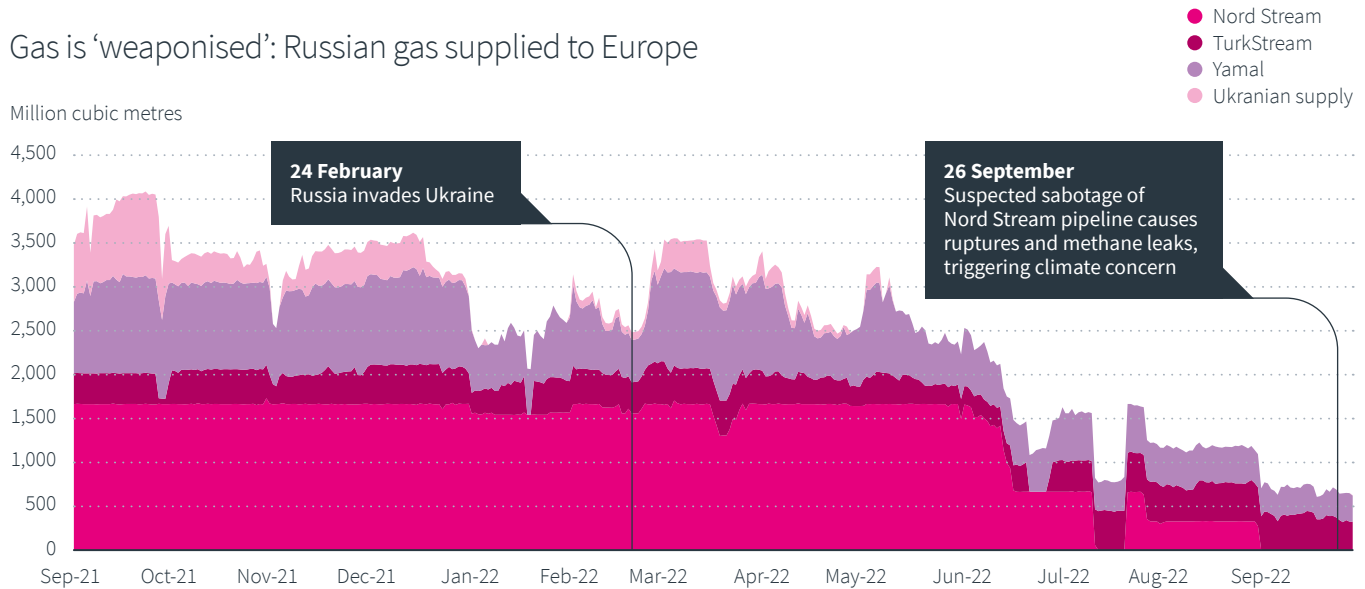




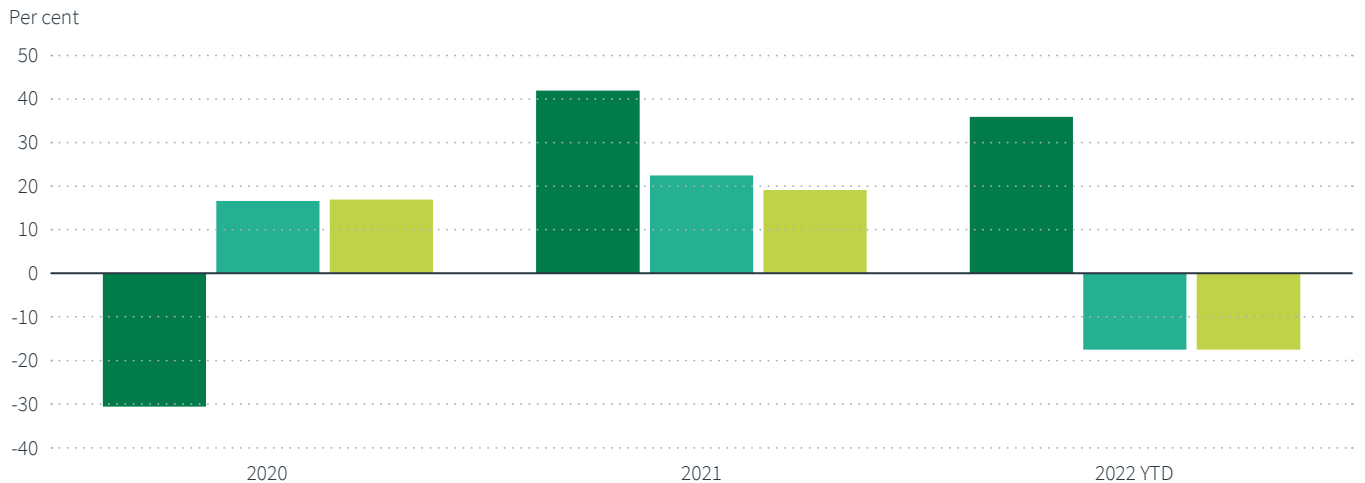
Spillovers from Russia's invasion of Ukraine

Energy sector sees multiple impacts

Gas is 'weaponised': Russian gas supplied to Europe

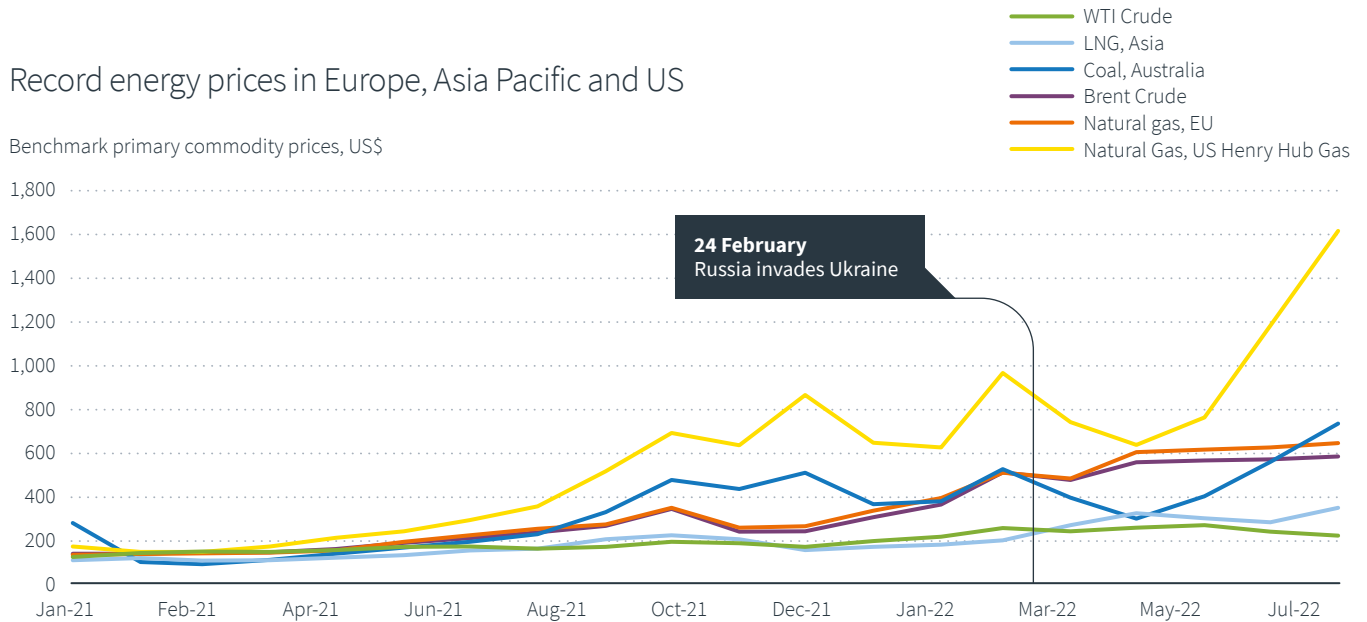


Relative energy sector equity performance



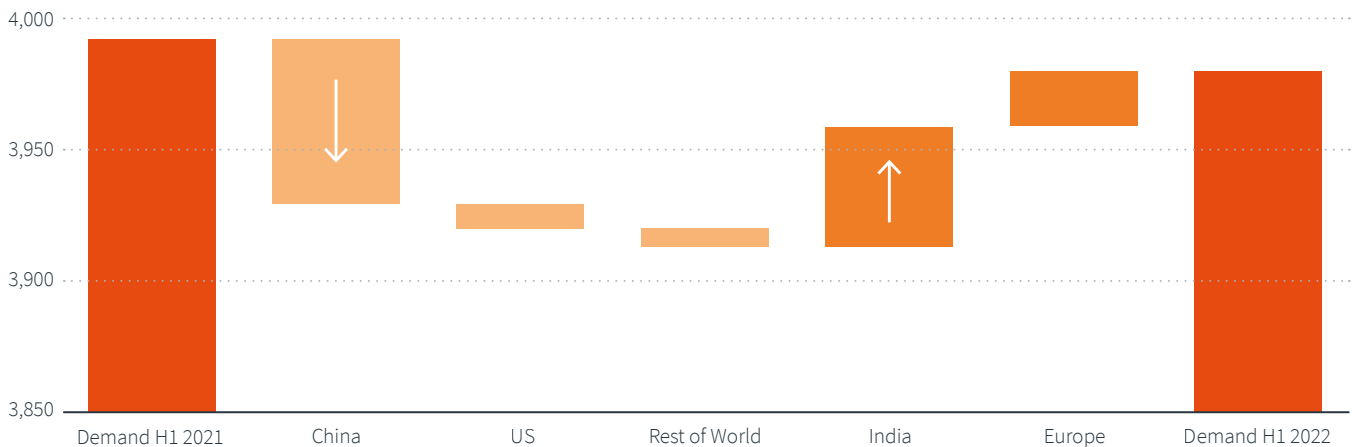
Record energy prices in Europe, Asia Pacific and US

Benchmark primary commodity prices, US\$



Global coal consumption: Demand rises in India and Europe

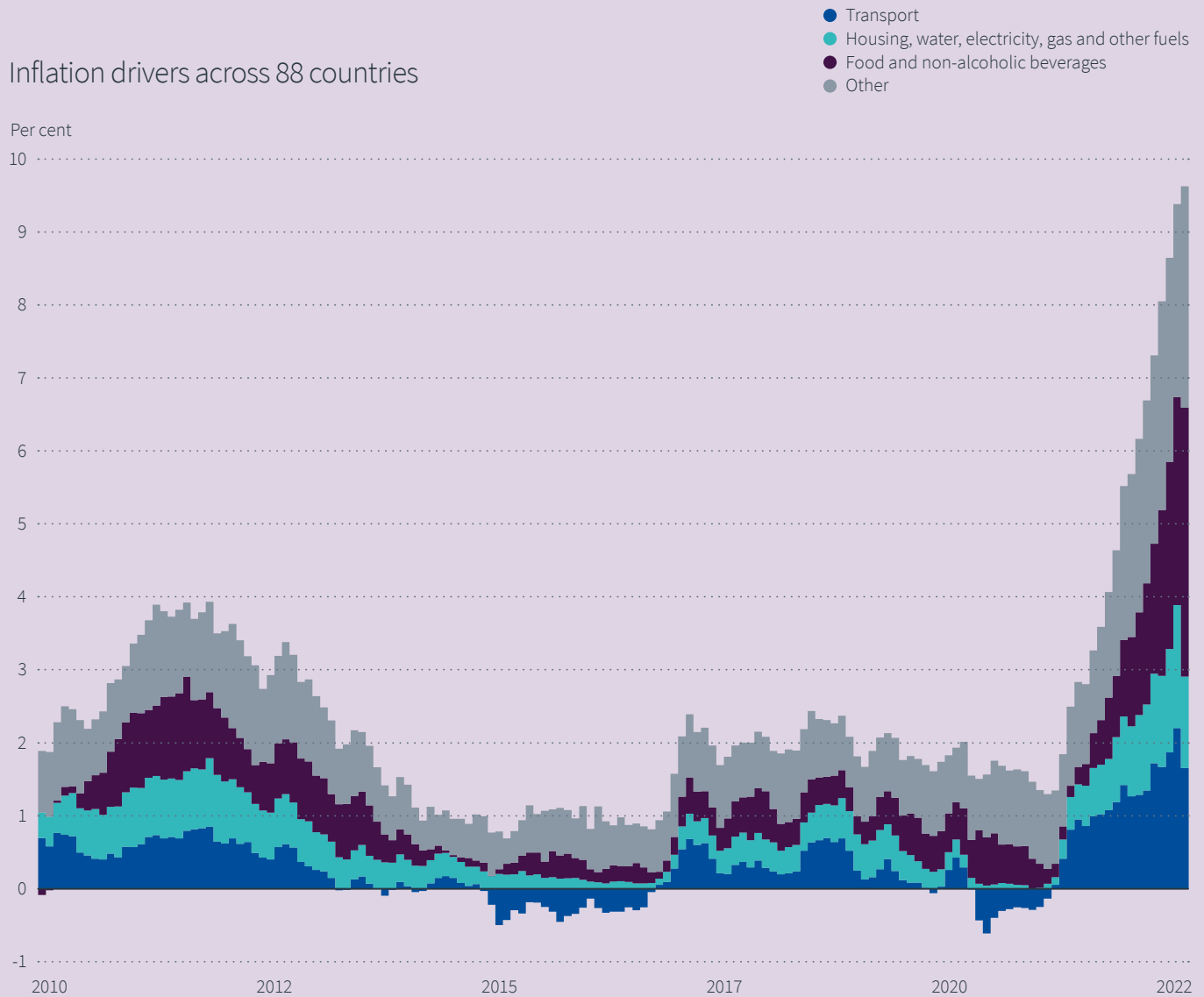
Million tonnes

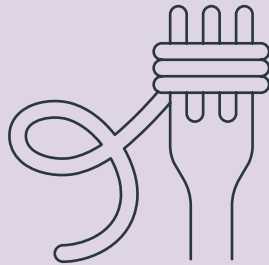


Guess who's back?

Food and energy prices drive global inflation surge

Inflation drivers across 88 countries





“This time last year, the cheapest pasta in my local supermarket was 29p for 500g. Today it’s 70p. That’s a 141 per cent price increase as it hits the poorest and most vulnerable households.”

Jack Monroe
Food writer and social commentator

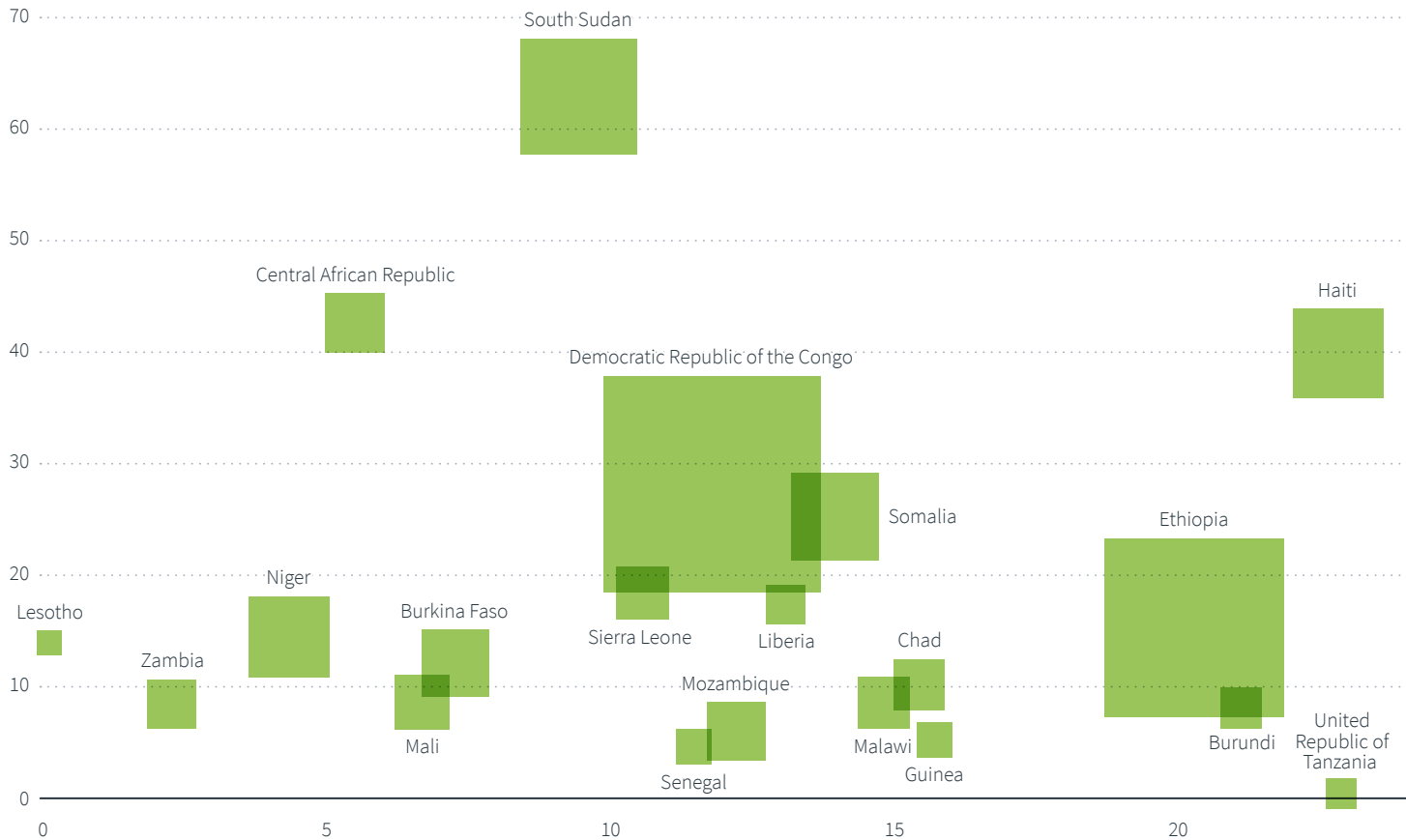
Food crisis

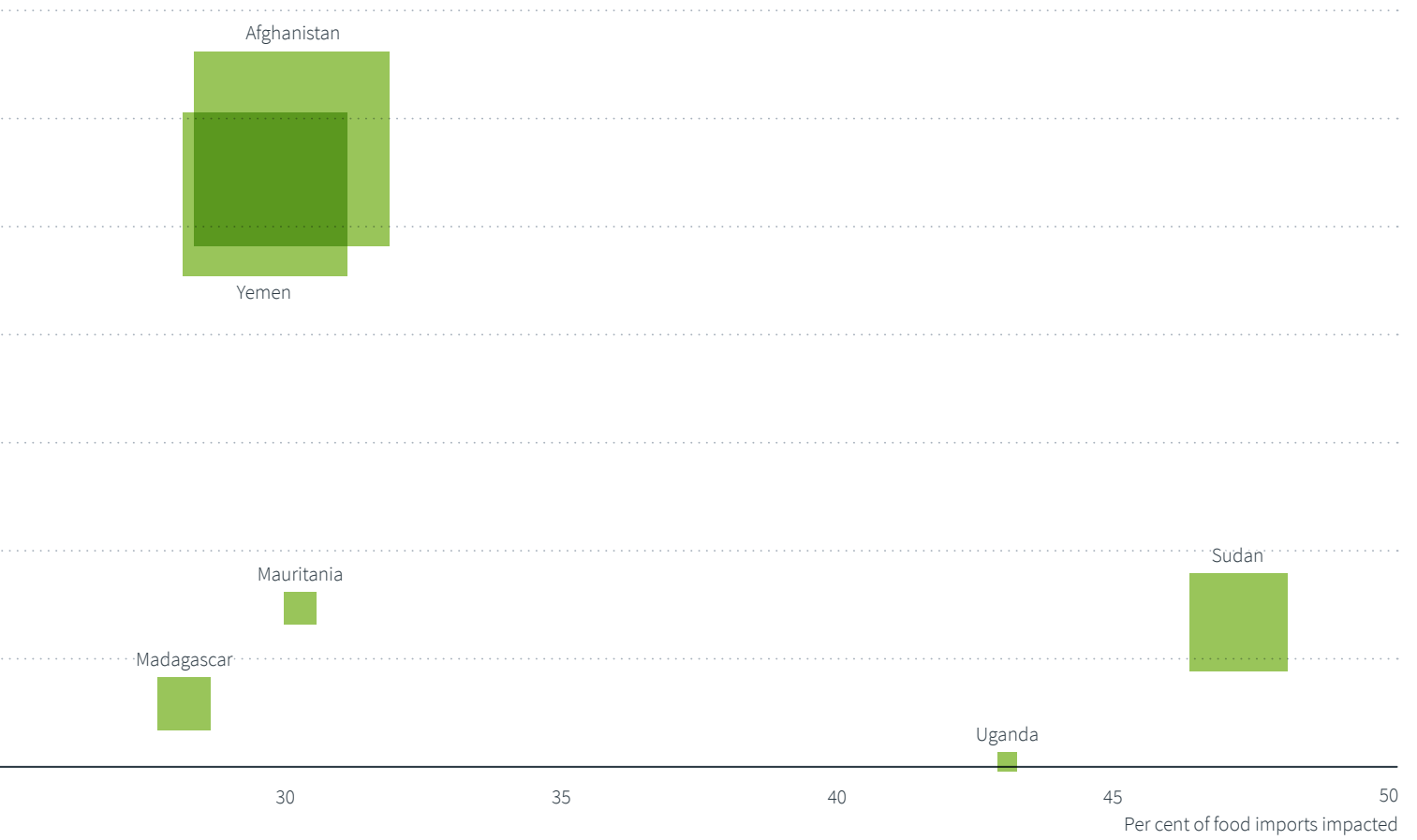
Concern over food security

Conflict between two of the world's major grain exporters, Russia and Ukraine, combined with drought and opportunistic trading, has created dangerous conditions in global food markets. Protectionism has increased while over 920 million people face severe hunger and malnutrition.

Food insecurity, scale of population affected combined with imports impacted

Per cent of population

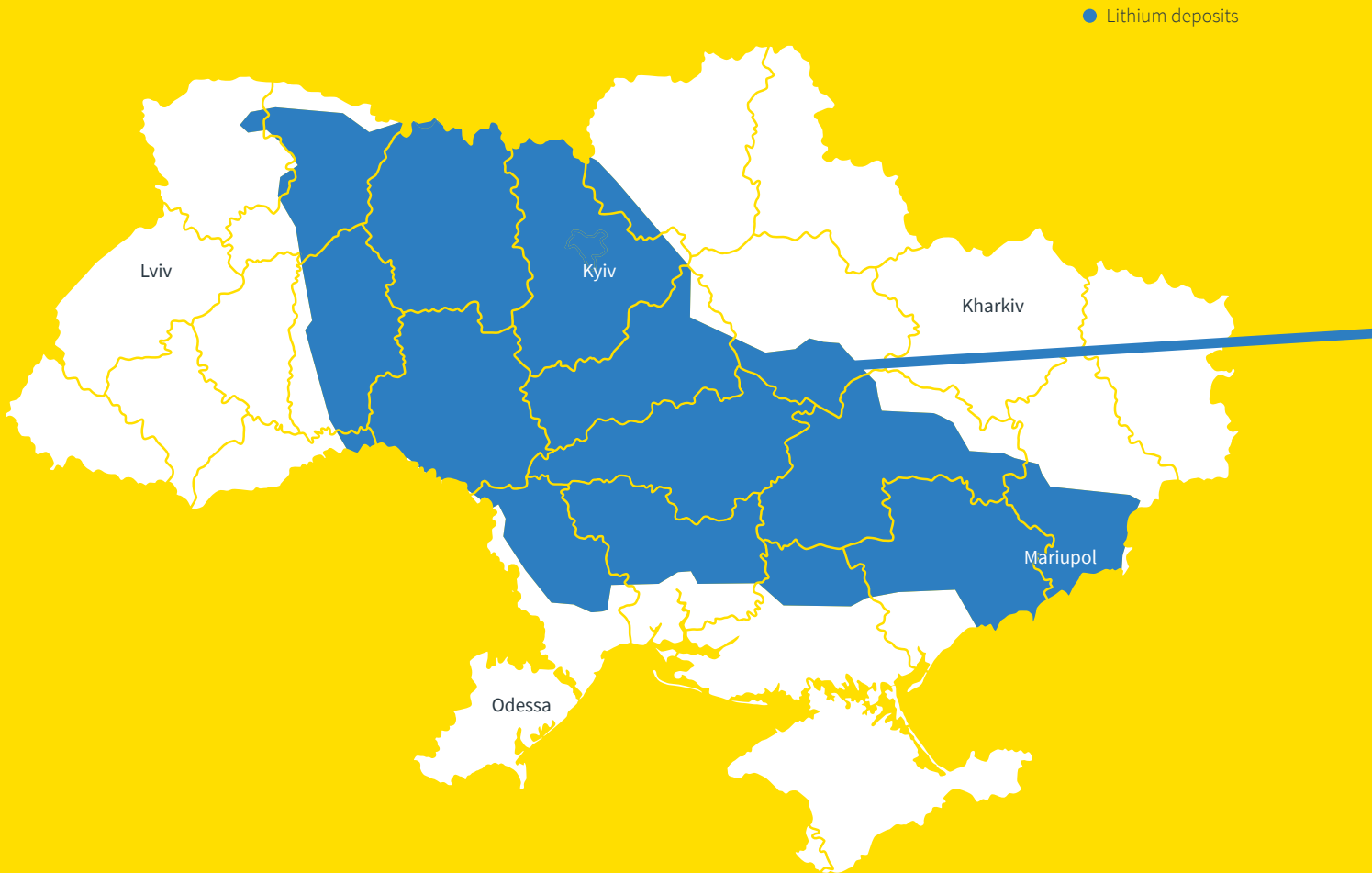




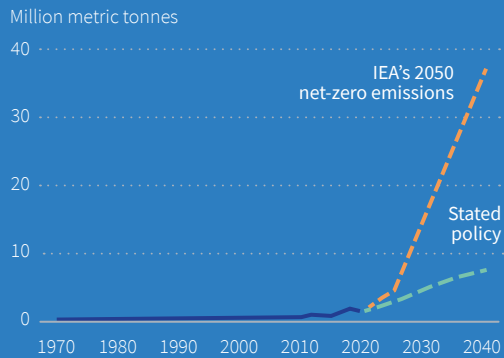
The first battle of the post-carbon world?

Lithium reserves in contested zones

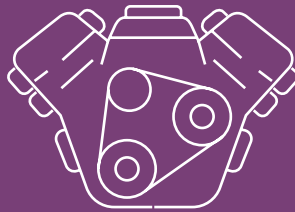
Estimated lithium deposits identified by Ukraine's geological service, 2022



Projected lithium consumption scenarios



The rationale for Russia's invasion of Ukraine has many dimensions. Geologists believe Ukraine has significant undeveloped reserves of lithium, a key input for EV batteries and energy storage. Prices surged over 700 per cent between January 2021 and March 2022. They could rise further due to the drive to net zero.

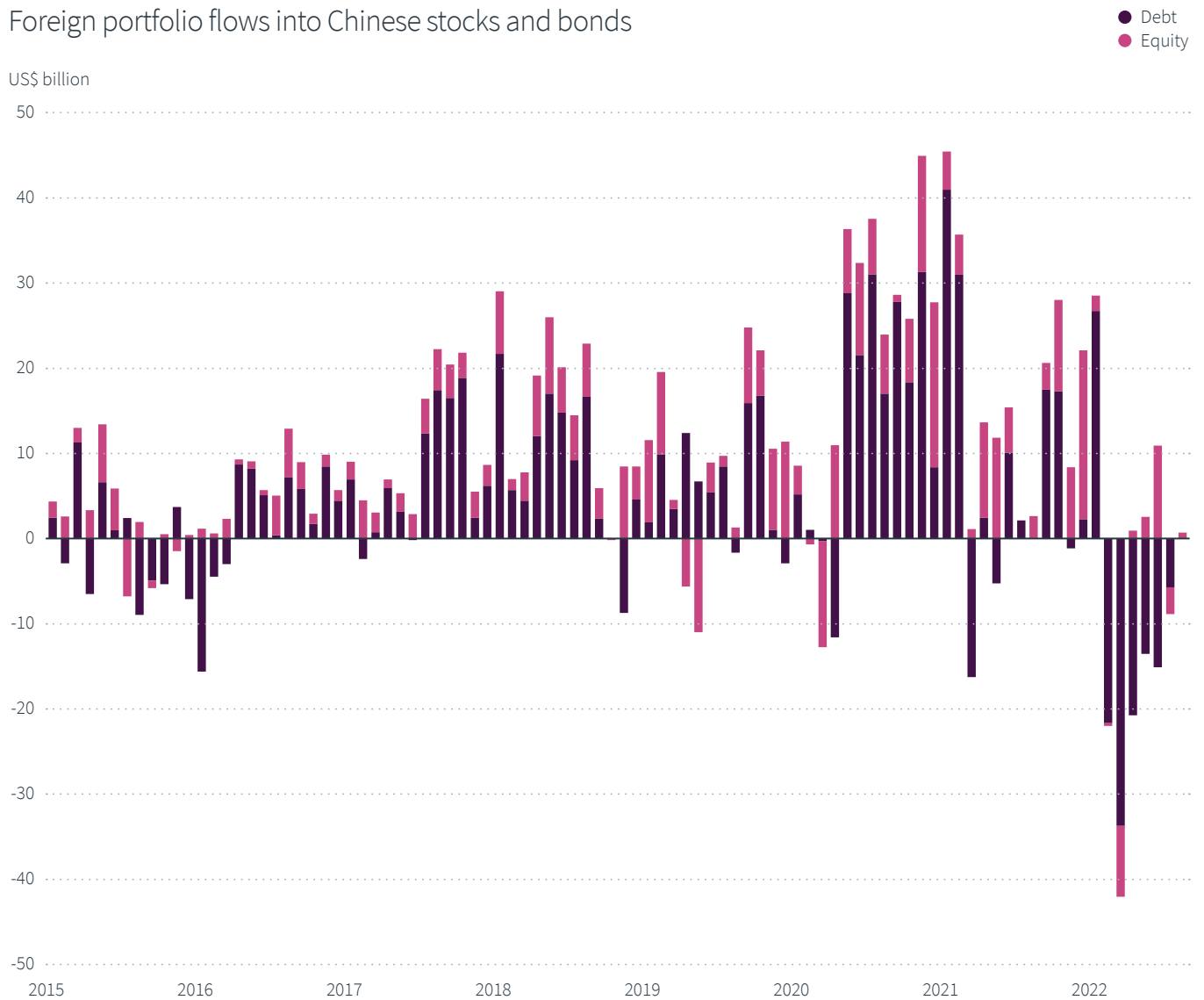


Growth is stuttering in the engine of the world economy. COVID lockdowns, supply chain issues, drought and worries about the financial sector have hit global investor sentiment towards China.

The faltering Chinese growth engine

Outflows as macro shocks hit sentiment

Foreign portfolio flows into Chinese stocks and bonds

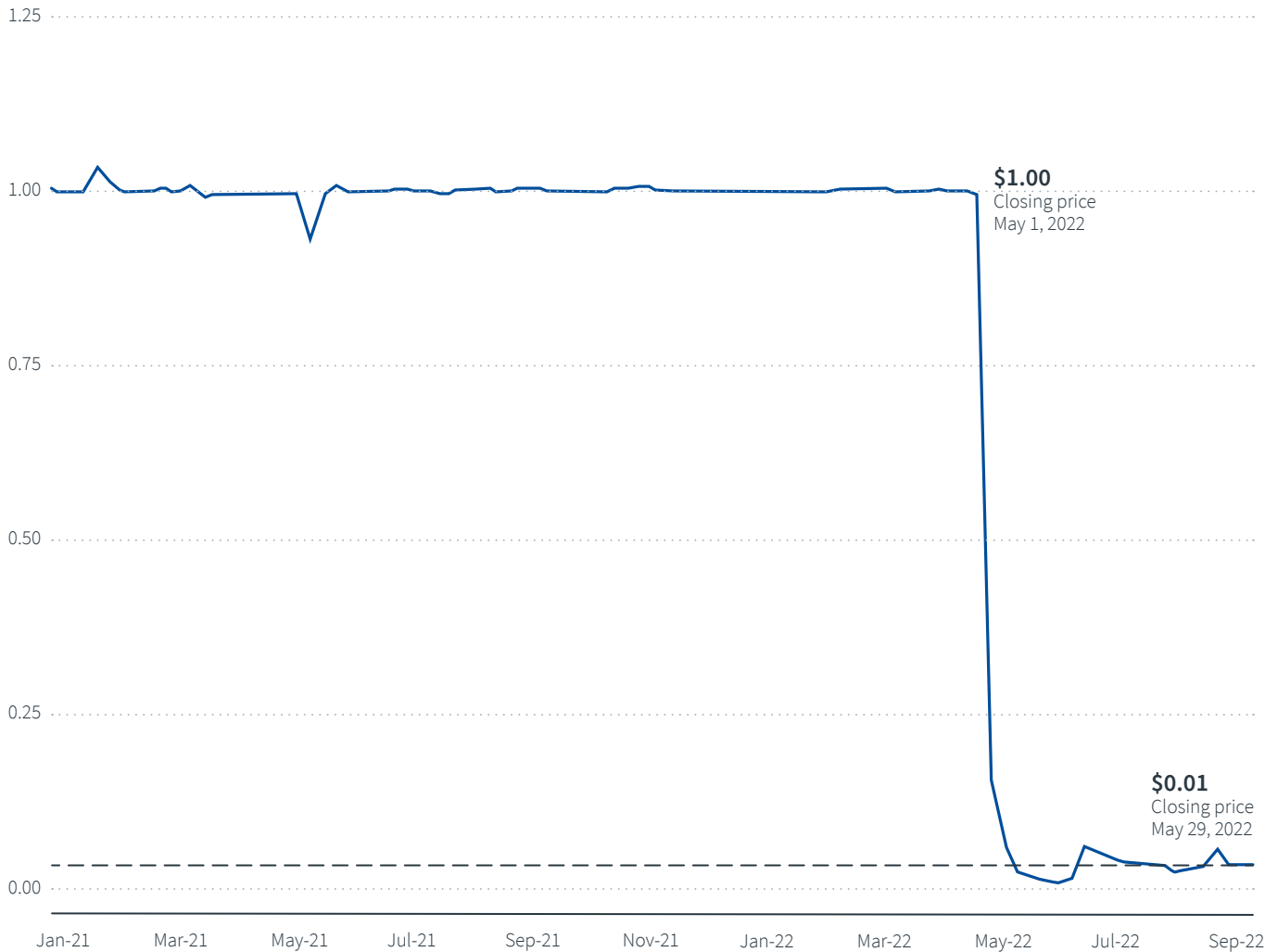


Digital winds blow cold

Crypto collapse highlights risk

Value of Terra

US\$



The failure of Terra, a 'stable coin' with an algorithmic peg to the US dollar, was likened to "a classic (bank) run" by Federal Reserve Vice Chair Lael Brainard. The slump wiped more than \$1 trillion off the value of the world's 100 largest cryptocurrencies, testing claims they can be useful for diversification and inflation hedging.

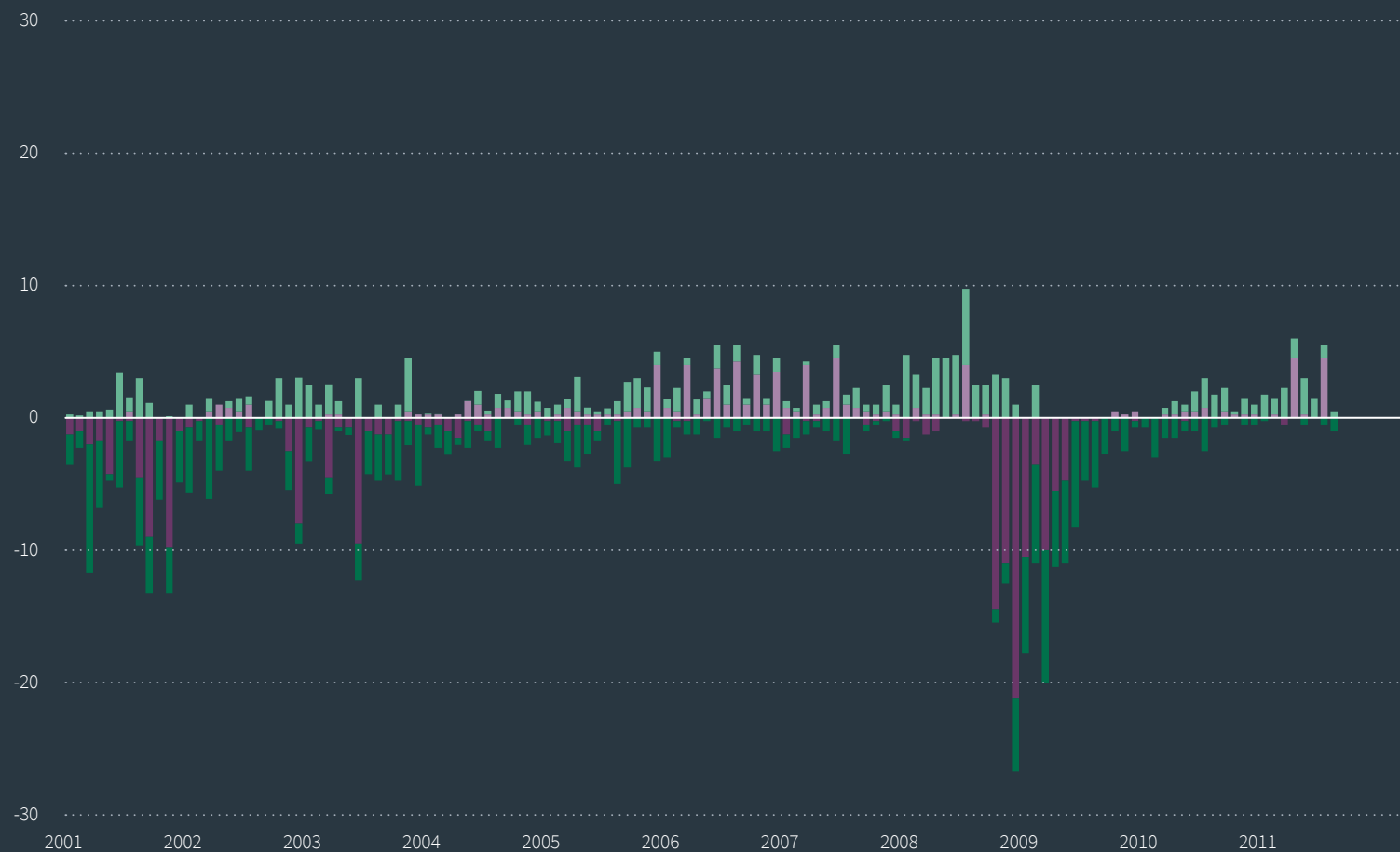
Taming the beast

Rate rises in the latest tightening cycle

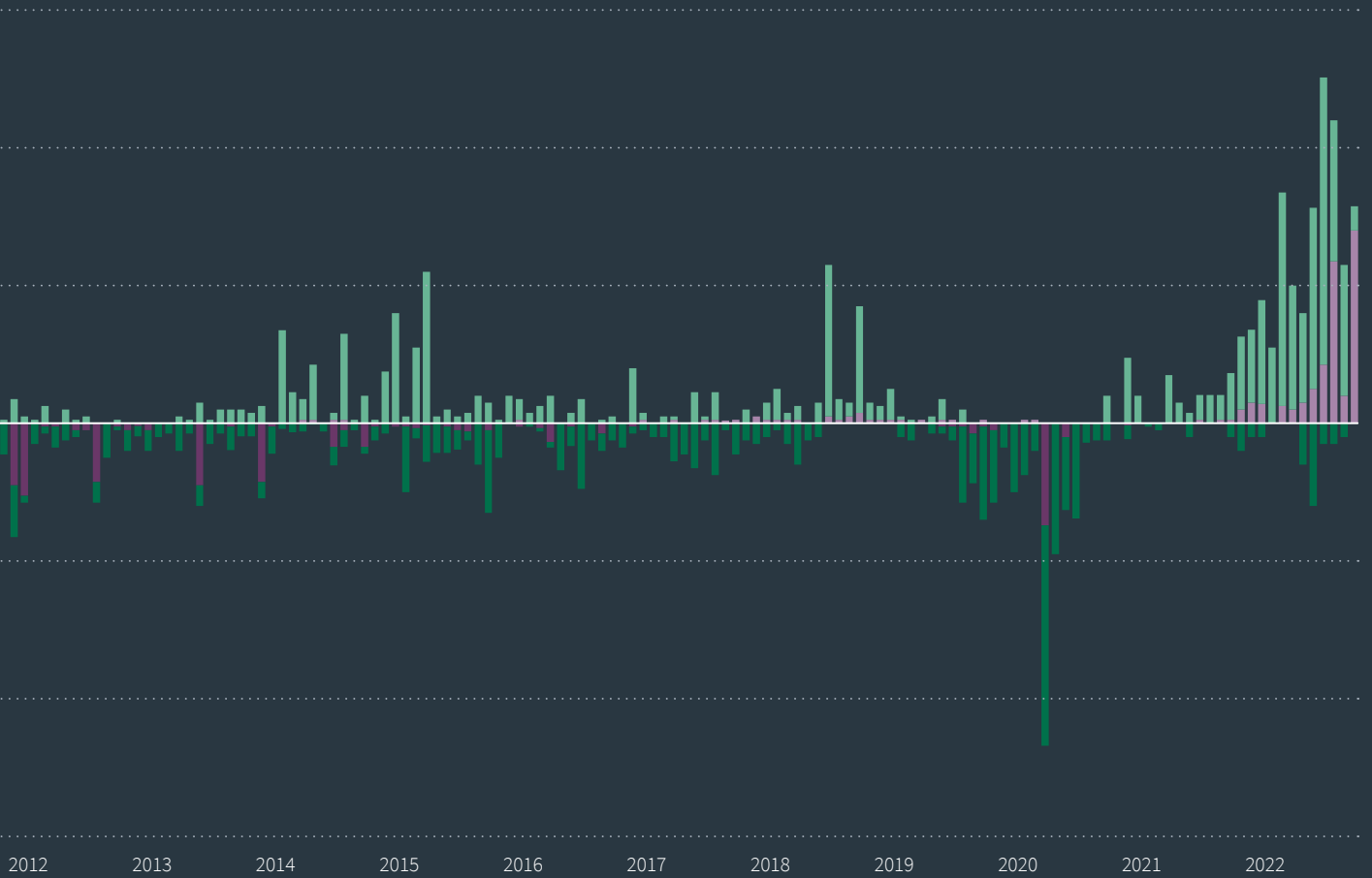
Over long time periods, inflation tends to be low apart from times of conflict. With inflation elevated, central banks have aggressively hiked rates in the fastest squeeze since the 1990s.

Policy rate moves

Basis points



- Hikes (emerging economies)
- Hikes (advanced economies)
- Cuts (emerging economies)
- Cuts (advanced economies)



In the red: Life after central bank support?

Few safe havens in 2022

Asset class performance

Per cent

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	H1 2022
Commodities	-1.06	-9.52	-17.01	-24.66	11.77	1.70	-11.25	7.69	-3.12	27.11	18.44
US Treasuries	2.17	-3.35	6.02	0.83	1.13	2.43	0.81	6.99	8.22	-2.38	-9.19
REITS	28.65	4.39	15.89	0.06	4.99	11.42	-4.74	23.06	-8.18	27.21	-20.35
Cash	0.11	0.07	0.03	0.05	0.33	0.85	1.88	2.28	0.67	0.05	0.14
Global investment grade	11.21	0.35	3.15	-3.56	4.27	9.09	-3.57	11.51	10.37	-2.89	-15.52
Gold	6.96	-28.26	-1.51	-10.46	8.63	13.68	-2.14	18.87	24.42	-3.51	-1.16
Global high yield	17.99	8.11	3.24	-3.09	15.50	7.39	-2.56	13.83	5.29	4.84	-14.05
S&P 500	16.00	32.39	13.69	1.38	11.96	21.83	-4.38	31.49	18.40	28.71	-19.96
MSCI EAFE	17.90	23.29	-4.48	-0.39	1.51	25.62	-13.36	22.66	8.28	11.78	-19.26
MSCI EM US\$	18.63	-2.27	-1.82	-14.60	11.60	37.75	-14.24	18.88	18.69	-2.22	-17.47

US Treasuries
Worst H1 since 1788

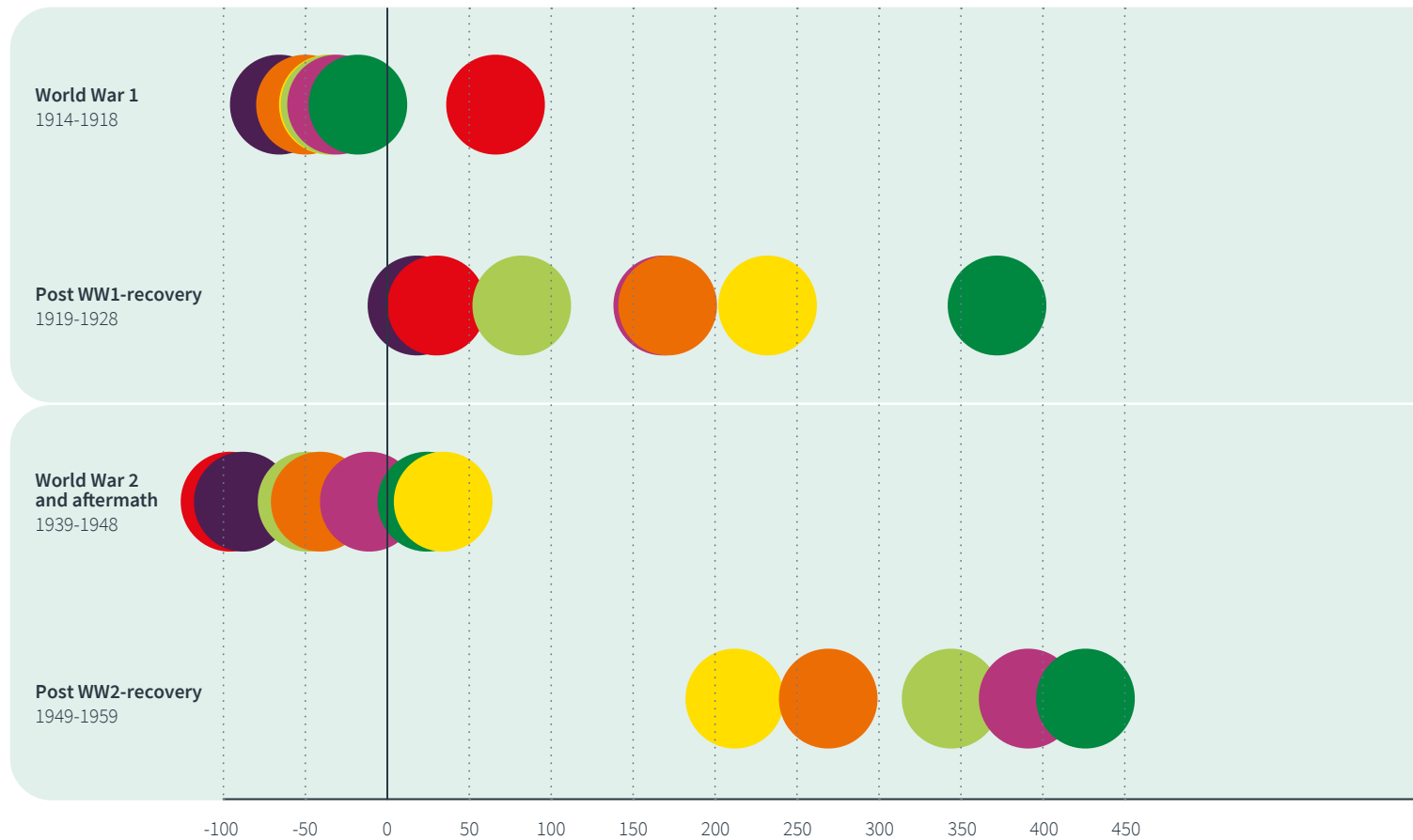
S&P 500
Worst H1 for over five decades

Post-conflict recoveries in equity markets

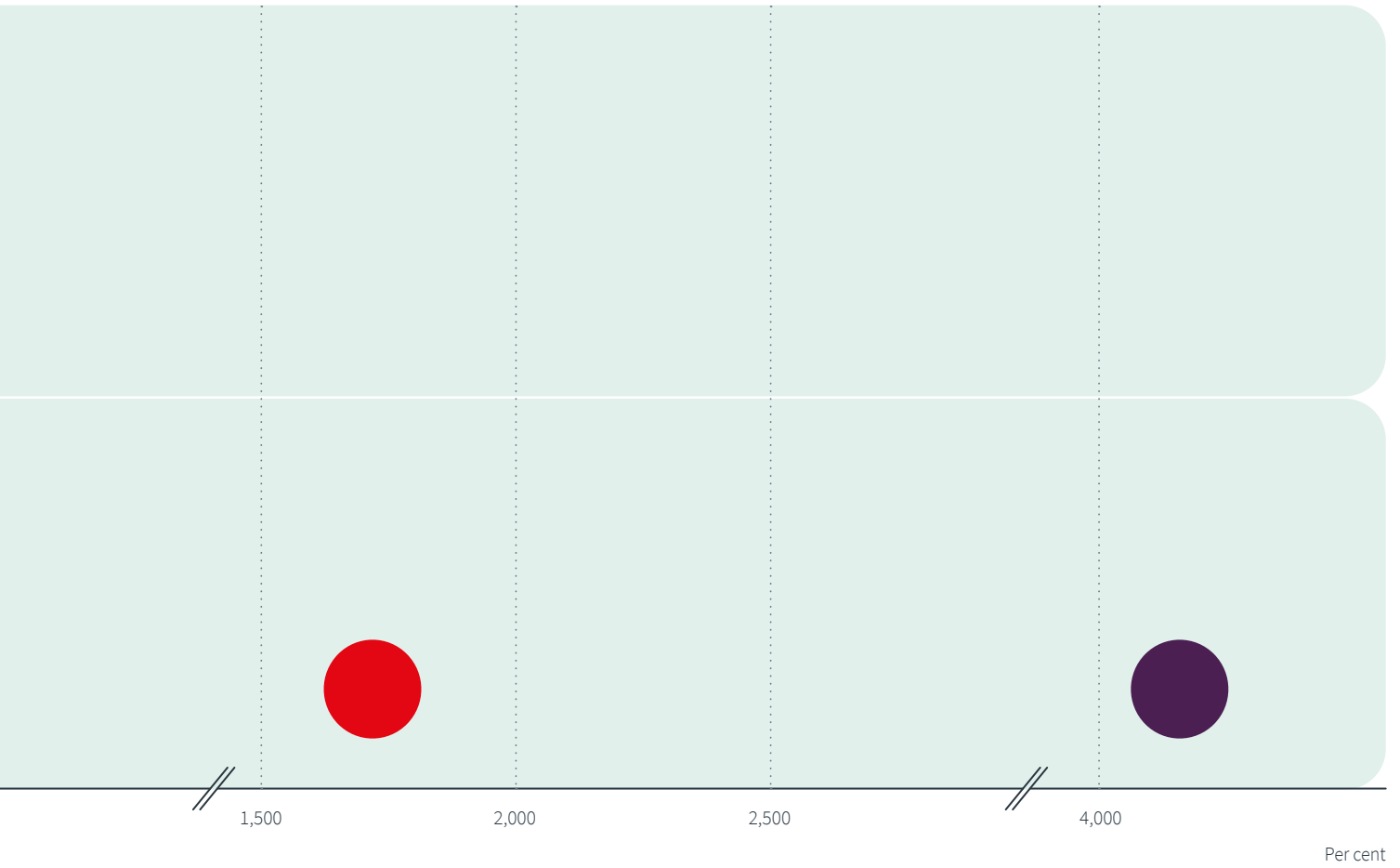
What history reveals

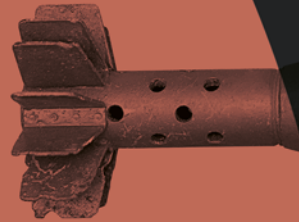
Both bond and equity markets have been challenged in 2022. Investors looking to rebuild capital might be interested in past studies showing exceptional performance in post-conflict recoveries. As each conflict is unique, there are no direct comparators.

Real equity returns in key markets during and after World Wars



- World
- World ex-US
- US
- UK
- France
- Germany
- Japan







Conflict

The social, economic and environmental costs of war



Fighting, shouting, fleeing

Conflict migrants around the world

Millions of people forcibly displaced worldwide, 2021





Even before the Russian invasion of Ukraine, over 90 million people were displaced around the globe, of whom 41 per cent were under 18. Some conflict hotspots relate to food and water scarcity, others are rooted in religious differences. They include areas in and around Syria, Afghanistan, Ethiopia, Nigeria, Myanmar and Democratic Republic of Congo.

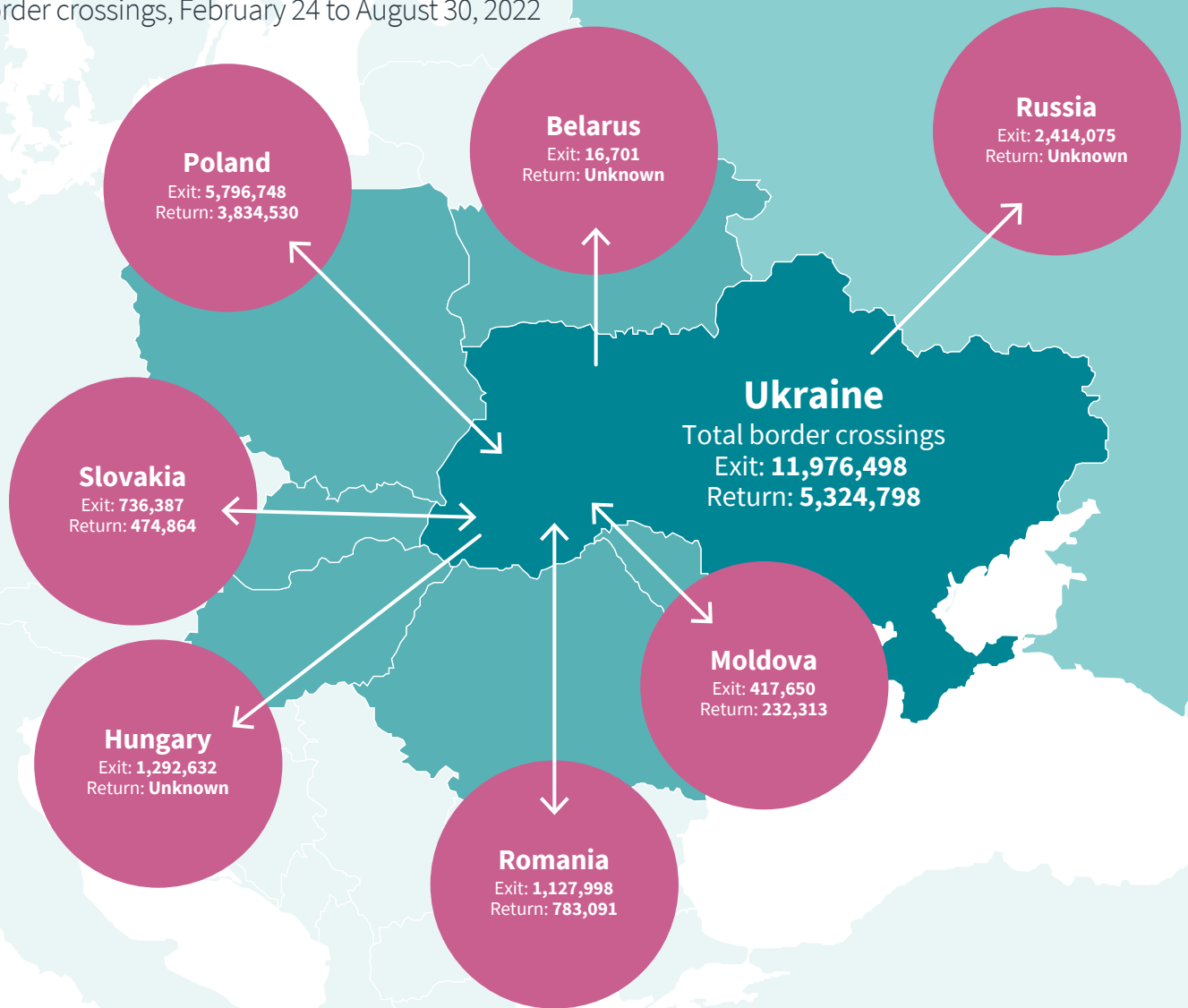
The quest for home

Human disruption around Ukraine

Conflicts are fluid, which makes managing the human dimensions challenging. The flow of people out of Ukraine has been dominated by working-age women and children (89 per cent), while martial law has ensured men stay to fight. Some that left Ukraine have already returned, including a significant number from Poland.



Border crossings, February 24 to August 30, 2022



The dragon and the black bear

China and Taiwan's military assets

China is becoming bolder in military exercises around Taiwan, an island it first claimed as its own in AD 239. China's military capability far outstrips Taiwan's; it is open about its desire for reunification and has boosted defence spending every year for more than two decades.

Total ground force personnel

1,040,000

88,000

1 = 5,000 soldiers

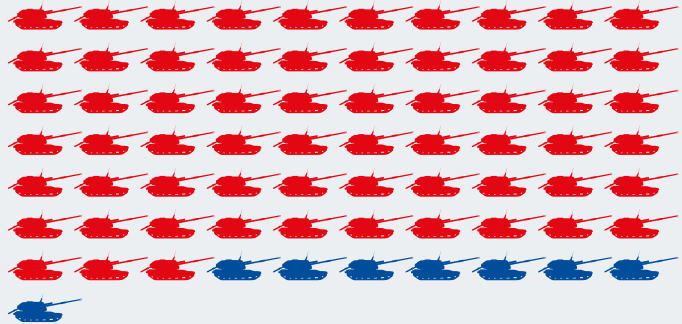


Tanks

6,300

800

1 = 100 tanks

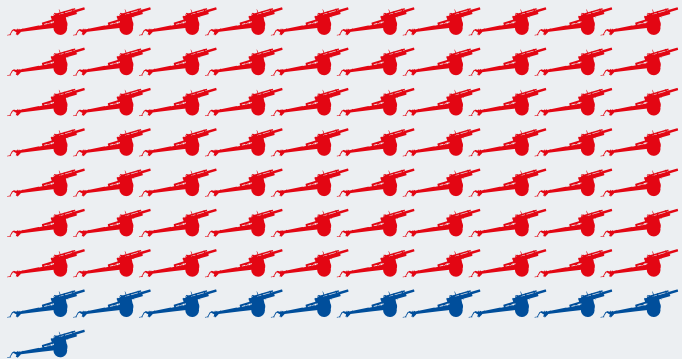


Artillery pieces

7,000

1,100

1 = 100 artillery pieces



● China
● Taiwan

Aircraft carriers

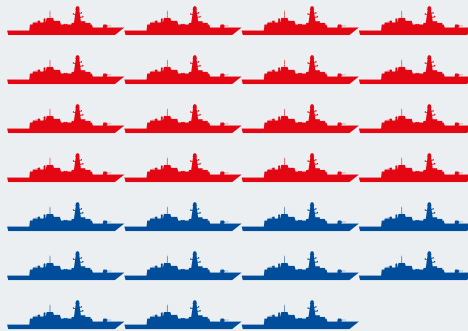
1
0



Destroyers

32
21

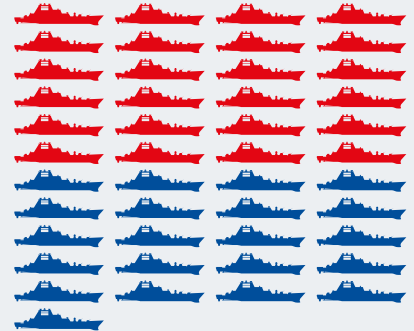
1 = 2 destroyers



Frigates

48
41

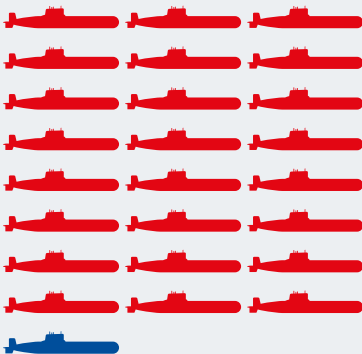
1 = 2 frigates



Submarines

71
2

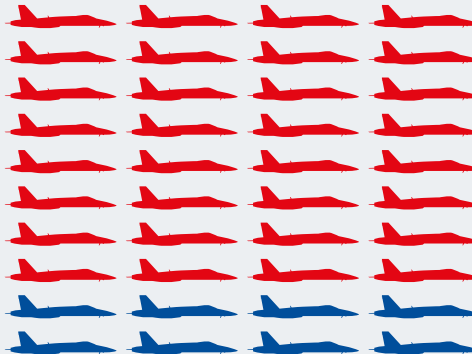
1 = 3 submarines



Fighter planes

1,600
400

1 = 50 fighter planes



Bombers

450
0

1 = 20 bombers



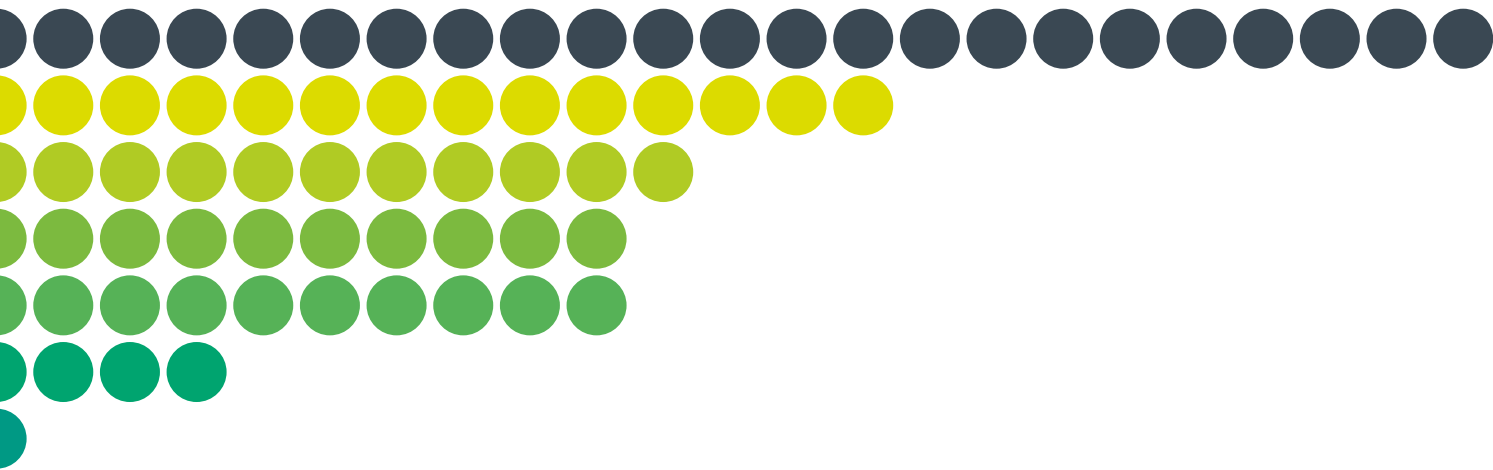
Combat is costing the earth

Counting carbon

Military carbon emissions are typically not included in national carbon accounts, despite the fact big spenders like the US Department of Defense generate more carbon dioxide than many small countries. Multi-billion dollar budgets and fuel-guzzling combat technologies make achieving net zero an even bigger challenge than is widely appreciated.

Annual emissions: US Department of Defense versus selected countries (million Mt CO₂e)

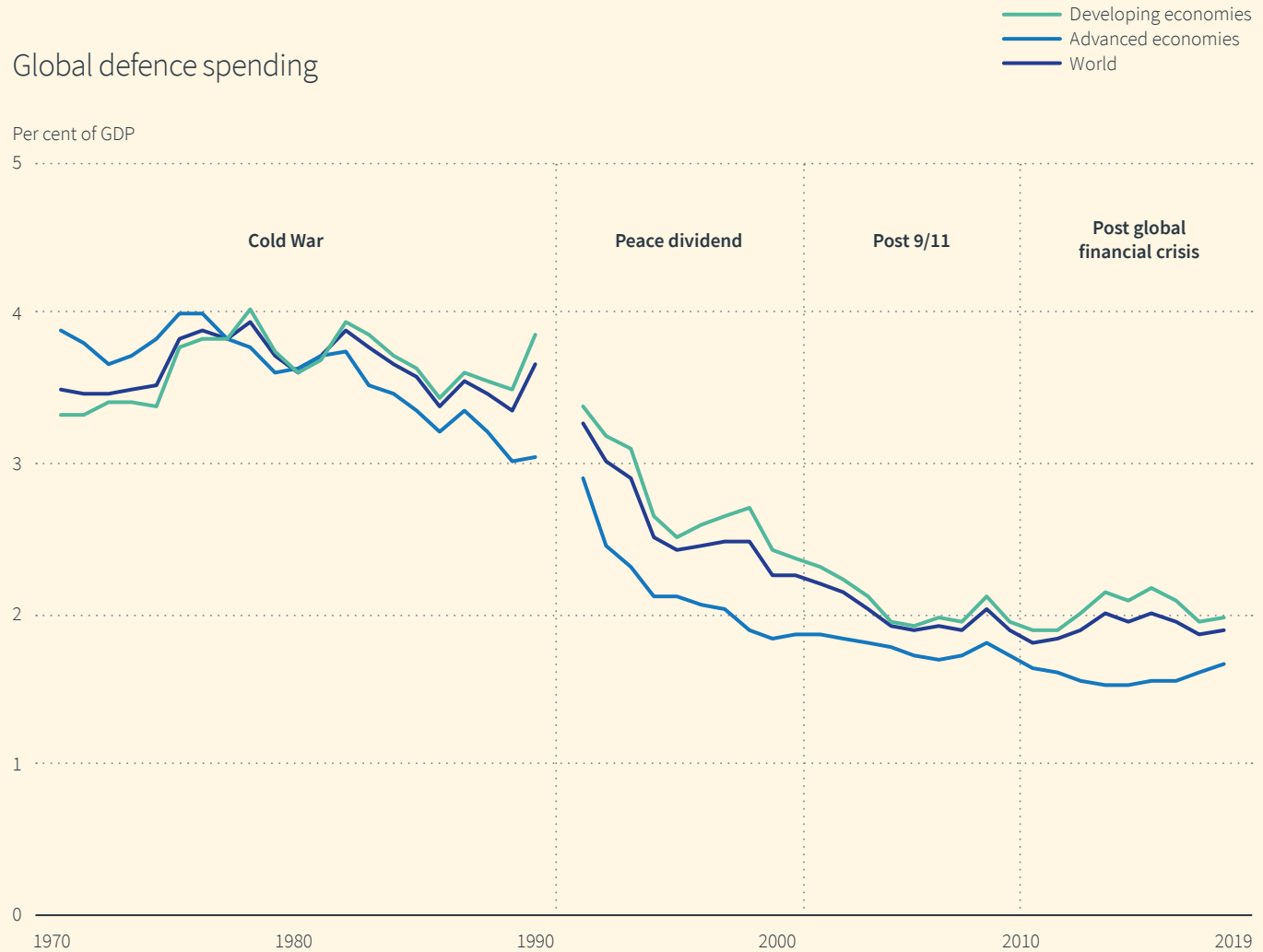




What happened to the peace dividend?

Spending for defending

Global defence spending has fallen sharply since the 1970s. The fall post-1990 meant more revenue could be directed elsewhere – a 'peace dividend' to benefit everyone.

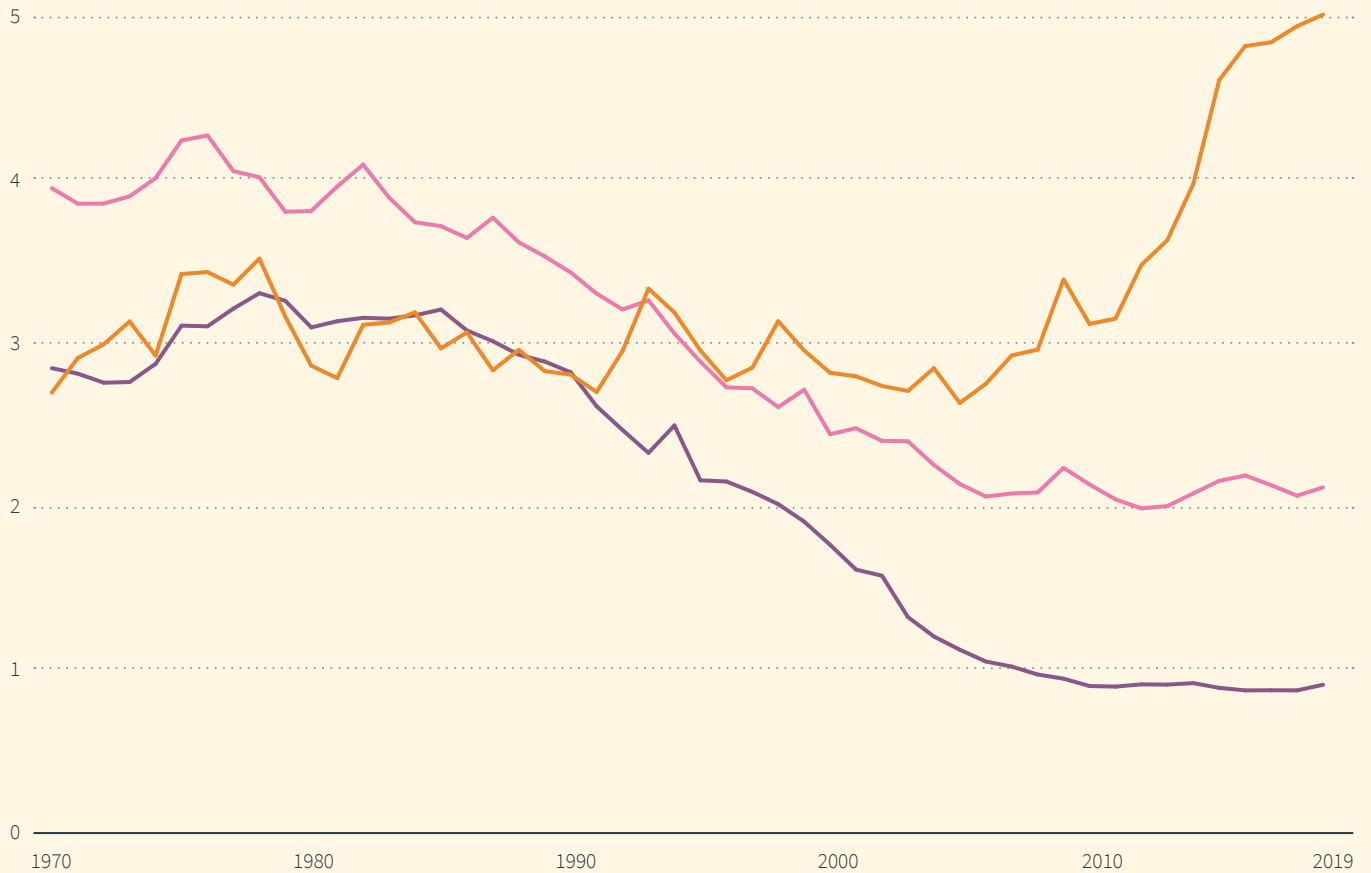


However, military spending is increasing again and expected to grow around 2.5 per cent in 2022. But the top-20 spenders, including Saudi Arabia, Oman and Democratic Republic of Congo, have been on this track for a while. The latest proposed increase from Taiwan is close to 14 per cent.

Global defence spending by segment

- Group 1 (20 countries)
- Group 2 (77 countries)
- Group 3 (41 countries)

Per cent of GDP



Who's buying Russian fuel?

Satisfying voracious energy appetites

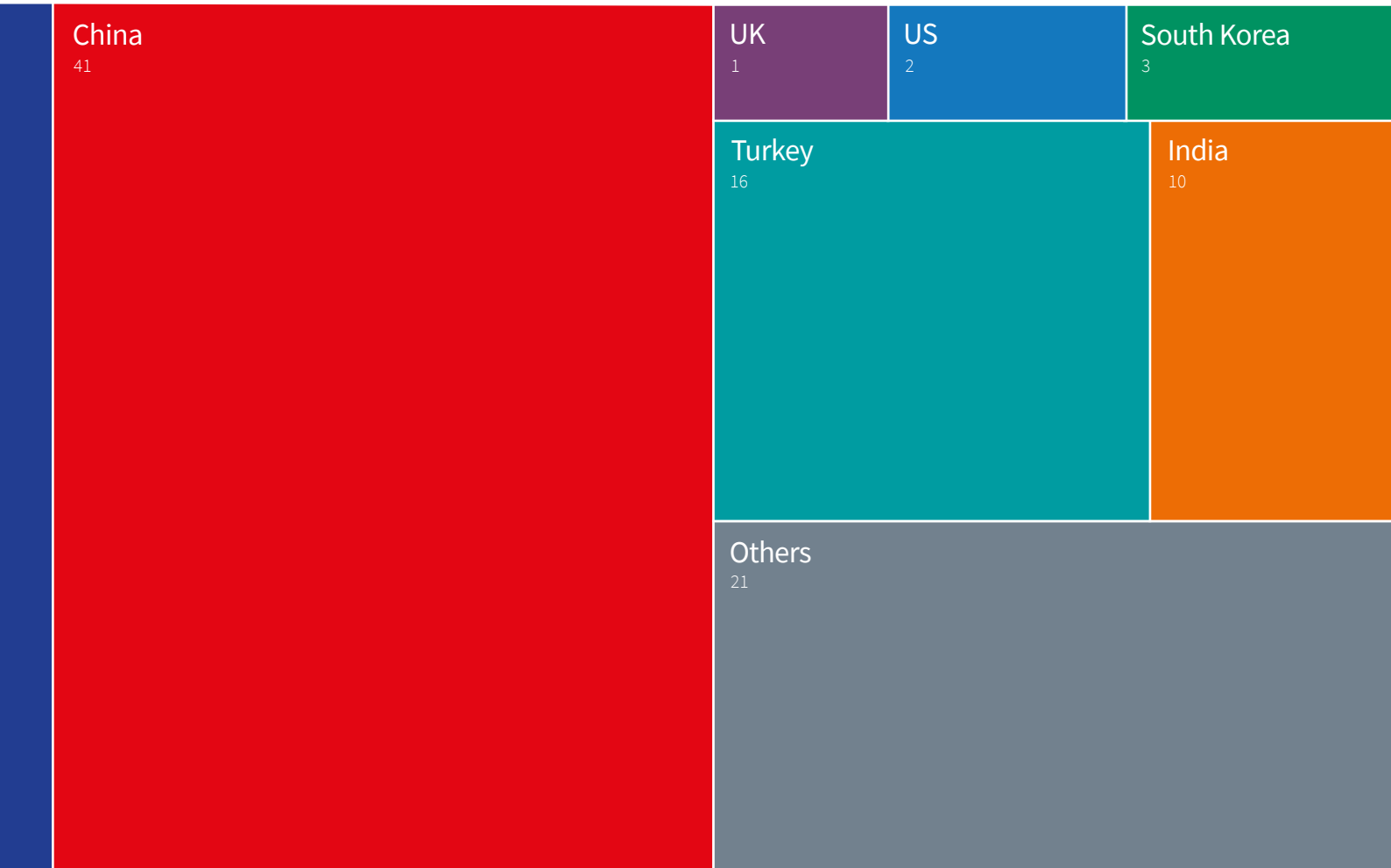
Despite the tough talk and supposedly even tougher sanctions, European countries are finding it difficult to shake their dependency on Russian fuel. It's estimated Europe has spent more than €109 billion acquiring essential energy at elevated prices in well under a year.

Largest Russian fossil-fuel takers, February 24 to October 5, 2022

US\$ billions

Europe

109

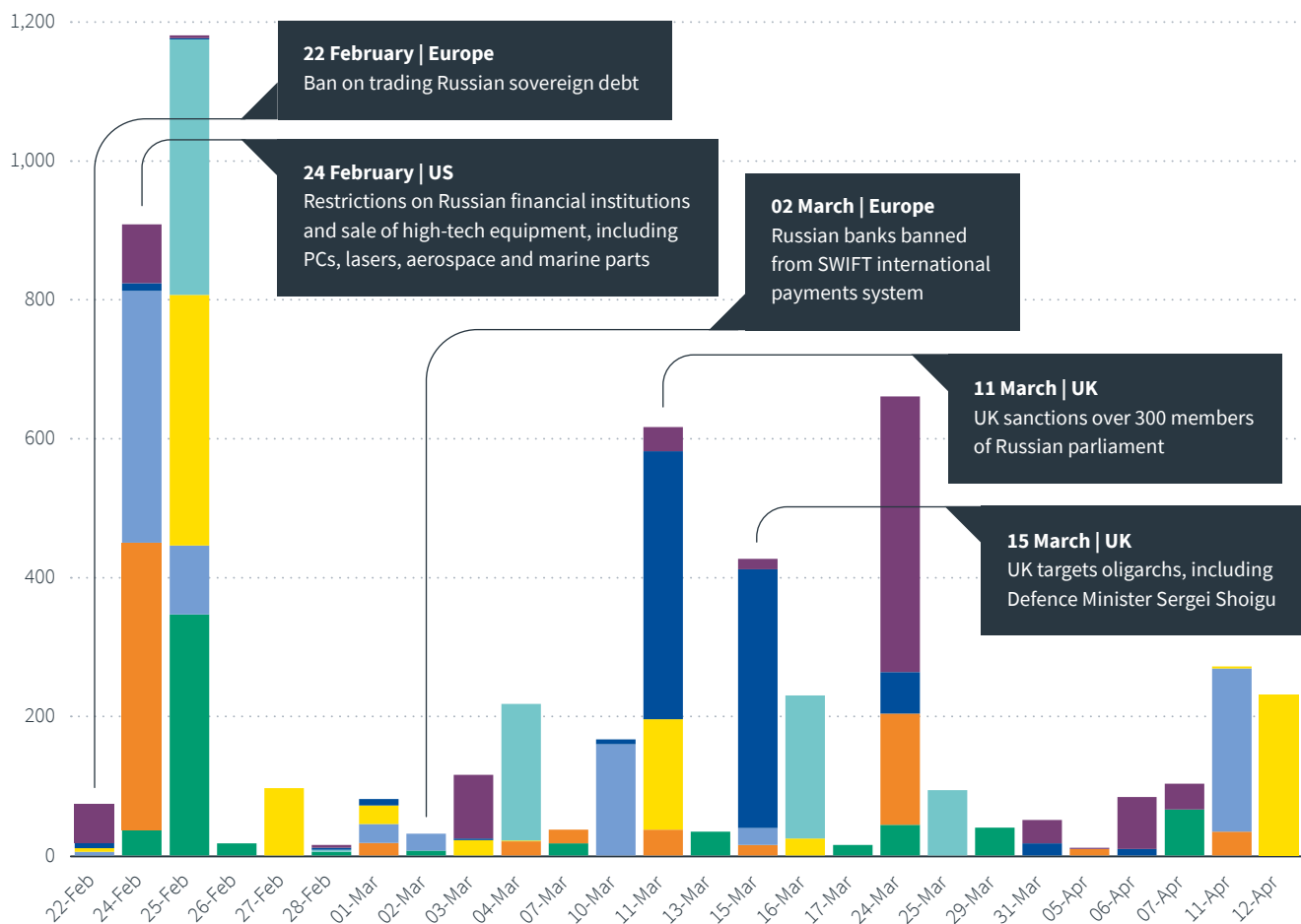


The economic front line

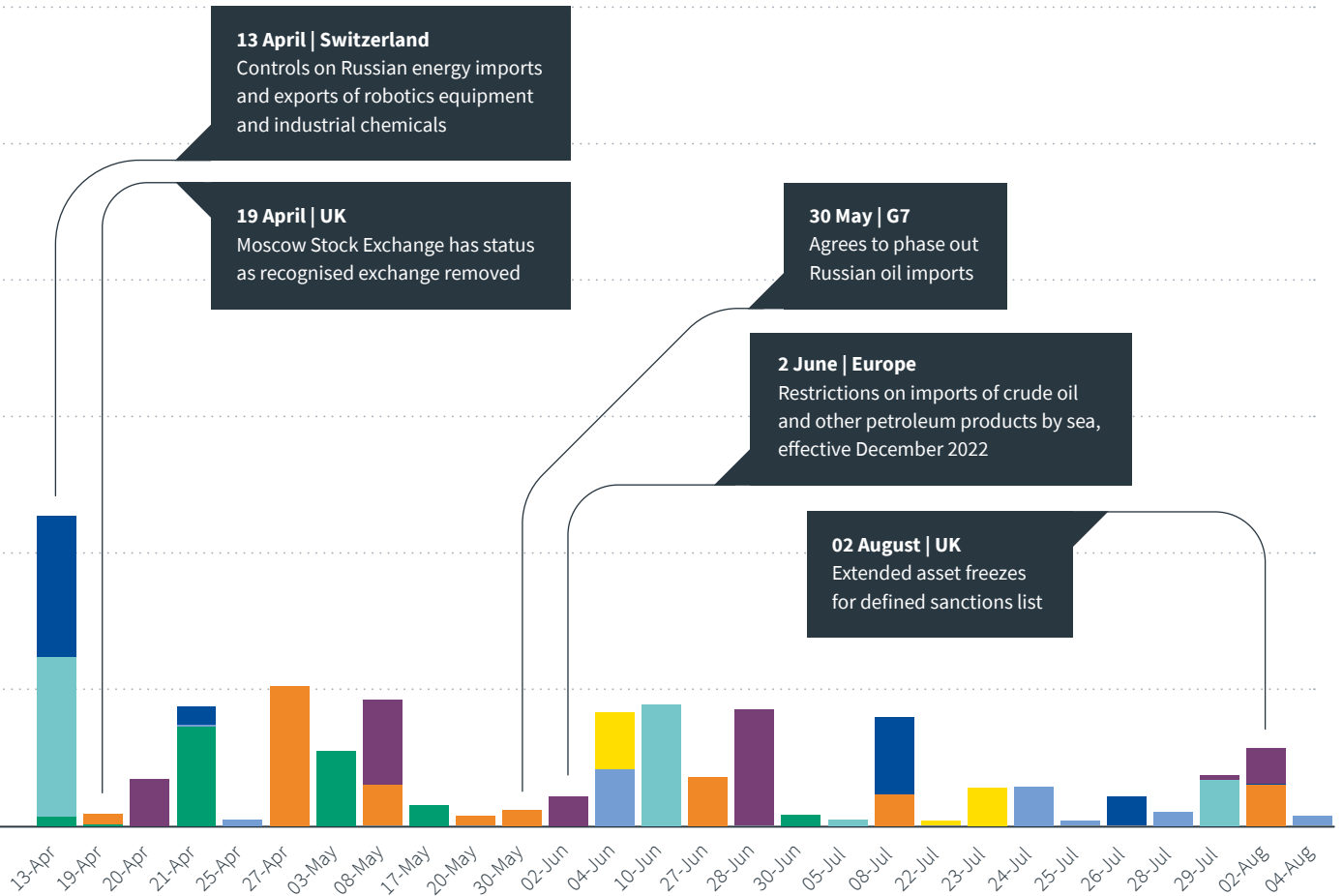
Do sanctions pack a punch?

The fallout from sanctions flows both ways. Sweeping action against Russia has triggered a sovereign default and shortages of essentials, from microchips to pesticides. Meanwhile, former import partners have their own energy, food and materials crises to grapple with.

Number of sanctions on Russia by country, 2022



- Australia
- Canada
- Europe
- France
- Switzerland
- UK
- US







People

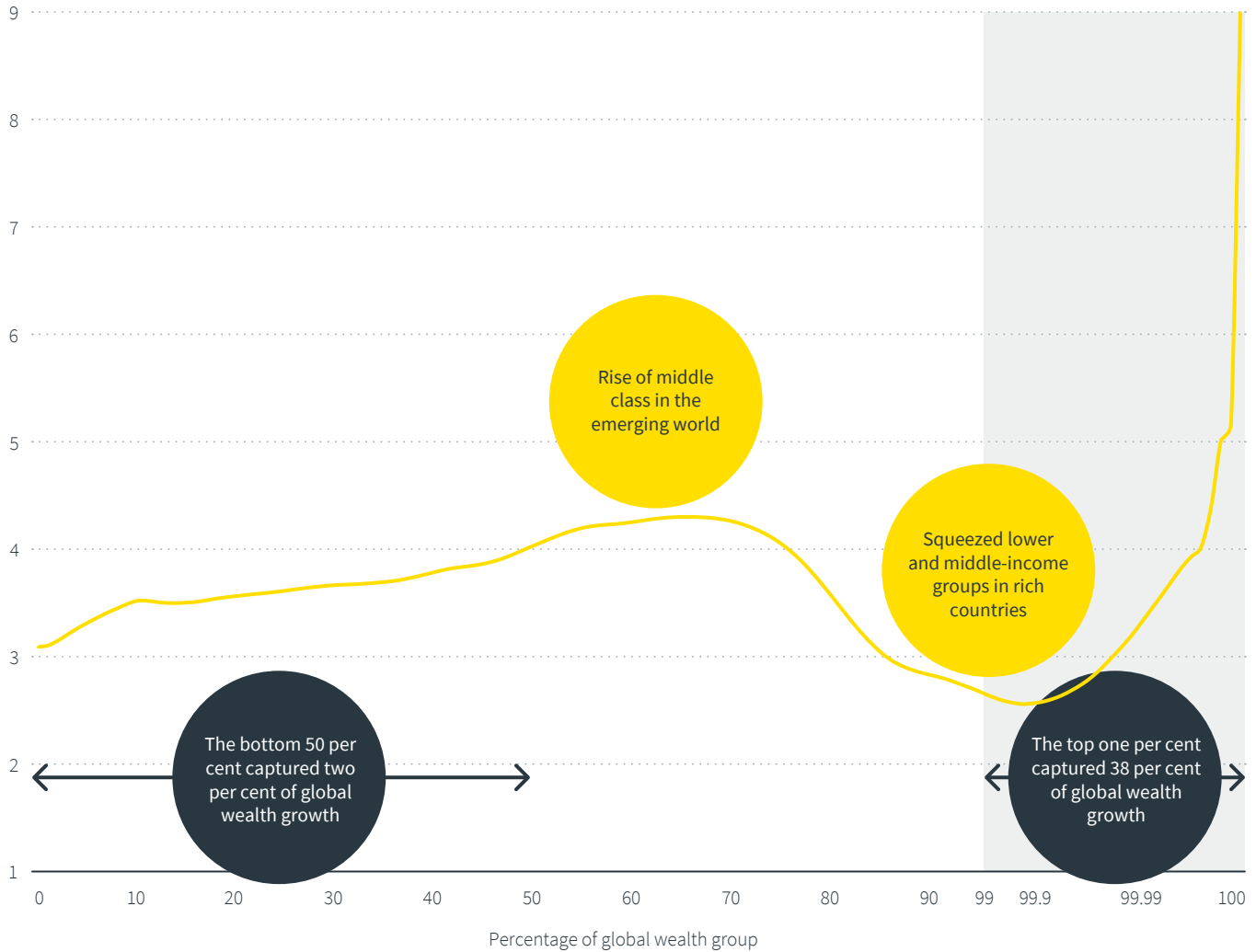
From rising inequality to a demographic bust

Boom times for some

The explosion of private wealth

Average adult annual wealth growth rate, 1995-2021

Per adult, net of inflation (per cent)





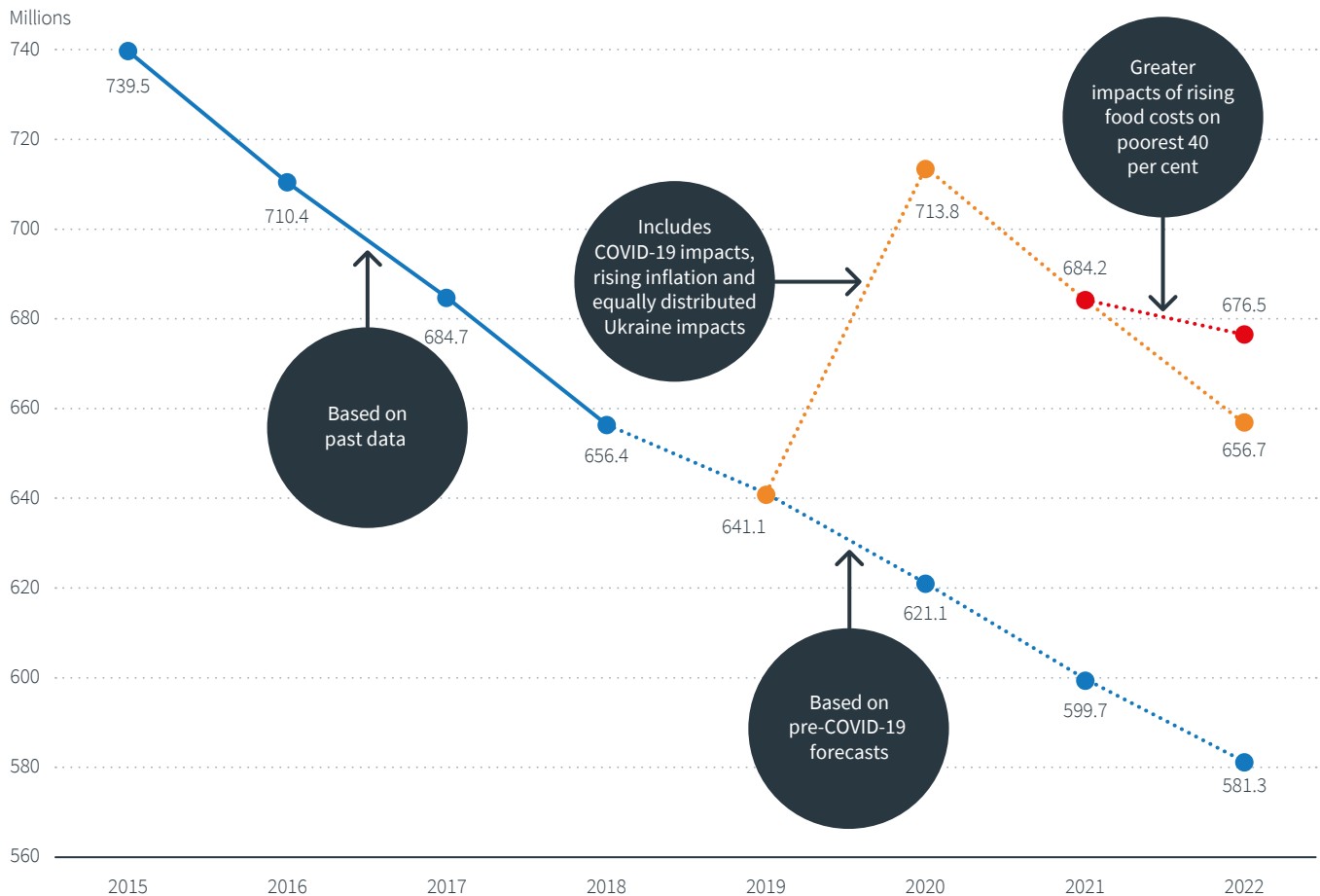
The world's richest one per cent have taken a large slice of the wealth accumulated since the mid-1990s, whereas the bottom 50 per cent have captured a meagre amount. These divergent outcomes continued during COVID-19; while millions struggled, a new billionaire was created about every 26 hours.

Extreme poverty for others

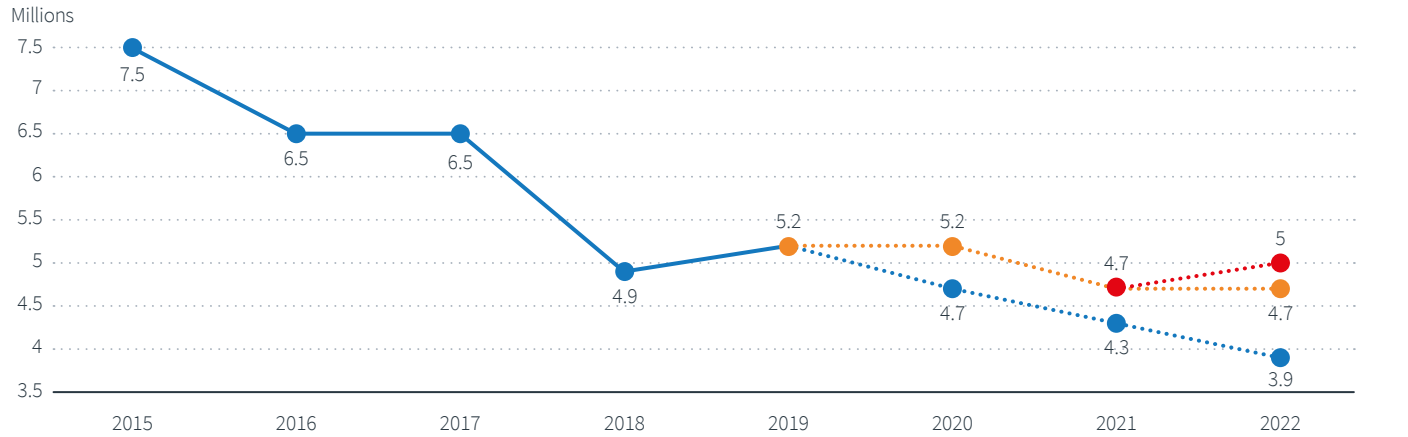
Living on less than \$2 per day

Over a quarter of a billion more people could experience extreme poverty in 2022, surviving on less than \$2 a day. Regional disparities are large, with extreme poverty increasing in all scenarios in Sub-Saharan Africa. In Europe and Central Asia, poverty is worsening, but by a smaller margin.

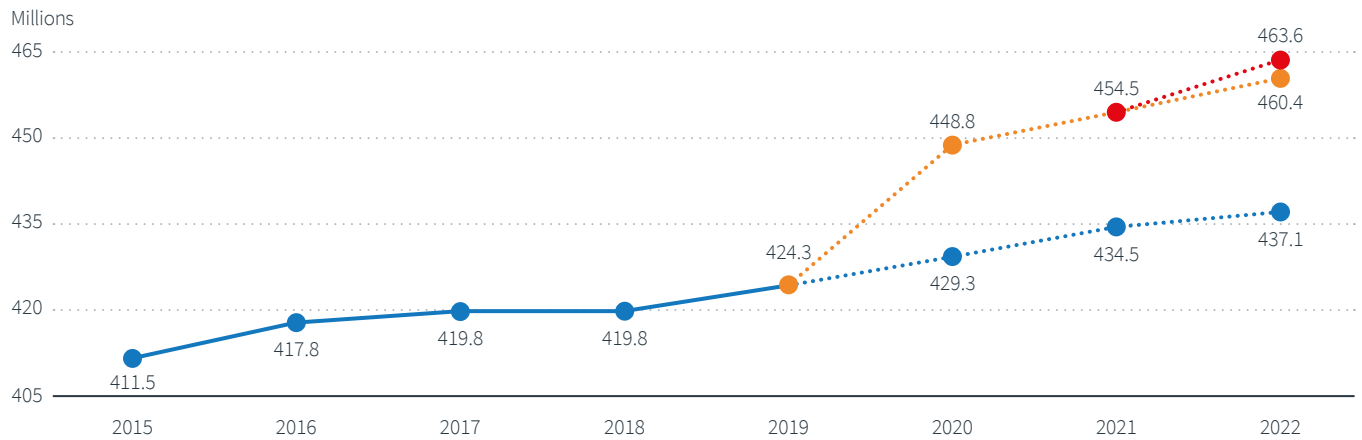
Extreme poverty globally



Europe and Central Asia



Sub-Saharan Africa



No escaping COVID-19

Restrictions trail on

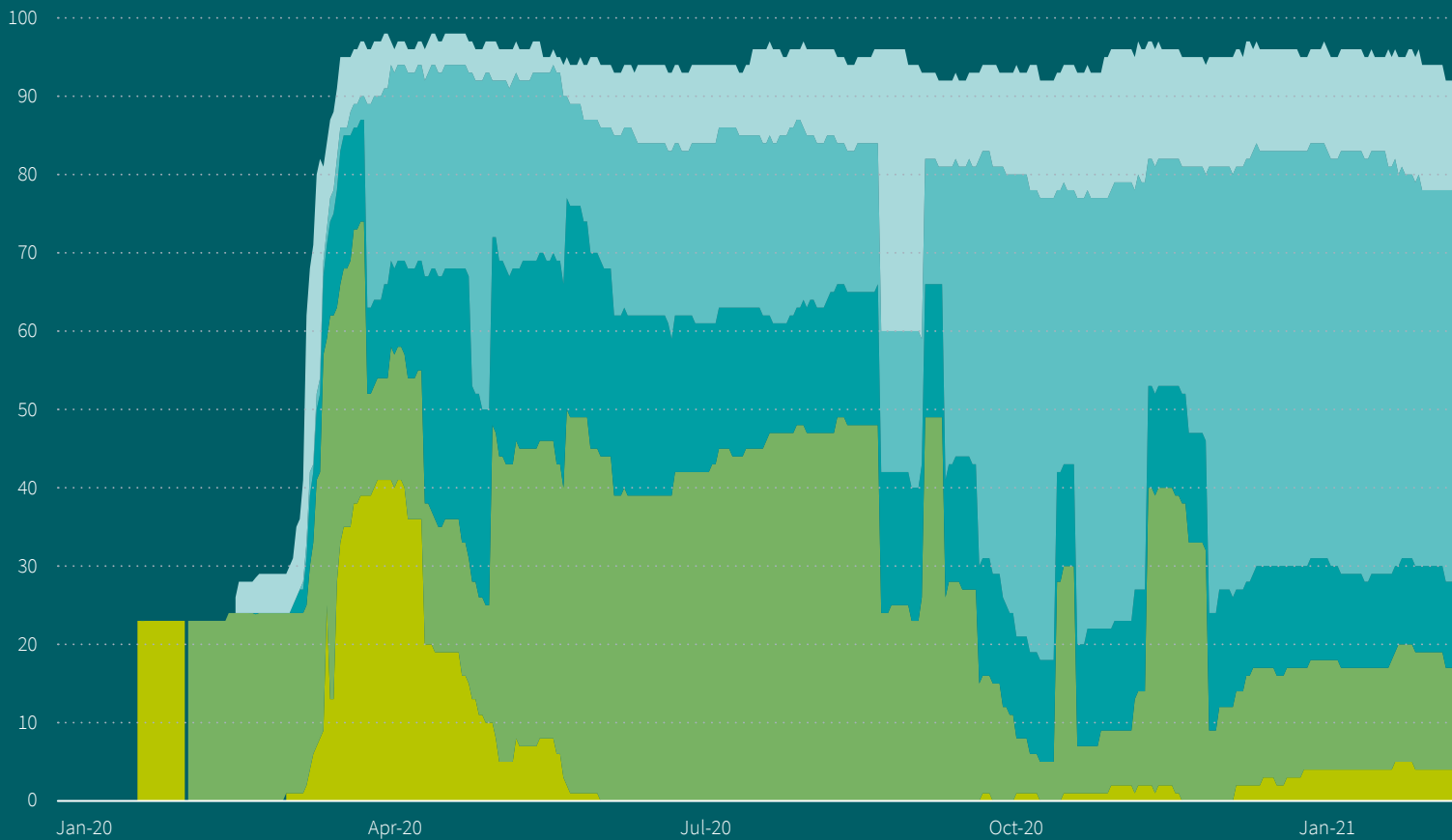
While some countries have sought to live with the coronavirus, others have continued restrictions on workplaces and other spaces, although workplace closures are currently on a downward trend and strict, economy-wide lockdowns are now rare.

“My emotions naturally range from complete denial and disbelief to anger, sadness and eventually hopelessness.”

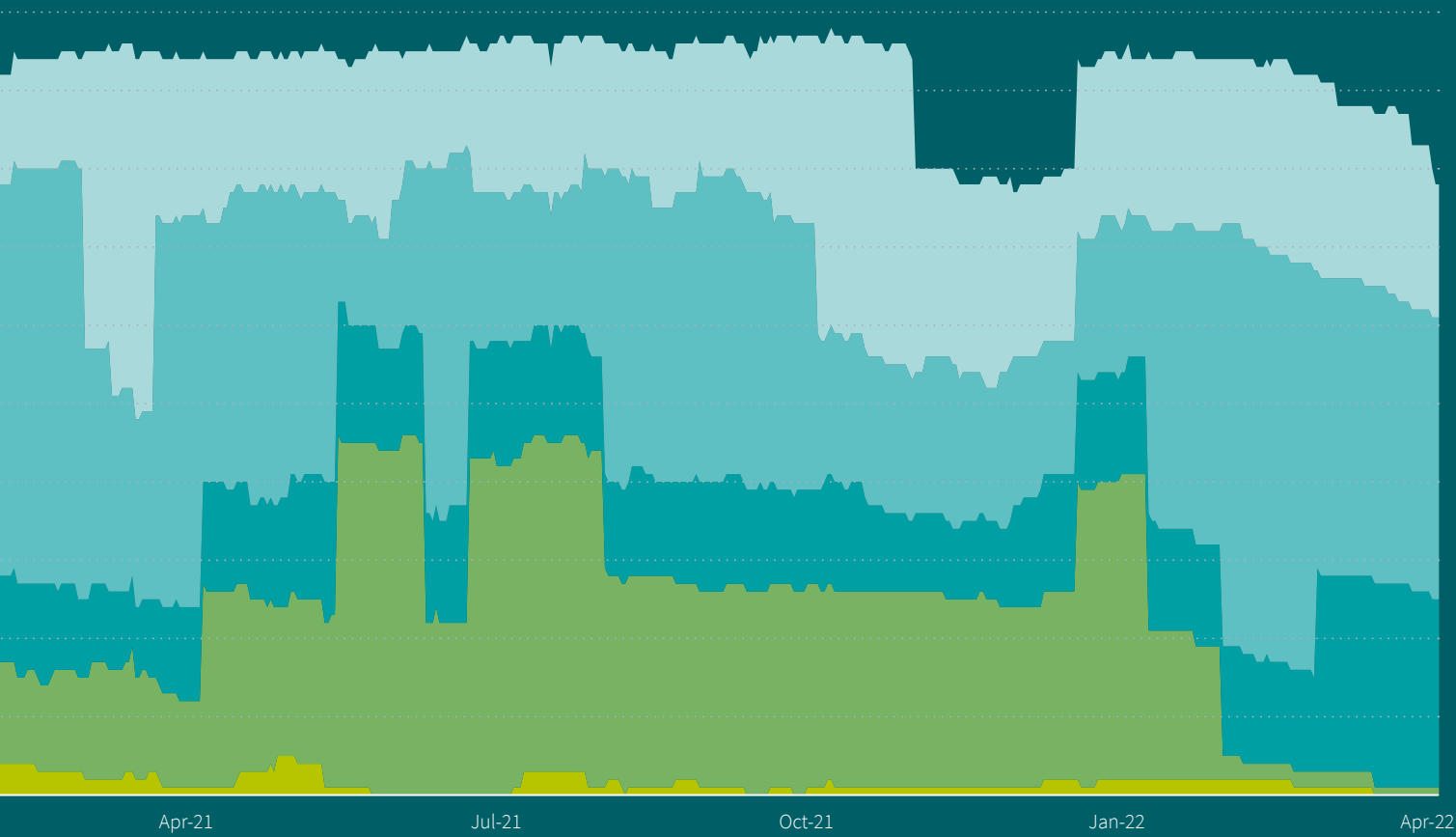
Brian Hall, professor, public health specialist, locked down in China in 2022.

Share of world's employed in countries with workplace closures

Per cent



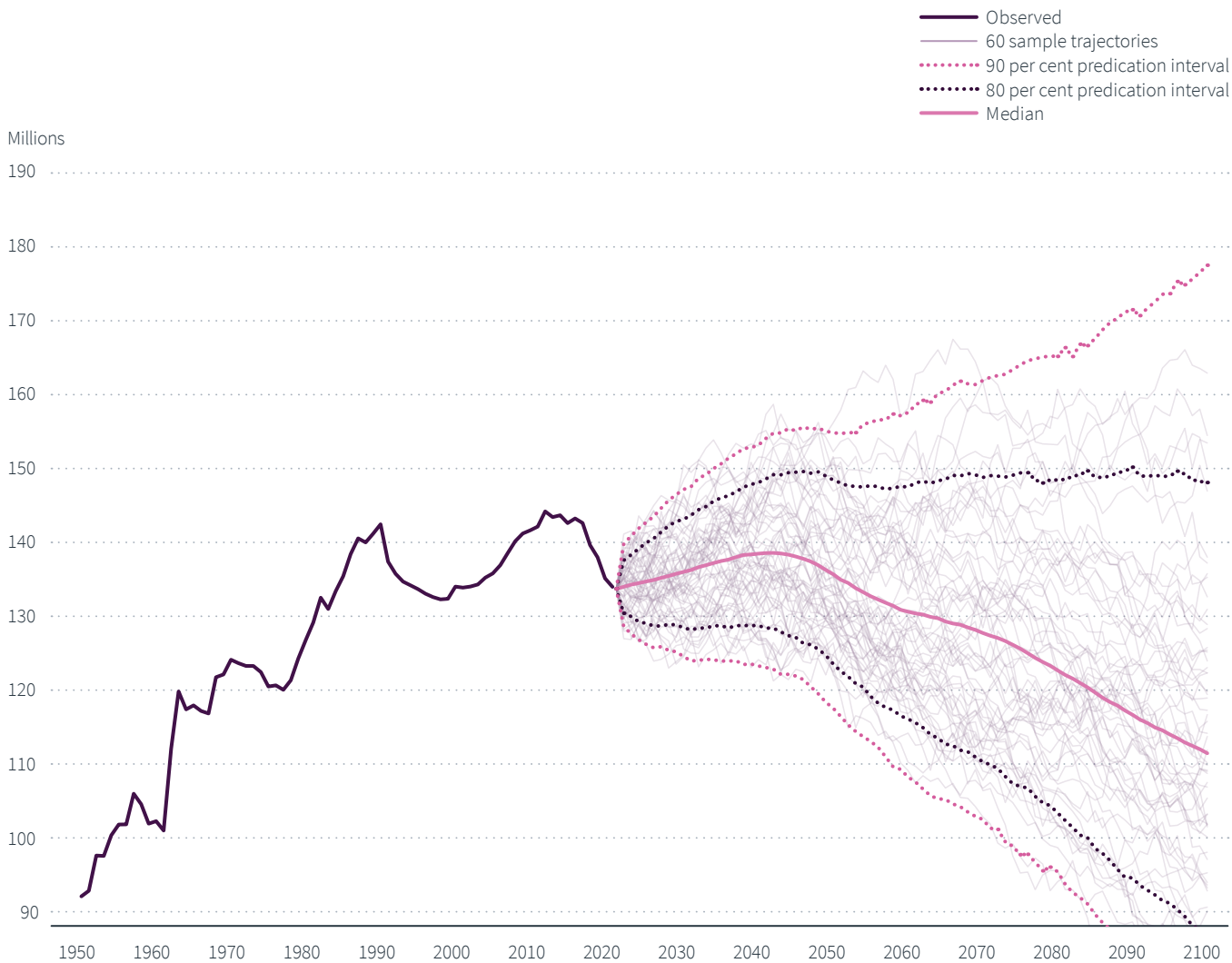
- Recommended closures
- Required closures for some sectors or categories of workers - targeted areas only
- Required closures for some sectors or categories of workers - total economy
- Required closures for non-essential workplaces - targeted areas only
- Required closures for non-essential workplaces - total economy



The baby bust?

A junction for life on earth

Annual number of births: Real world observations and range of projected trajectories





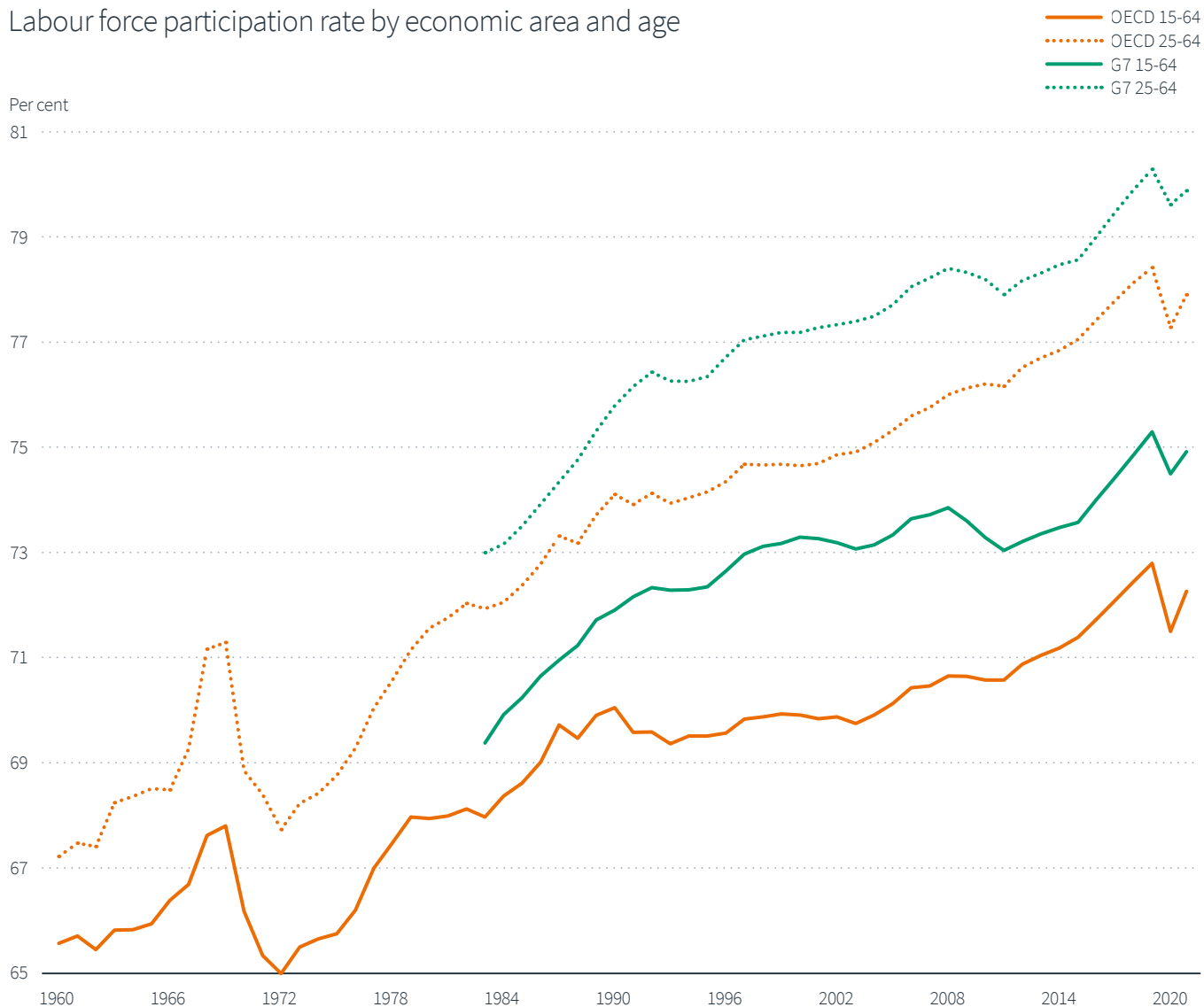
Population forecasting is hard. Pre-pandemic, global population growth was slowing across all income groups everywhere, with births in many high- and upper-middle-income countries below replacement rates. Now areas that experienced rigid lockdowns are reporting births slumping, which could take the population pathway onto a lower trajectory.

COVID-19 led many workers to rethink working arrangements, and change is not over. “What we are seeing is a fundamental mismatch between companies’ demand for talent and the number of workers willing to supply it,” says consultant McKinsey. Its polls in India, Australia, US, UK and Singapore suggested over one third looking to switch posts in the next three-six months; in India, the figure was 66 per cent.

The great resignation?

COVID-19 and employee turnover

Labour force participation rate by economic area and age

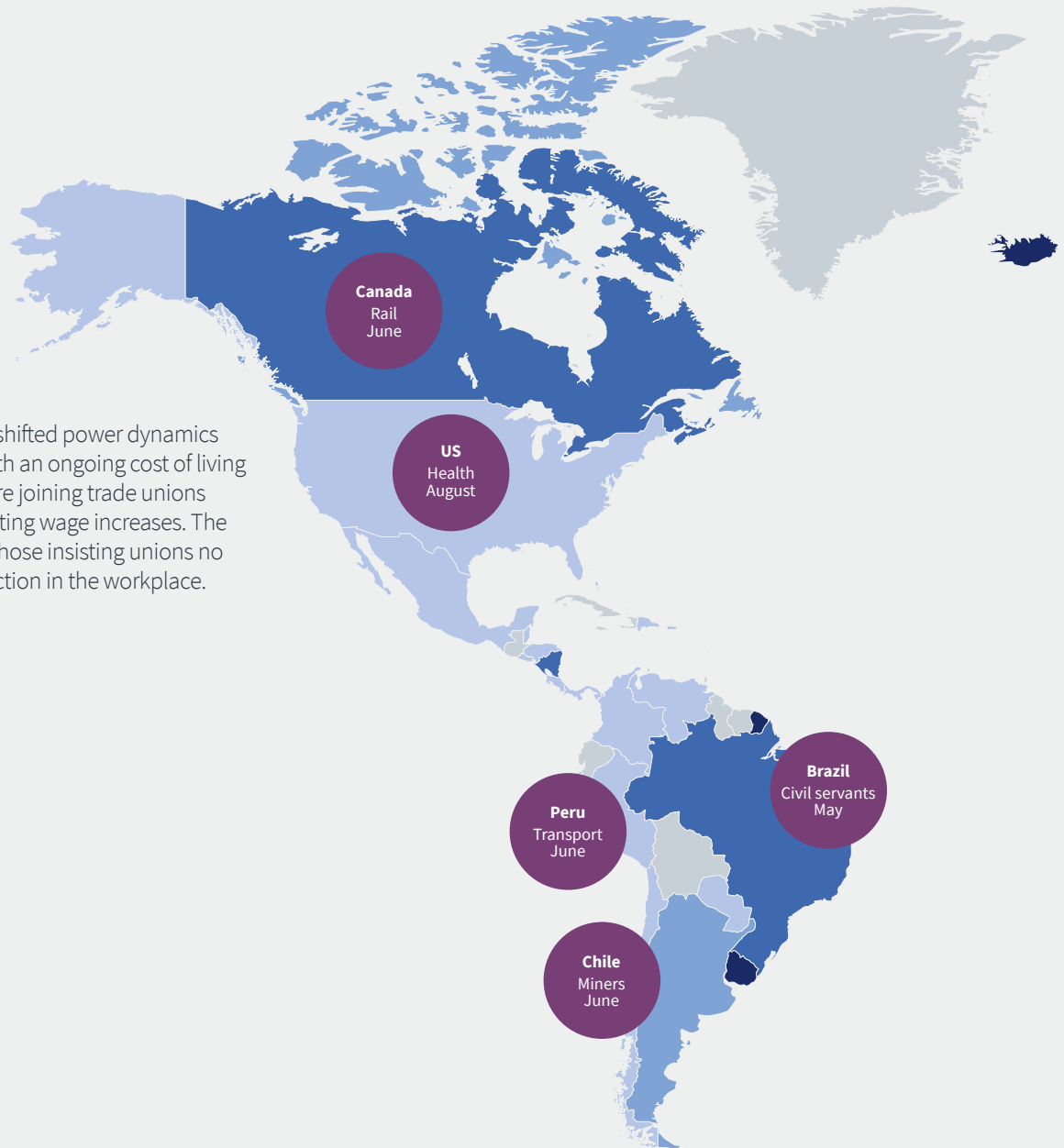


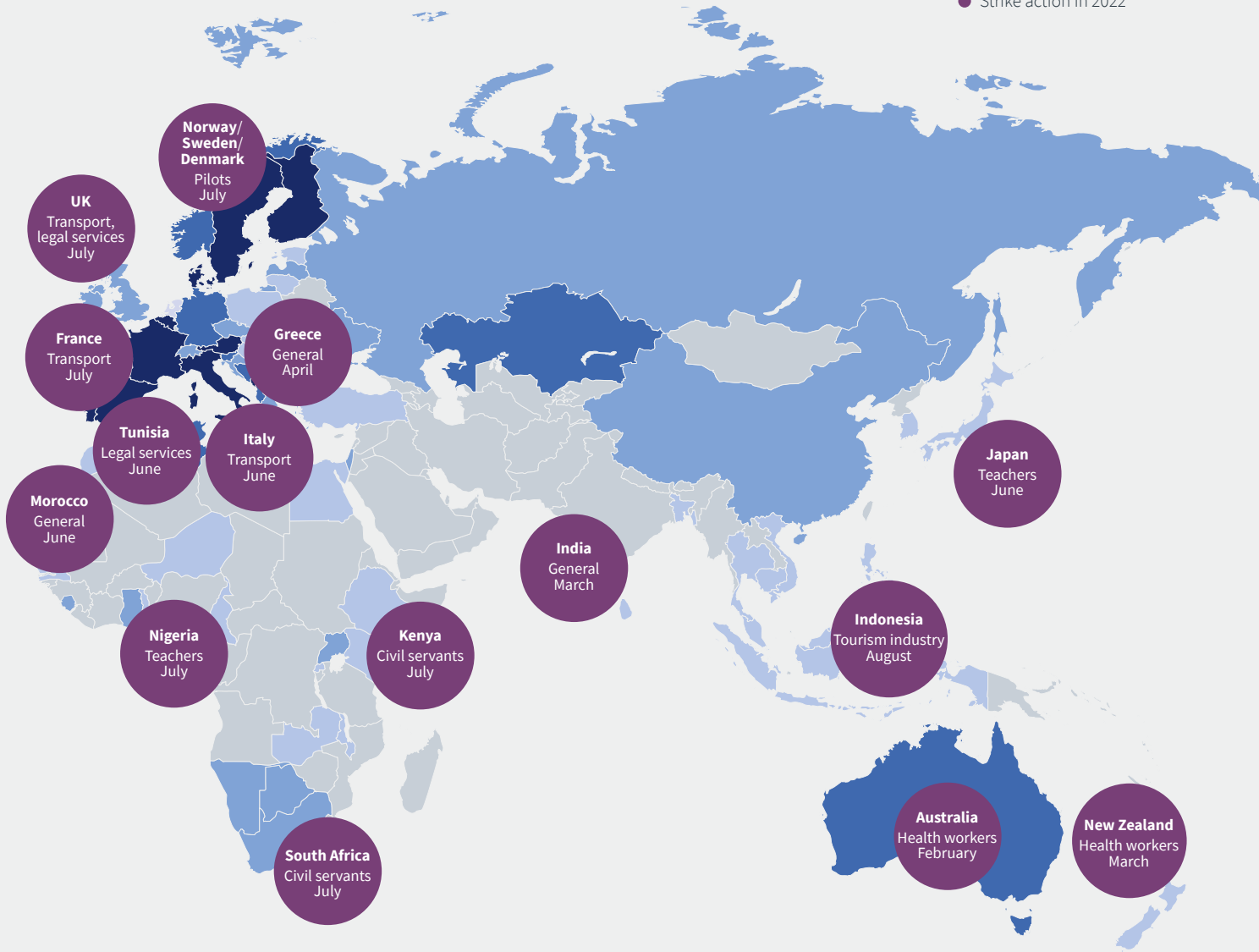
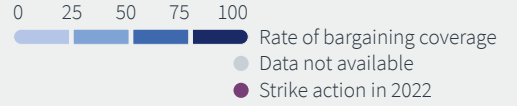
Collective bargaining is back

Unions trigger strike action

Percentage of bargaining coverage and selected coordinated strike action

A shortage of talent has shifted power dynamics in the labour market. With an ongoing cost of living squeeze, more people are joining trade unions to press for inflation-busting wage increases. The strikes have blindsided those insisting unions no longer have a useful function in the workplace.



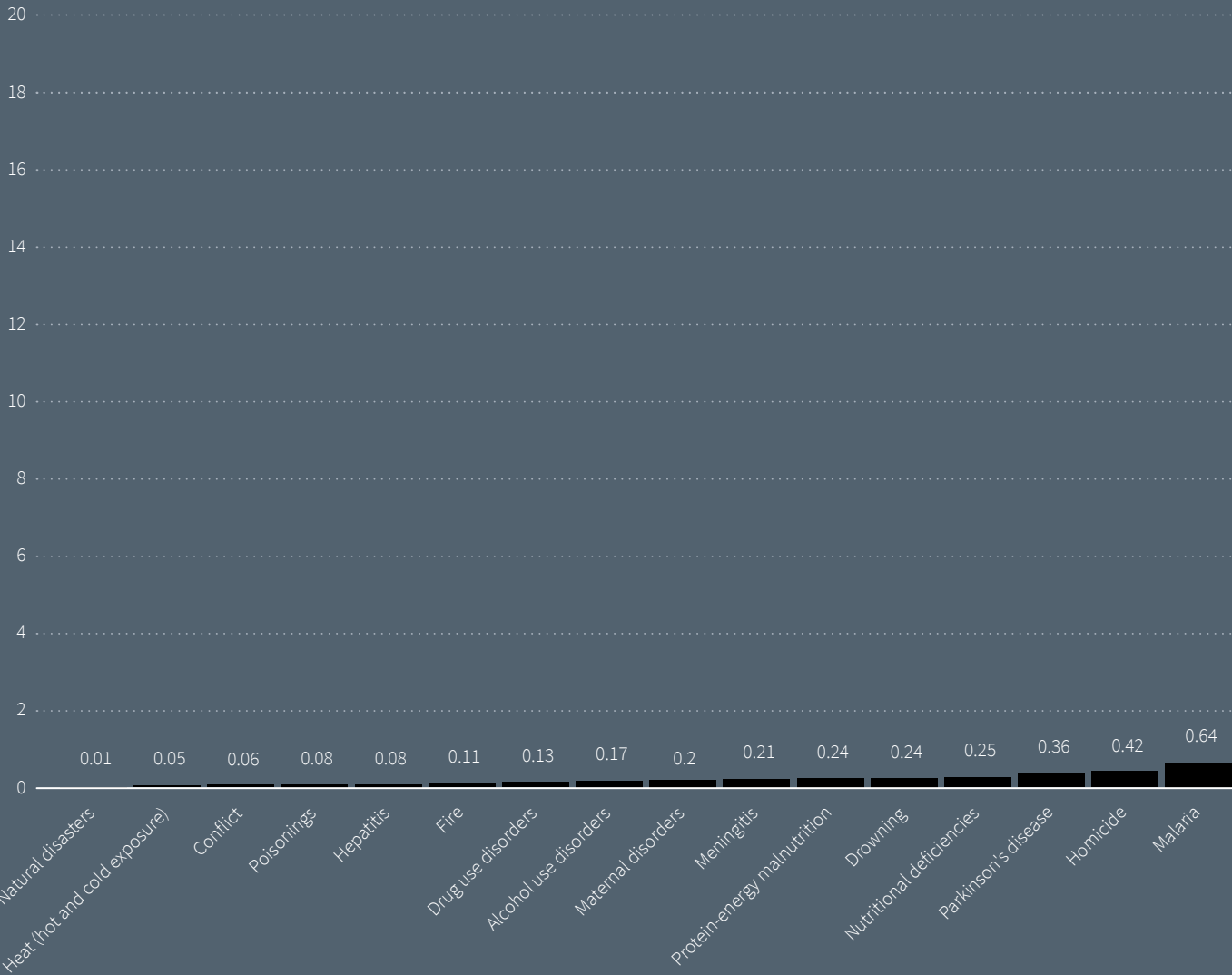


Drugs and superbugs

Deaths from antimicrobial resistance compared with other mortality factors

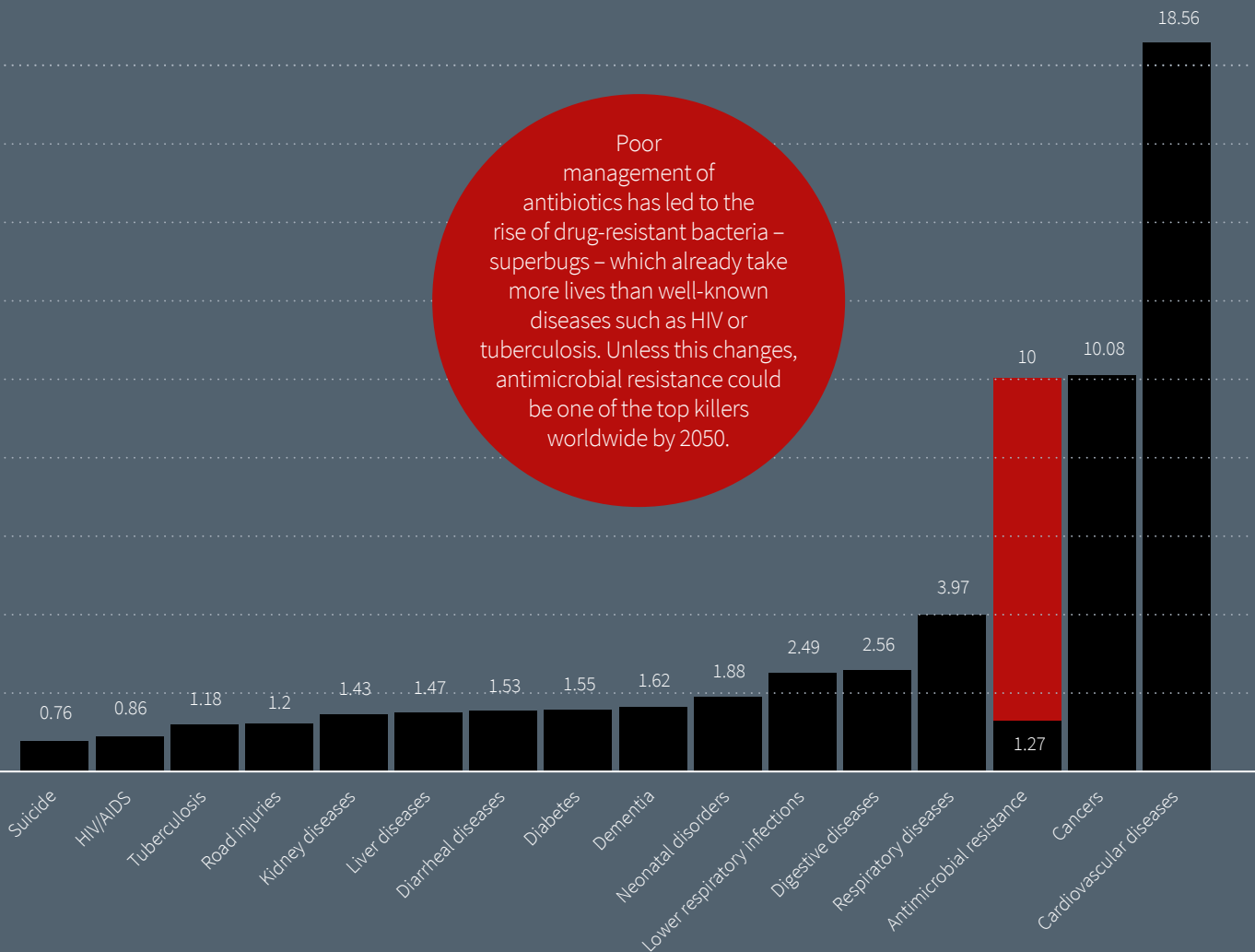
Number of deaths by cause

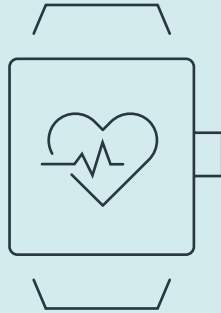
Millions



● 2019
● 2050 forecast

Poor management of antibiotics has led to the rise of drug-resistant bacteria – superbugs – which already take more lives than well-known diseases such as HIV or tuberculosis. Unless this changes, antimicrobial resistance could be one of the top killers worldwide by 2050.





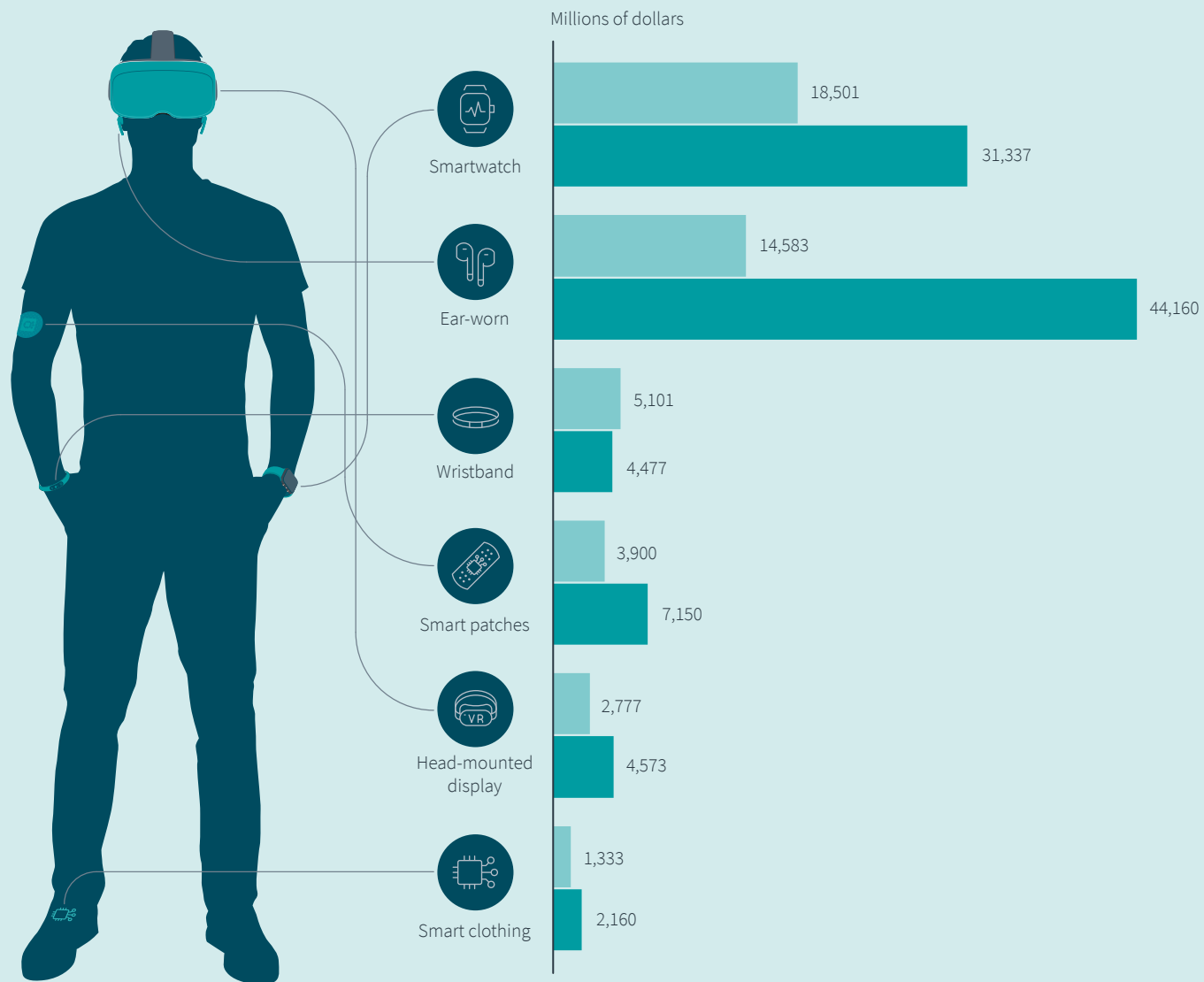
Interest in wearable devices that deliver information on essentials like heart rate, blood pressure and sleep continues to grow. It's a small step towards the next healthcare industry goal: personalised medicine.

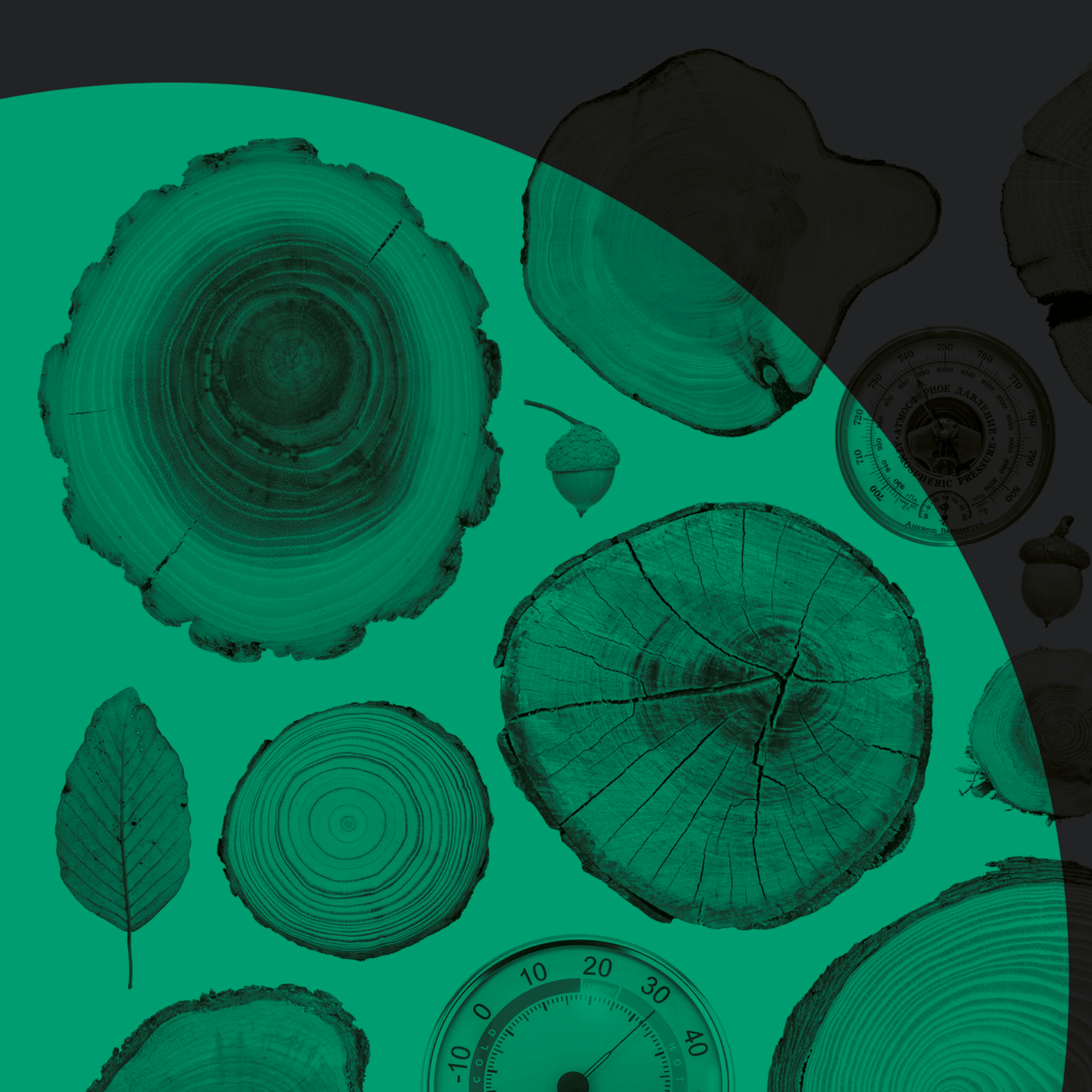
Taking control

Monitoring personalised health information

Worldwide wearable devices end-user spending

● 2019
● 2022





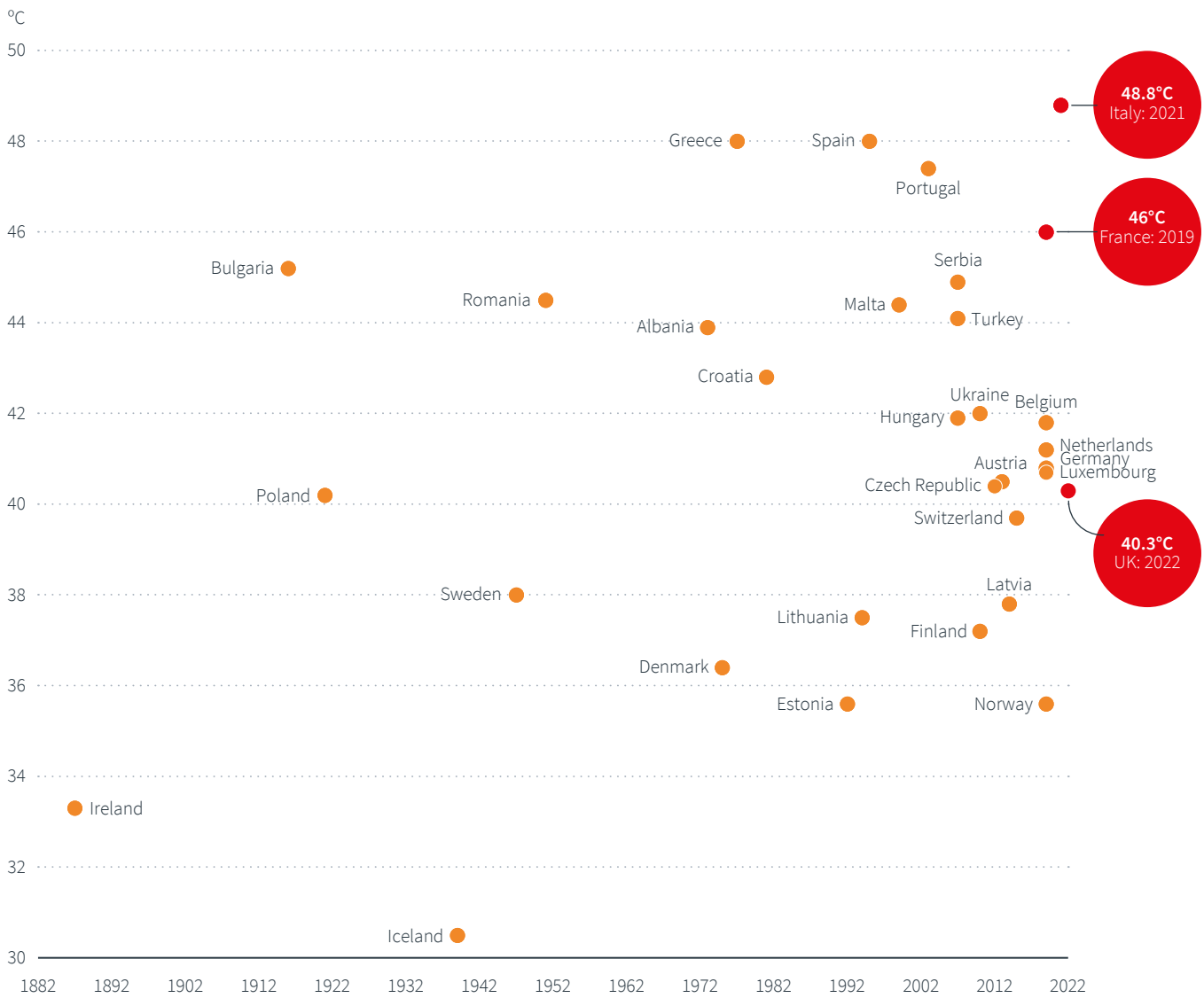


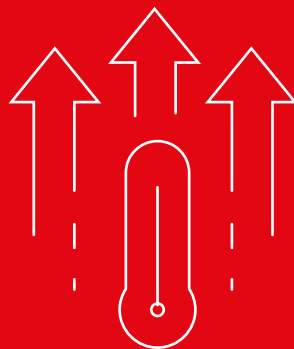
Climate

As temperatures and natural disasters surge, make no mistake:
this is an emergency

Mercury rising

Record high temperatures in Europe



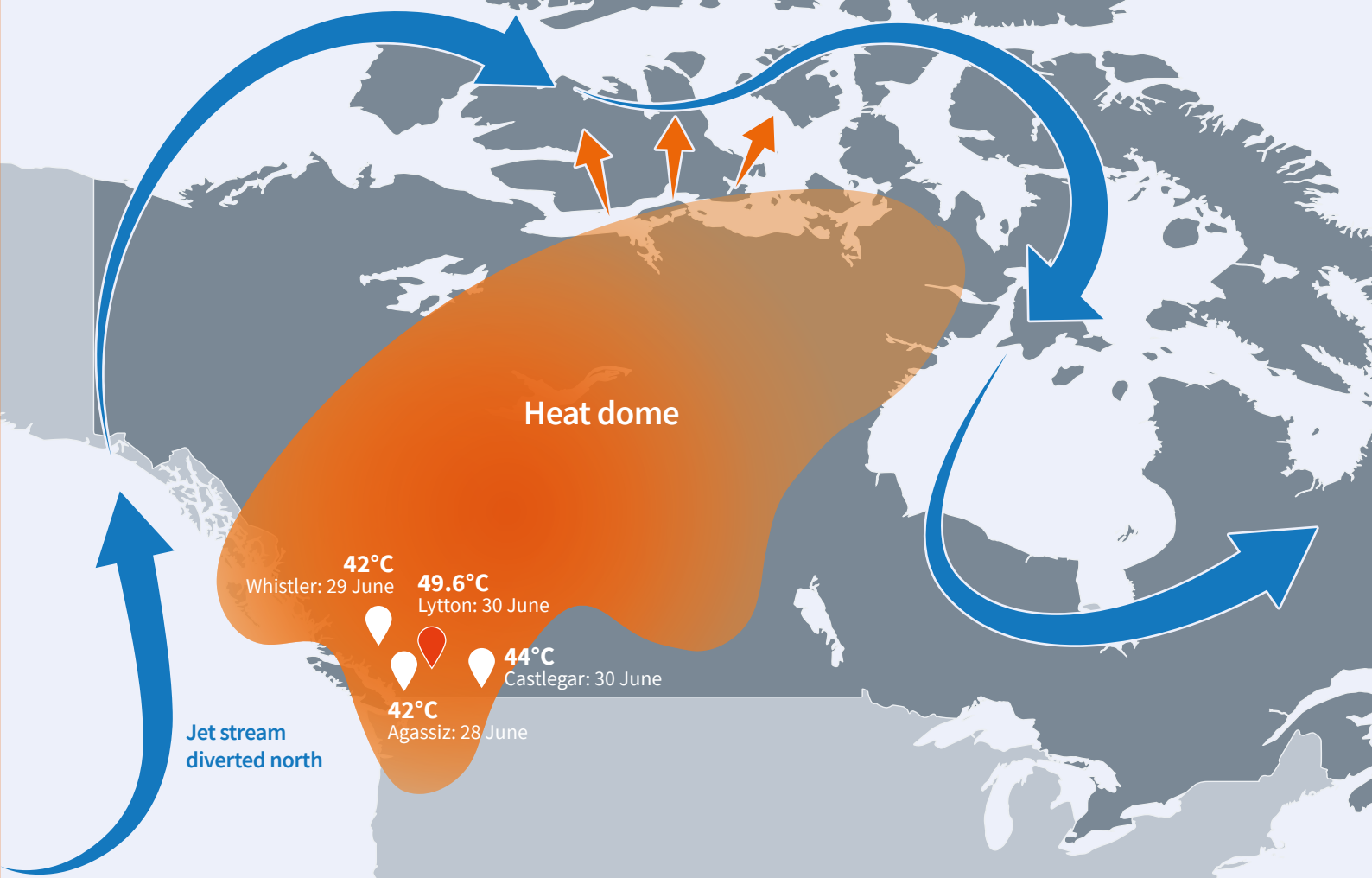


Climate change is leading to more frequent and extreme heatwaves across Europe: 19 countries have hit record high temperatures over the last decade, and ten since 2019.

Sweltering in heat domes

Human impacts as high pressure traps heat

Canada, 2021

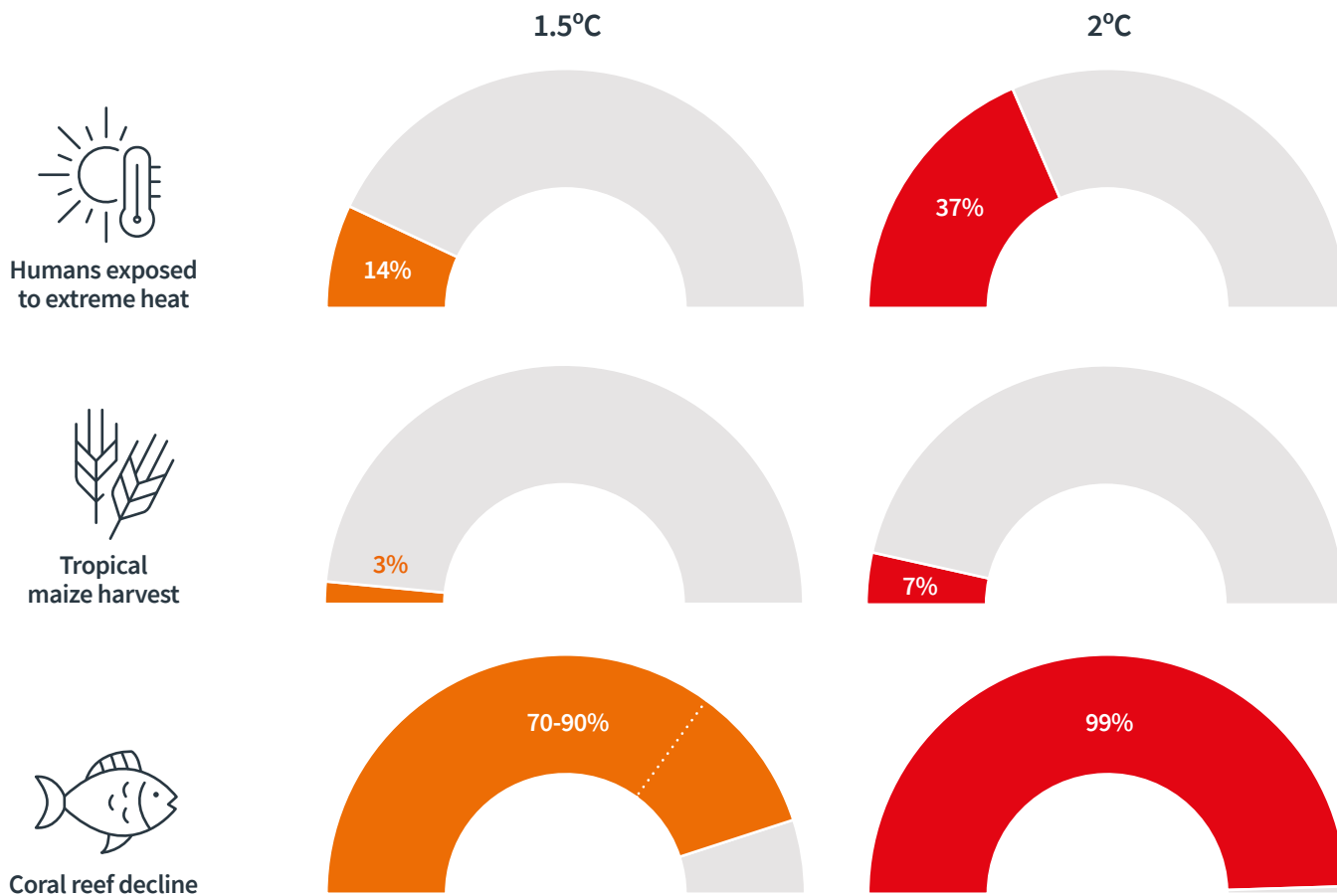


Small number, big impact

Why 0.5°C makes a world of difference

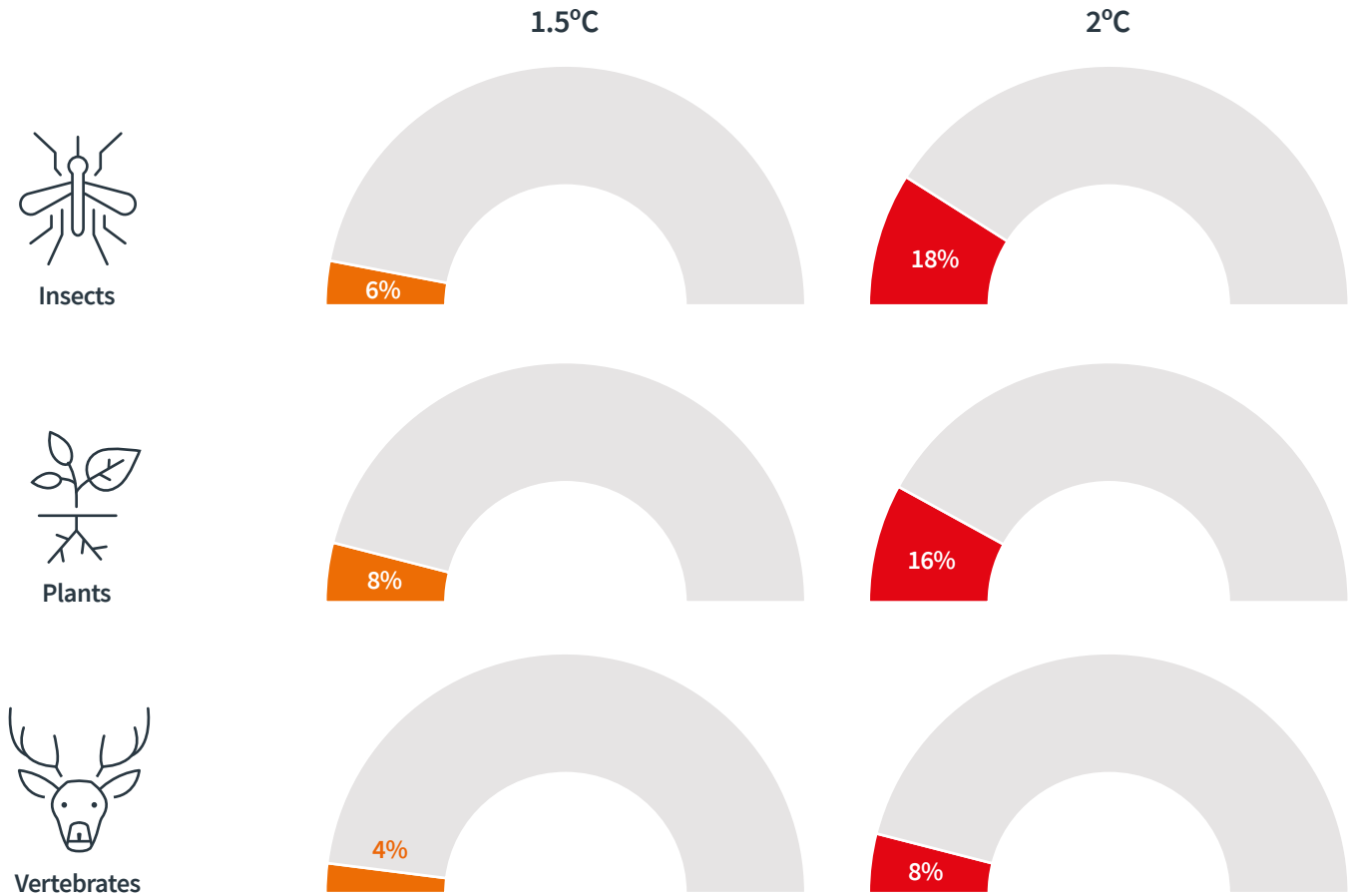
What difference might a 0.5-degree increase in average global temperatures make? How hard should we strive to cap the increase? These are questions for everyone. Contributors to the IPCC have grappled with them and concluded a small headline difference might change things a lot. In the frame: the resilience of food supply chains on land and sea.

Ecosphere impacts



A temperature increase of 0.5°C is expected to diminish species range, with the greatest negative impact in the insect world. Insects support the base of the food chain and play an important role as pollinators. “No insects equals no food equals no people,” notes Dino Martins, entomologist at the Mpala Research Centre in Kenya.

Decline in species range



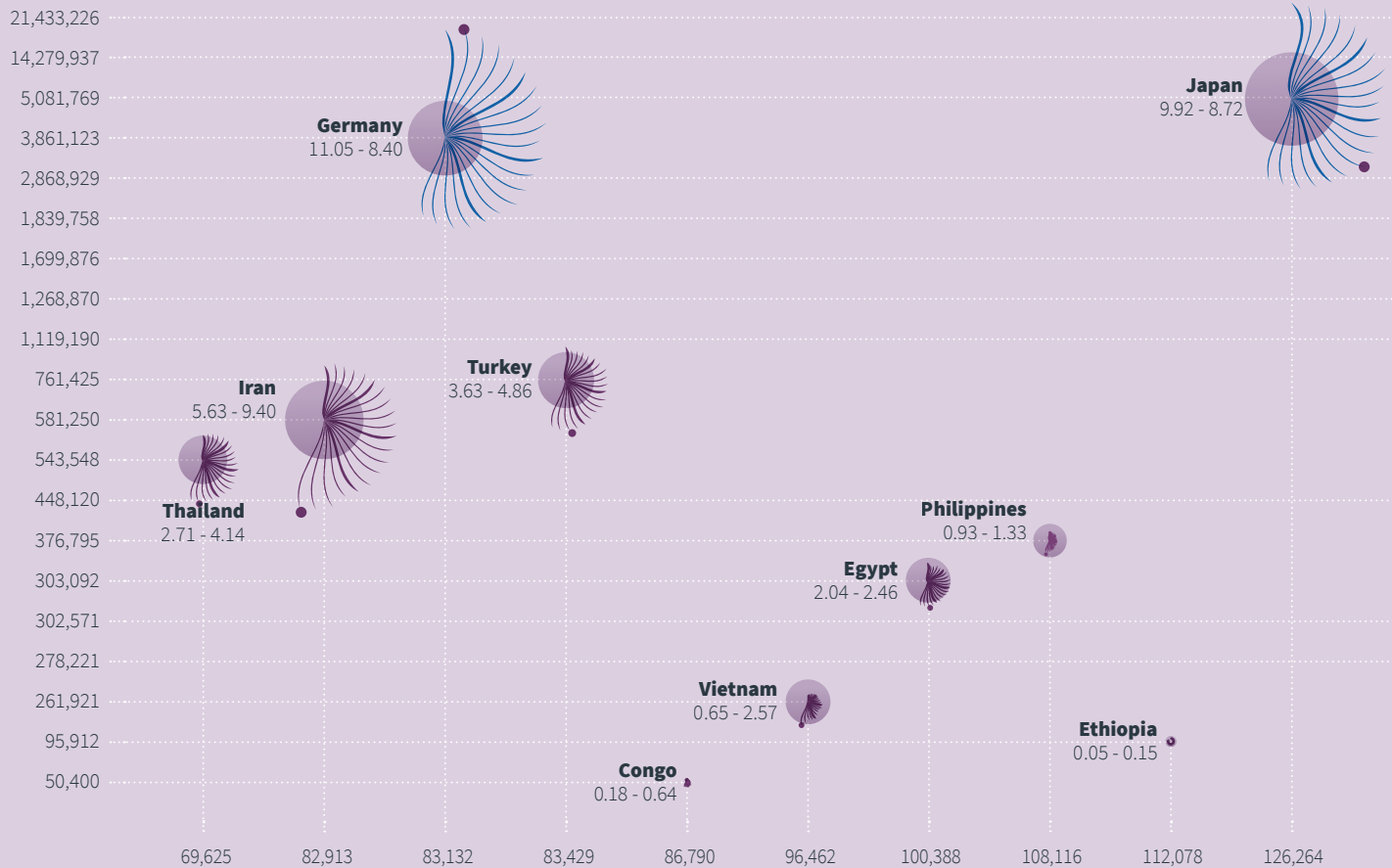
Who are the giant polluters?

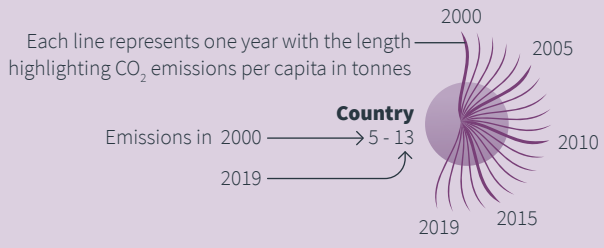
Contemplating scale and emissions trajectory

The visualisation shows data on total annual and per capita CO₂ emissions in 20 different countries, ranked by total population in 2019. Countries are ordered along the horizontal axis by total population and along the vertical axis by total GDP. National per capita emissions range from 0 (minimum CO₂ emissions) to 20+ (high per capita CO₂ emissions).

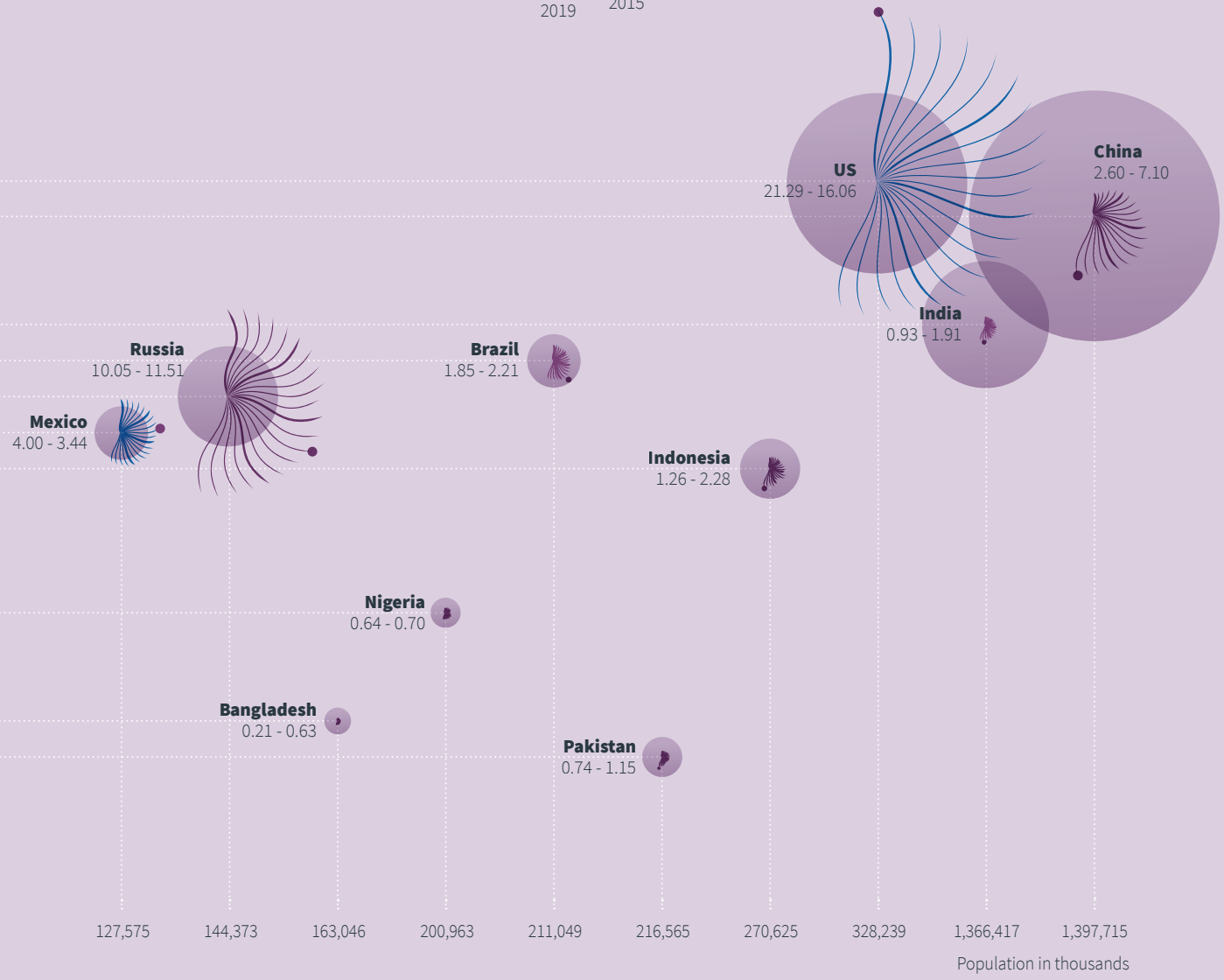
Emissions by country, ranked by population and per capita, 2000-2019

Countries ordered by GDP US\$ millions, 2019





- Peak of CO₂ emissions within range
- Area represents total annual CO₂ emissions in tonnes n 2019
- Per capita emissions in 2000 were lower than in 2019
- Per capita emissions in 2000 were higher than in 2019



Acts of God or consequences of man?

Extent of protection from extreme climate events

Insured and total damages, 2000-2022

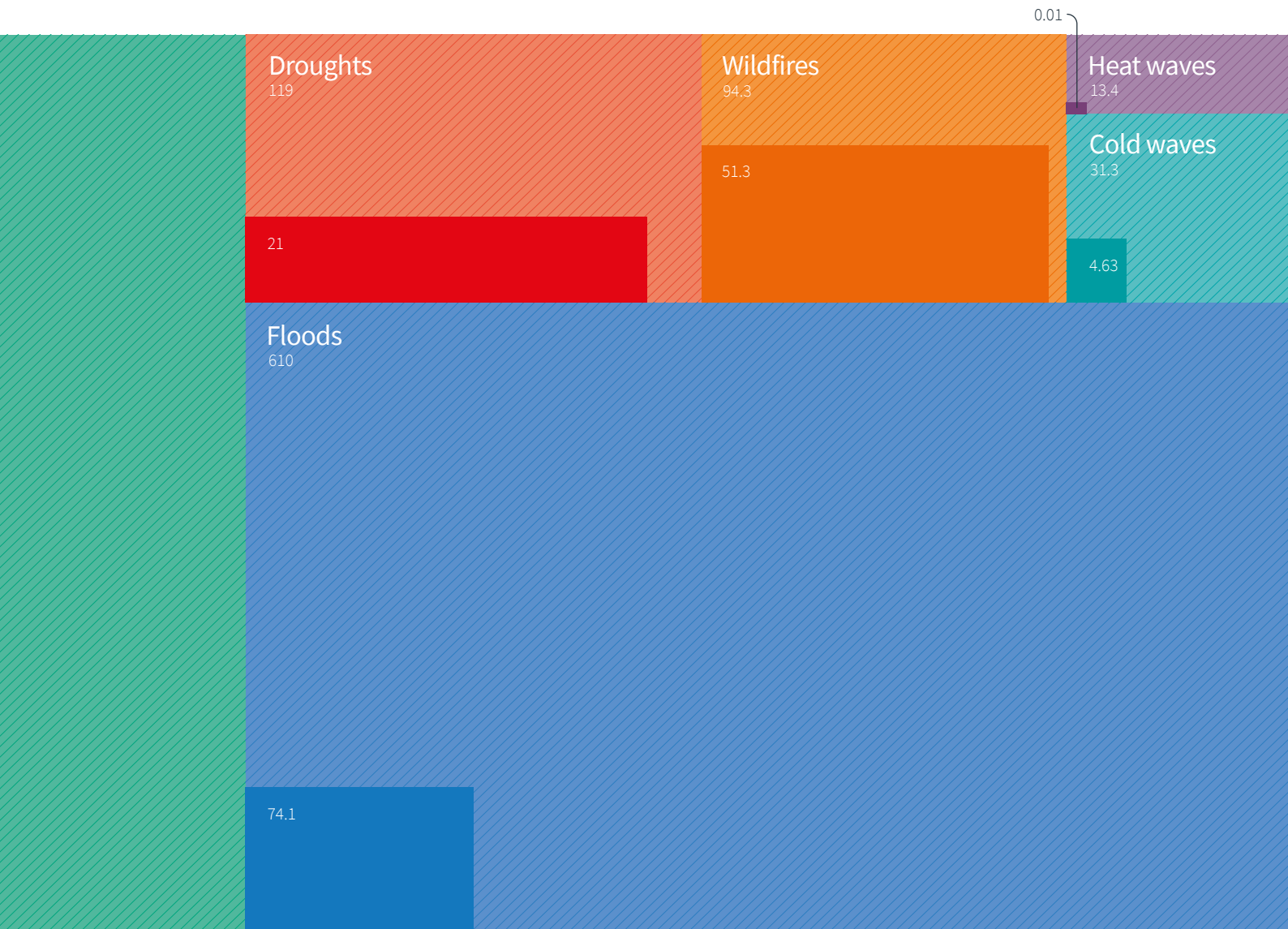
US\$ billions

Storms

1,300

499

/// Total damages

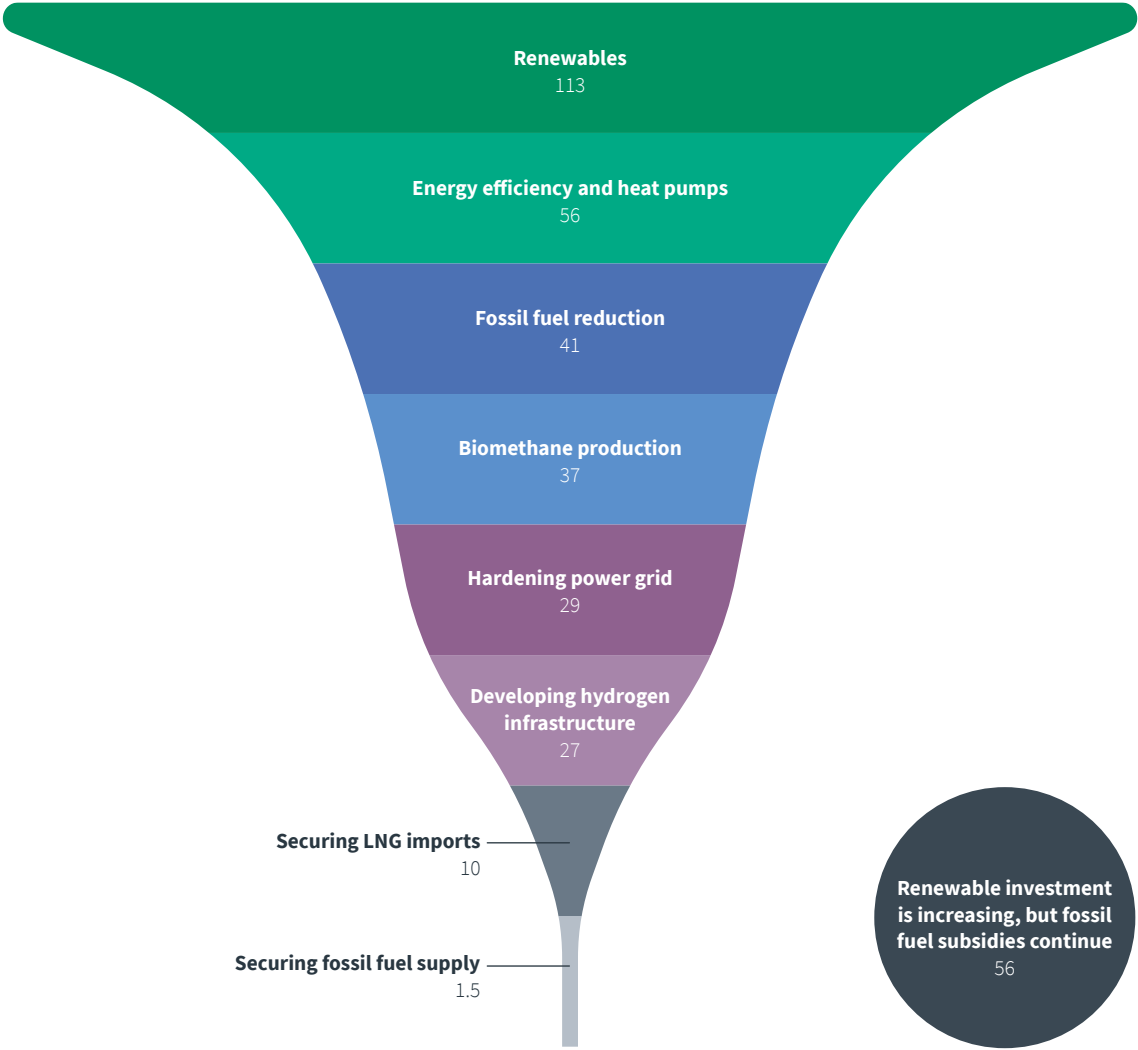


With extreme climate impacts and vulnerabilities from energy dependency building, one obvious response is to accelerate the transition, which is what Europe intends with REPowerEU. This multi-billion euros investment scheme intends to make Europe independent from Russian fossil fuels before 2030. In this context, the scale of fossil-fuel subsidies is worth a closer look.

Accelerating the energy transition

Funneling investment with geopolitical considerations in mind

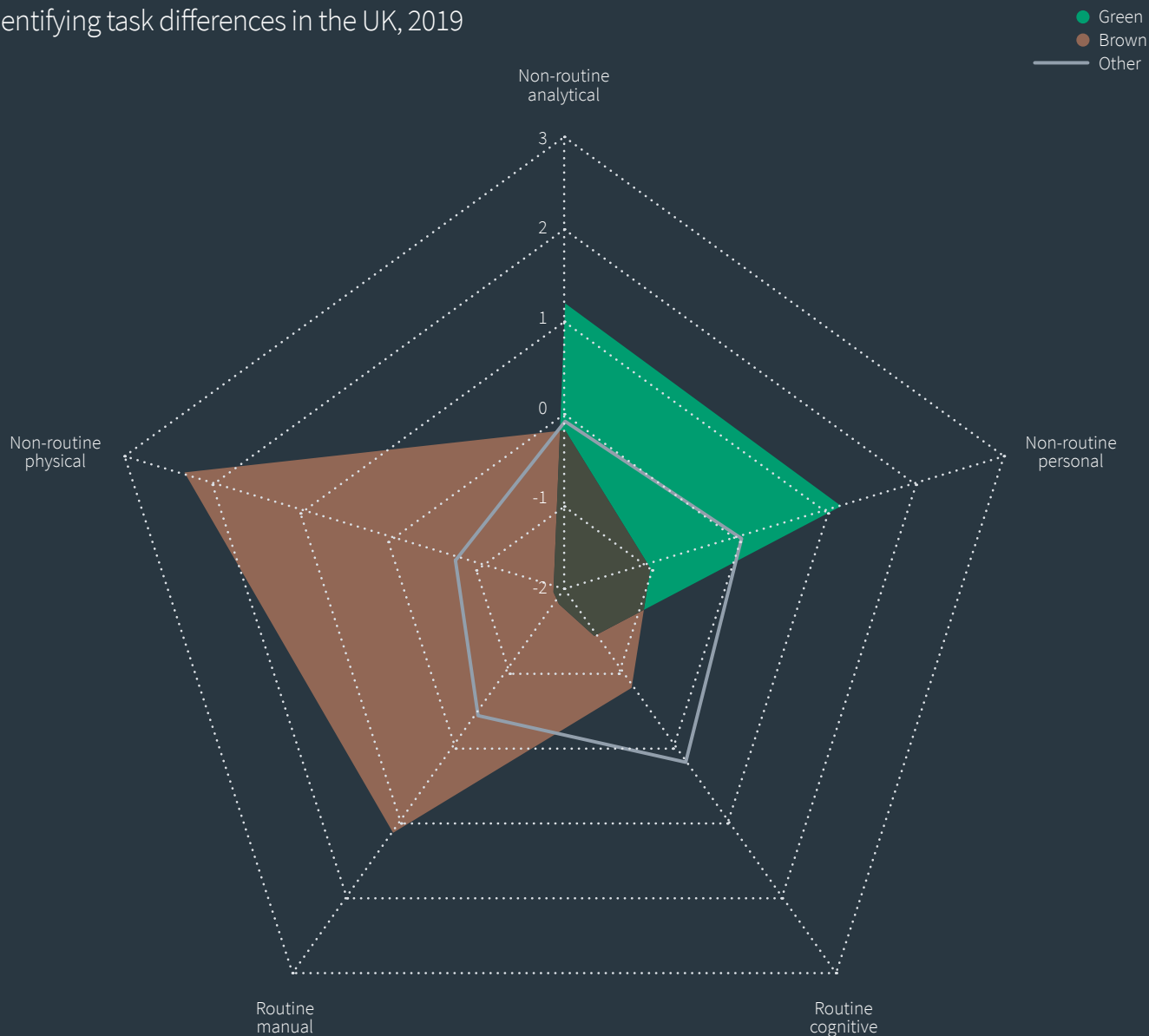
REPowerEU strategic investment target, 2027-2030 (€bn)



The world of work is changing

Assessing the nature of green and brown jobs

Identifying task differences in the UK, 2019





What could the energy transition mean for the job market? There will be growth in some sectors and contraction in others, but employment in many industries will not fit neatly into a binary 'green or brown' classification. Instead, it might be helpful to think about how the nature of work could change.

Rethinking the carbon cycle

Sustainable building materials could trap carbon

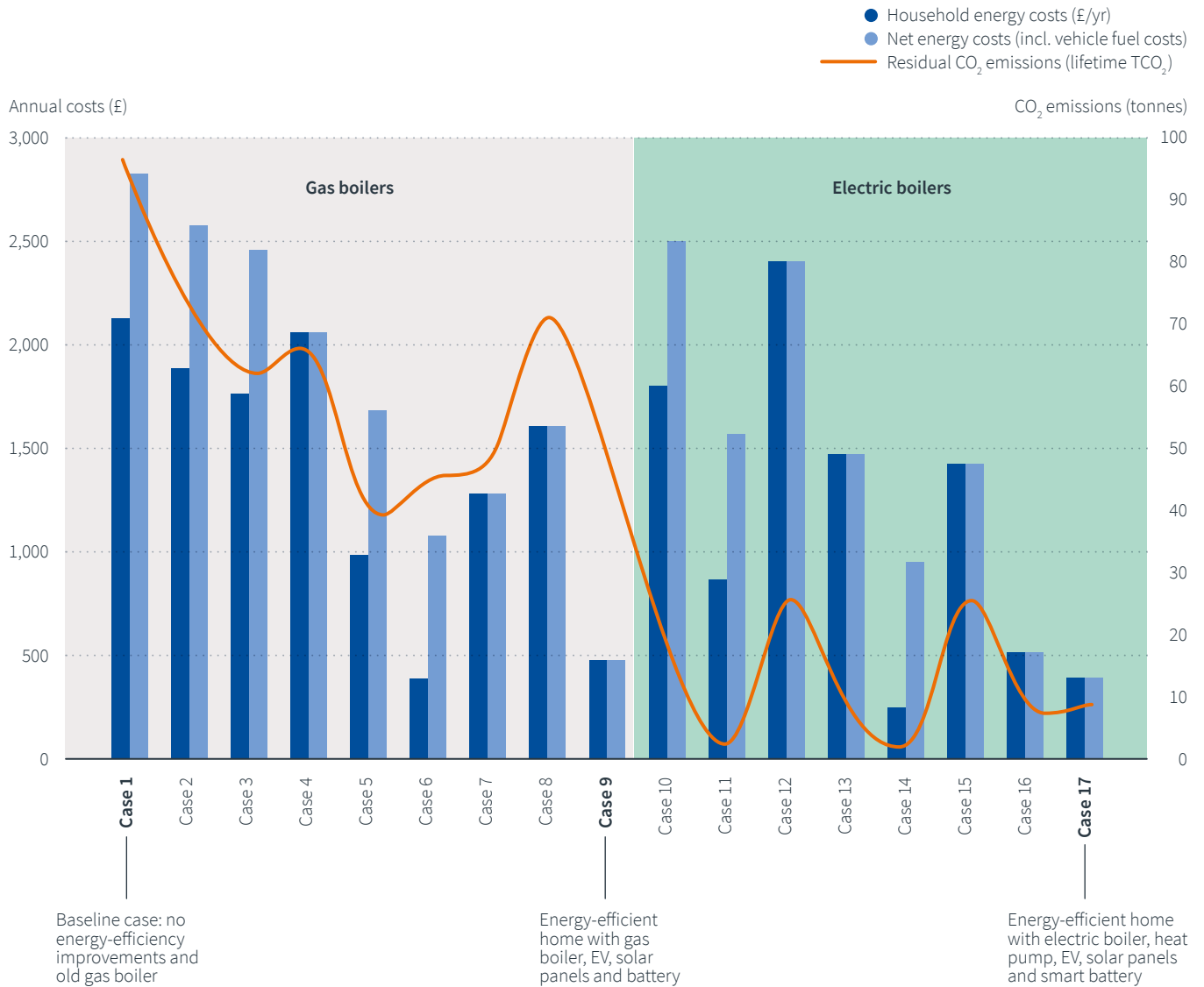
Bio-based construction materials could trap carbon and replenish the land carbon pool. Researchers are also exploring ways to use captured CO₂ as an ingredient in concrete: CO₂ can be added in the form of aggregates or injected during mixing.



WWF-UK and ScottishPower's *Better Homes, Cooler Planet* report shows how low-carbon technologies could reduce energy bills and carbon emissions. The report considered the effect of installing a range of technologies at the household level and estimated the impact on annual energy bills through running-costs modelling, as well as the carbon savings.

Making positive changes to decarbonise

Emissions savings from different technology combinations







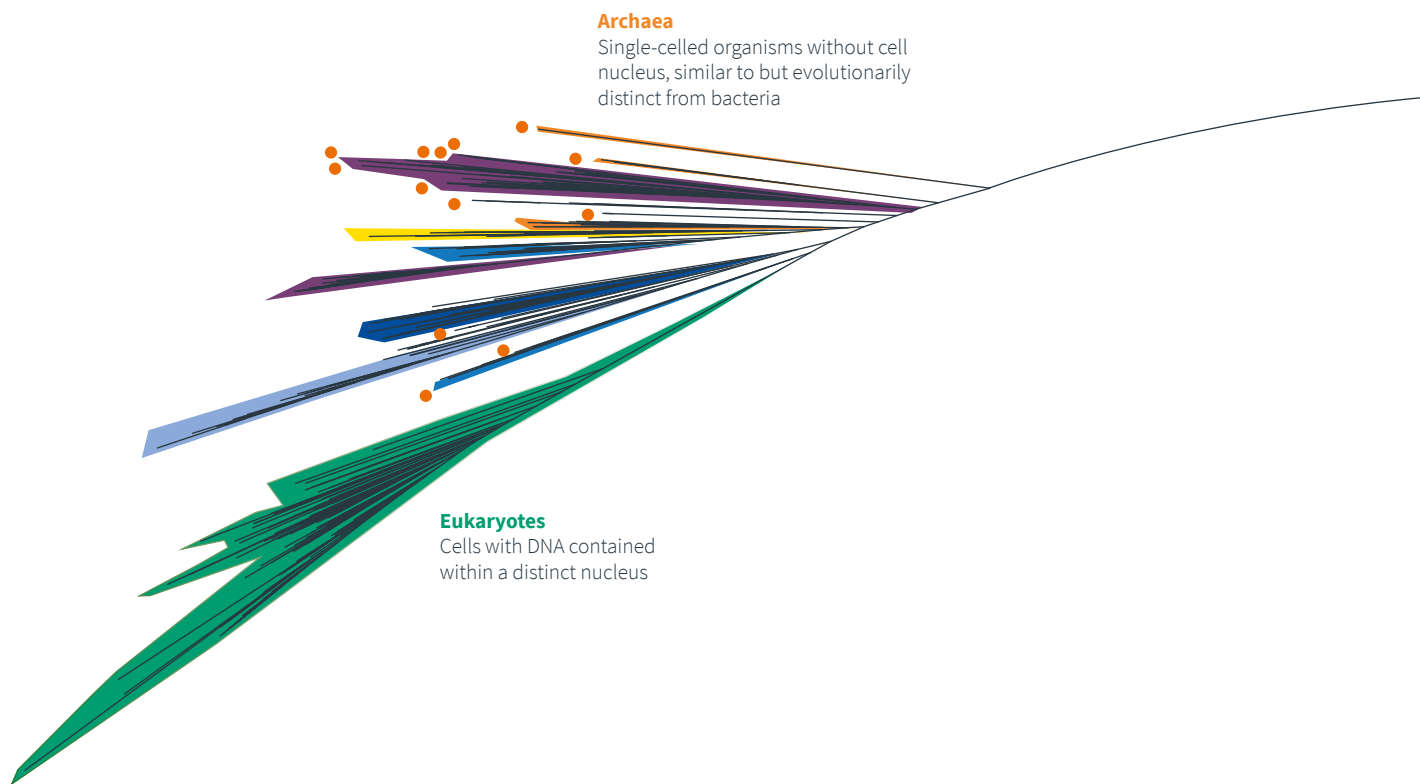
Earth

Putting the spotlight on natural capital

Still learning about our planet

DNA sequencing: Radically changing our understanding of the Tree of Life and diversity of microbes

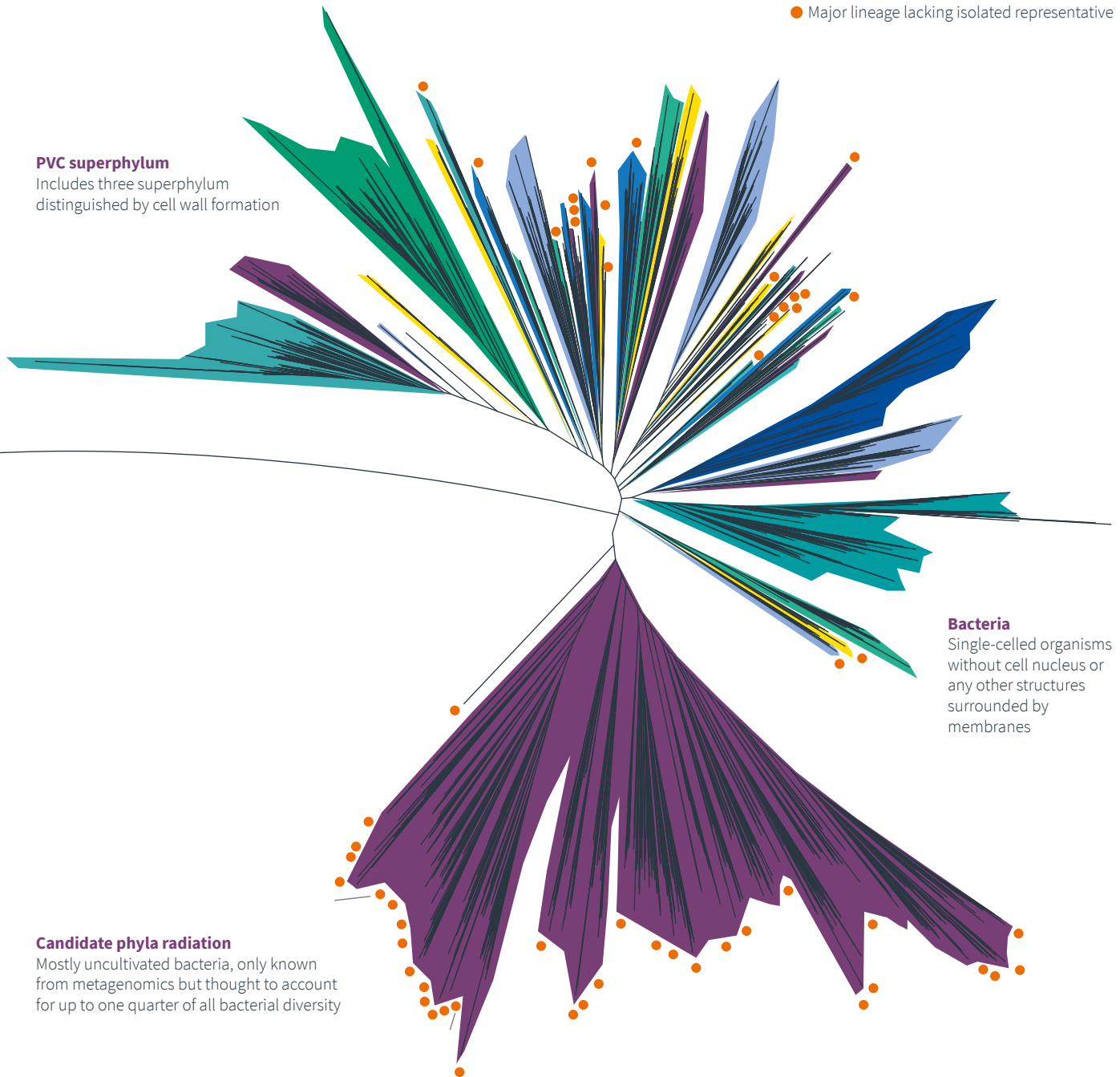
Organisms were classified by their appearance for more than 100 years, but DNA sequencing is revealing new relationships. Some things believed to be closely related are not, and the range of life forms that cannot be seen by the human eye is much larger than first thought. This new version of the Tree of Life shows organisms within the three major domains of life: bacteria, archaea and eukaryotes. Major lineages within each group are categorised by colour.



● Major lineage lacking isolated representative

PVC superphylum

Includes three superphylum distinguished by cell wall formation



Bacteria

Single-celled organisms without cell nucleus or any other structures surrounded by membranes

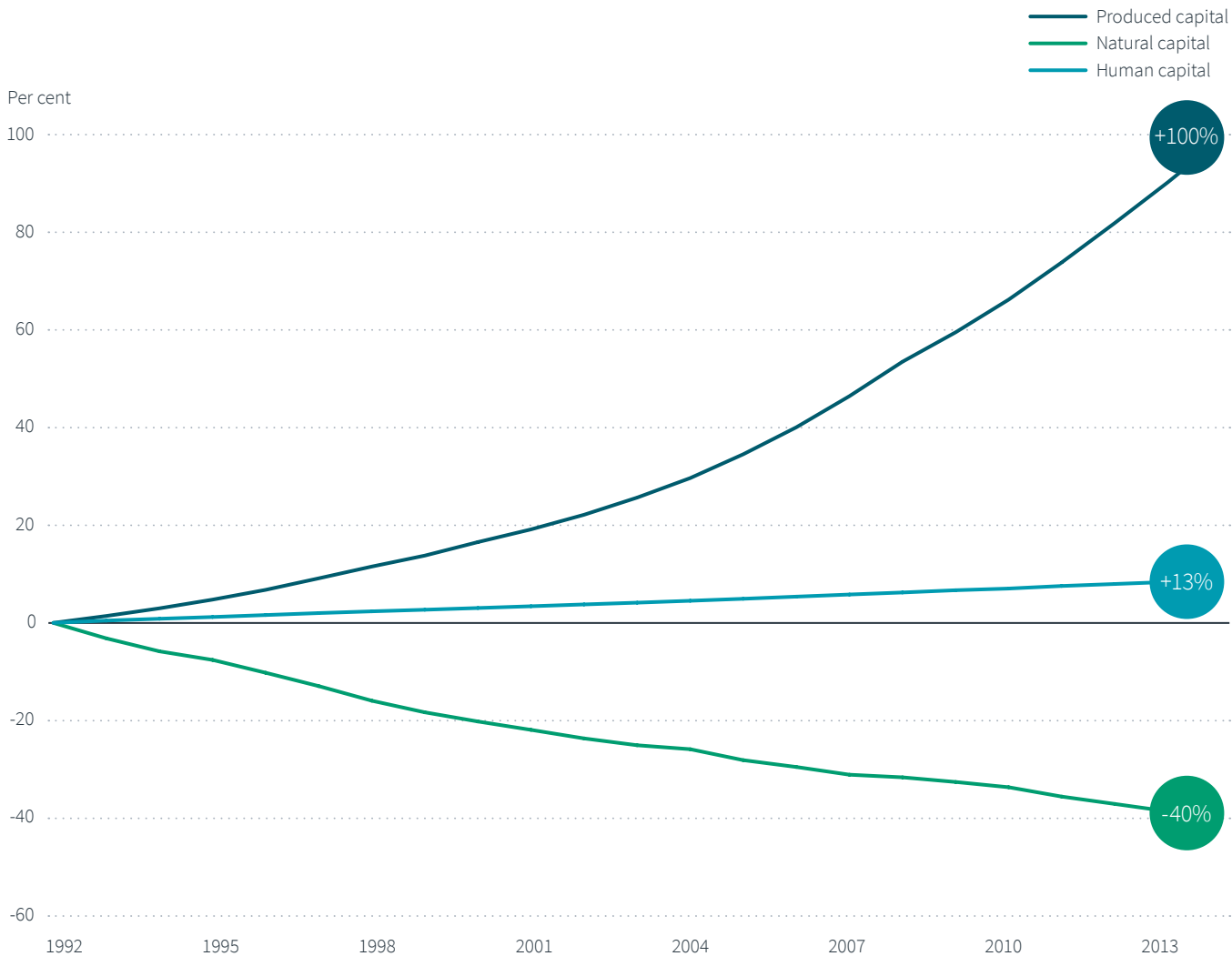
Candidate phyla radiation

Mostly uncultivated bacteria, only known from metagenomics but thought to account for up to one quarter of all bacterial diversity

Living beyond our means

Using too much, delivering too little

Human activity is becoming increasingly unsustainable. In just over two decades, we have doubled the output of physical goods and materials, but diminished the ability of the natural world to replenish and restore itself.





“Nature is our home. Good economics demands we manage it better.”

Professor Sir Partha Dasgupta
University of Cambridge

Creating super-sized pollution threats

Dispersal of plastic debris



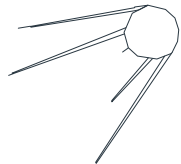
1907

Bakelite, first fully synthetic material, arrives



1957

Sputnik 1, first artificial satellite, sends plastic into space



2000
213m Mt

2017
438m Mt

2022

UN Environment
Assembly pledges
to create the first
binding treaty on
plastic pollution
by 2024

2014

Microplastics
found in North
Pole, within Arctic
ice cores



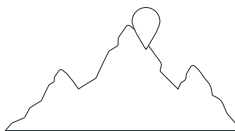
2015

In the Atacama
Desert, Chile, in
pellets from
turkey vultures



2019

Close to the peak of Mt. Everest,
Nepal, 8,382 metres above sea level



2019

10,972 metres deep in
the South Pacific Ocean



2021

In marine life near
Tristan da Cunha,
the world's most
remote inhabited
island



2022

In human blood



Where will transition metals come from?

Copper usage in electric vehicles

Striving for net zero is expected to boost demand for transition metals like copper, cobalt, nickel and neodymium (used in cables, lithium ion batteries and magnets for renewable energy generation, transmission and transport). It has left metals analysts asking: is there enough to go around?



23 kg

Internal
combustion
engine

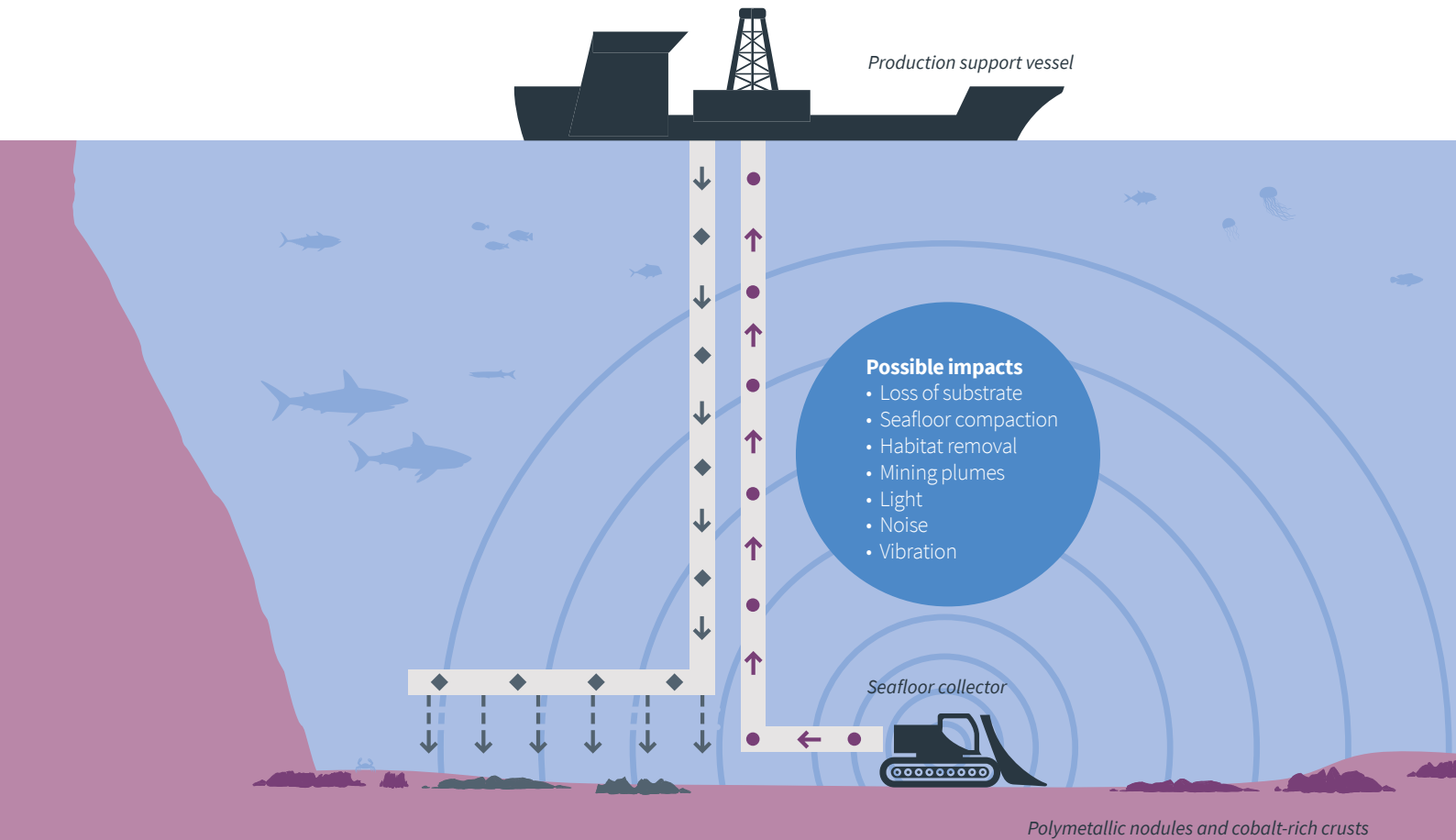
Plug-in hybrid
electric vehicle
60 kg

Battery-powered
electric vehicle
83 kg

Battery-powered electric bus
≥224 kg

Assessing deep sea mining impacts (over 200 metres below sea level)

With demand exceeding supply for metals like copper and cobalt needed for the energy transition, negotiations to mine the ocean floor have begun. The International Seabed Authority has issued 29 licenses to mine in fragile marine ecosystems, but activity is on hold for further impact assessments.



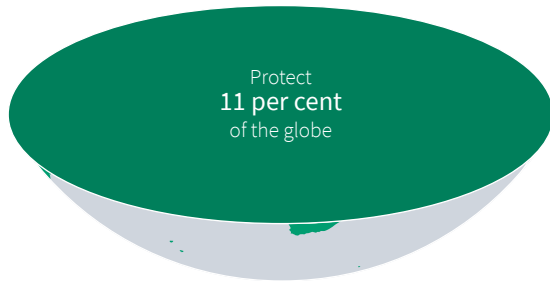
Seeking solutions

Changing goals for nature restoration and recovery

There have been numerous initiatives calling for more space for nature to restore itself, but the goalposts keep shifting. To date, no major global biodiversity targets have been achieved.

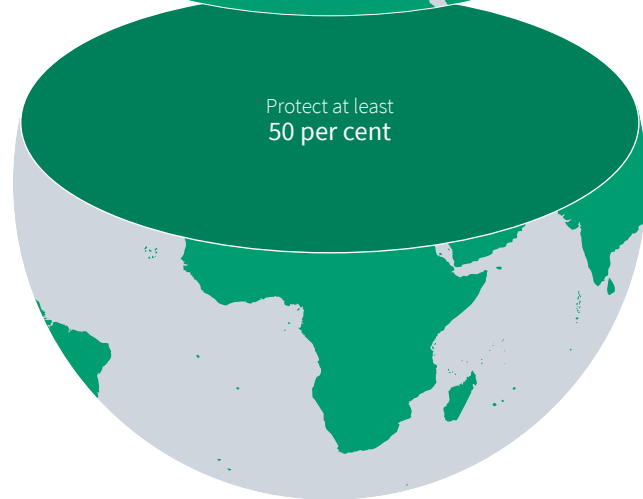
1987

Brundtland Commission 'Our Common Future'



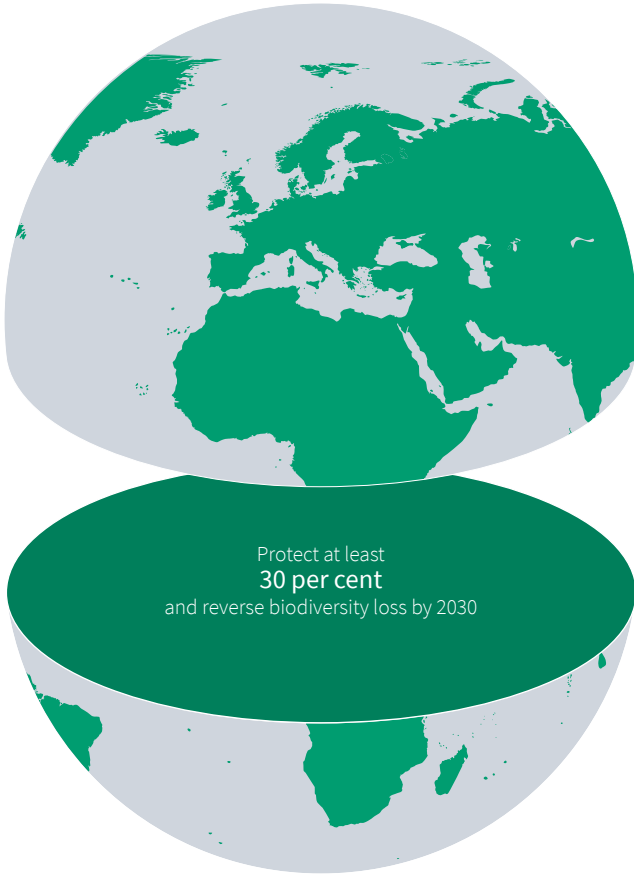
2013

Nature Needs Half



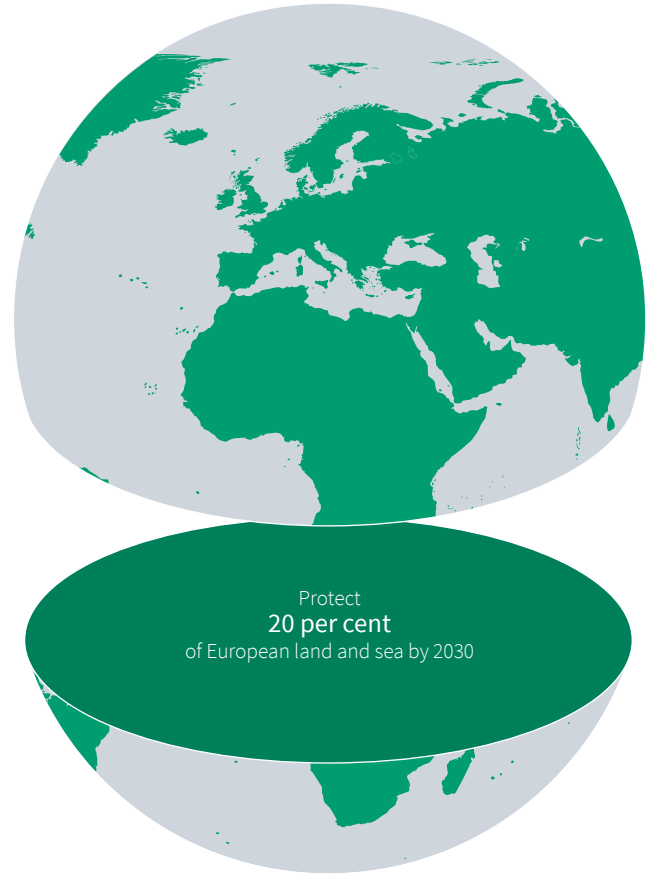
2021

G7 2030 Nature Compact



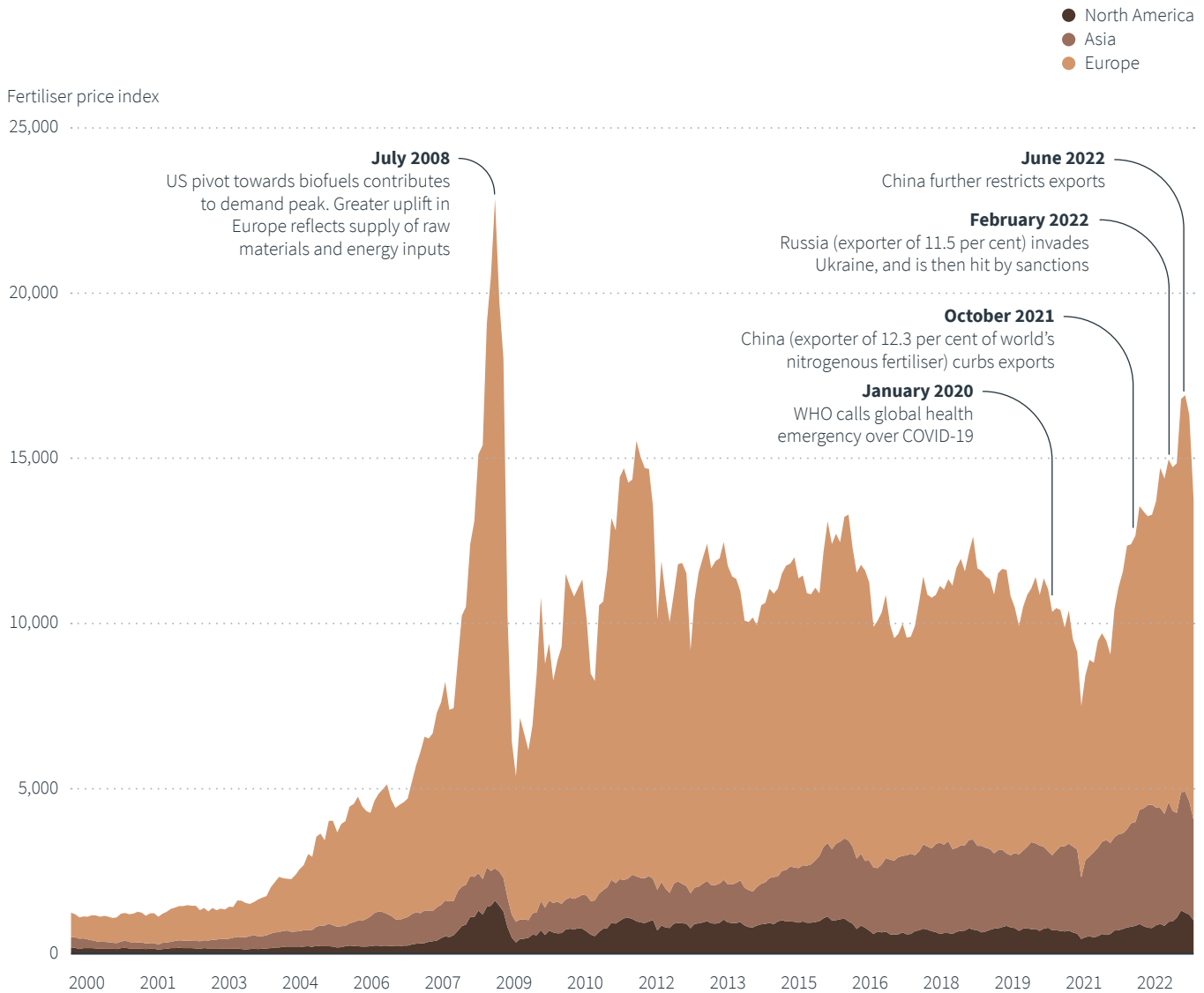
2022

Proposed EU Nature Restoration Law



Rethinking agriculture

Fertiliser: Surging costs trigger demand for manure and treated human waste





*“Manure is absolutely a hot commodity.
We’ve got waiting lists.”*

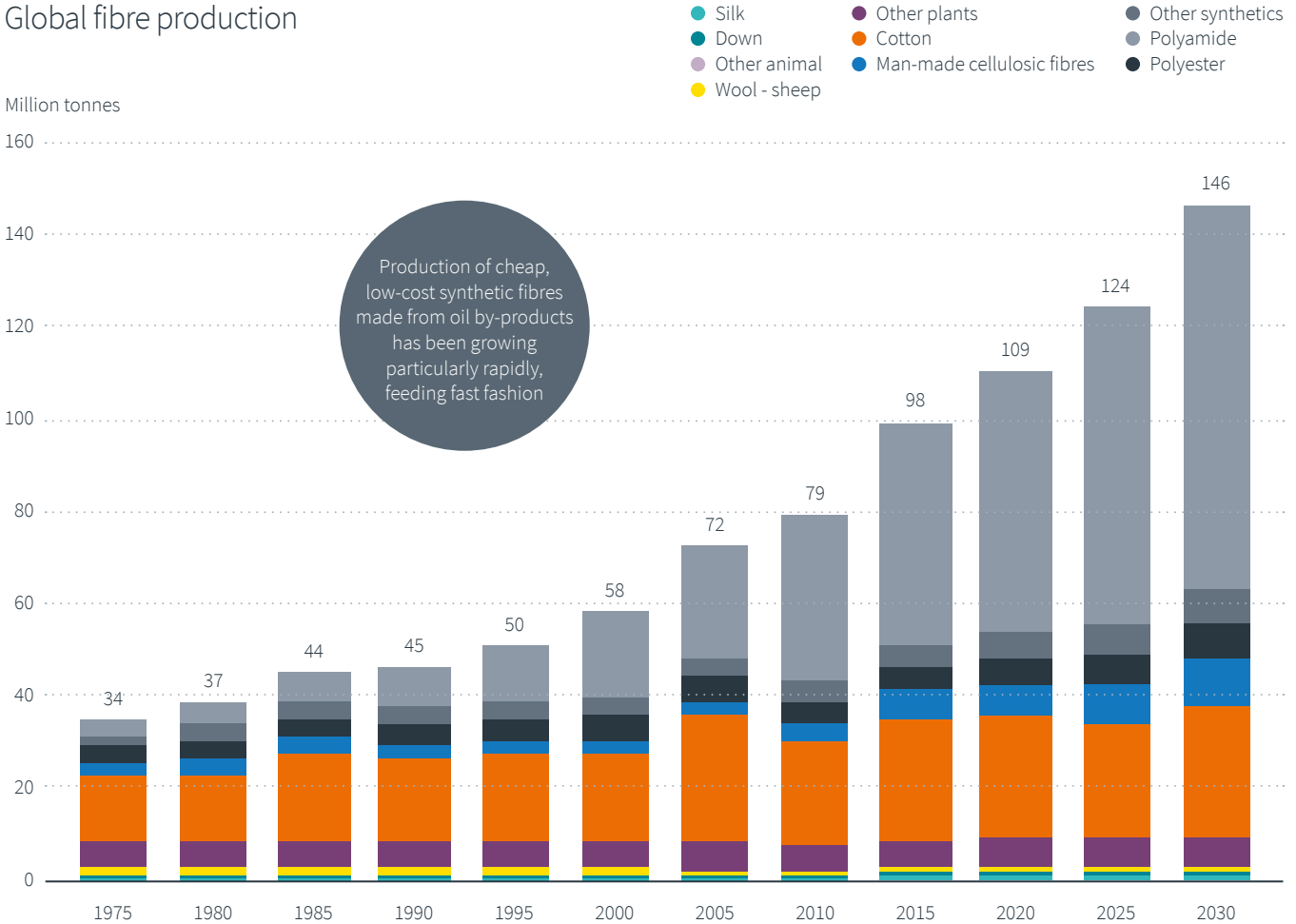
Allen Kampschnieder
Consultant, Nutrient Advisors

Inspired by nature

Addressing emissions in textiles production

Demand for textiles has been growing fast, contributing around ten per cent of global carbon emissions and increasing demand for water. New biomimetic processes that draw on the way spiders 'pull' fibres from protein to create silk-like filaments are being developed, estimated to use 1,000 times less energy than synthetic fibre formation.

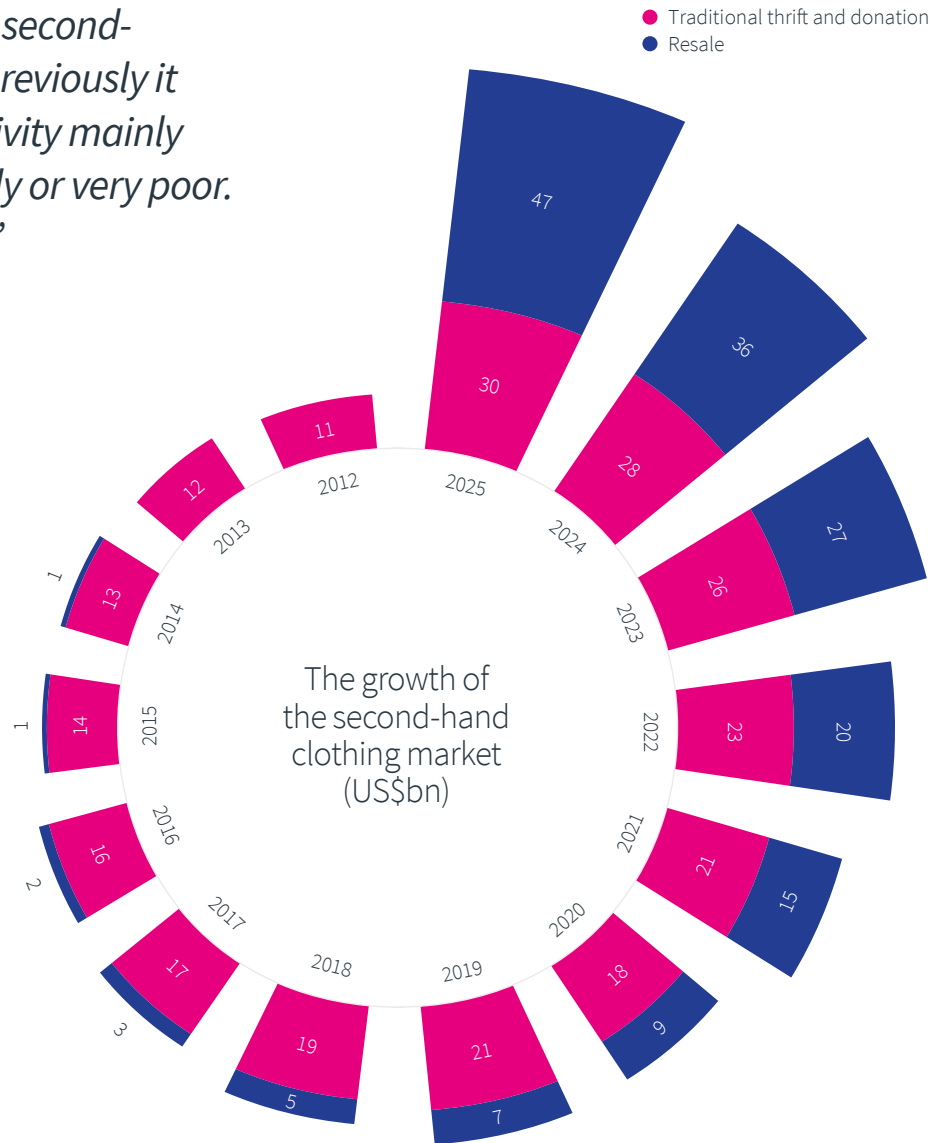
Global fibre production



Circular behaviour

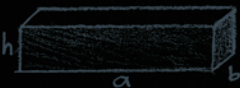
“Many young people buy second-hand clothes, whereas previously it would have been an activity mainly undertaken by the elderly or very poor. The culture is changing.”

Tim Cooper
Professor of Sustainable
Design and Consumption,
Nottingham Trent University



Appendix

$$(\ln x)' = \frac{1}{x}$$



$$\log_a(xy) = \log_a x + \log_a y$$

$$\sqrt{2} = 1,41$$

$$\Sigma$$

$$\pi = 3,14$$

$$y = |x-2|$$

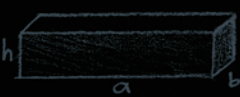
$$\sum_{k=0}^{\infty} \frac{f^{(k)}(a)}{k!} (x-a)^k$$

$$\operatorname{tg} \alpha = \frac{\sin \alpha}{\cos \alpha}$$

$$(x^n)' = nx^{n-1}$$

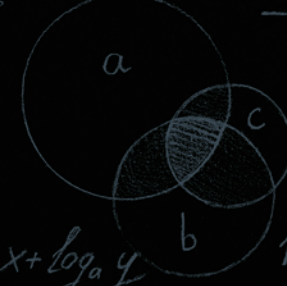
$$(\sqrt{x})' = \frac{1}{2\sqrt{x}}$$

$$(\ln x)' = \frac{1}{x}$$



$$\log_a(xy) = \log_a x + \log_a y$$

$$\sqrt{2} = 1,41$$



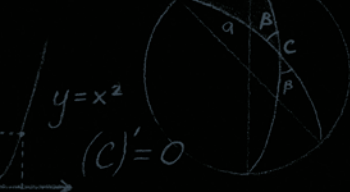
$$\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$$



$$S_k = \sum_{i=1}^k a_i$$

$$\log_a \frac{x}{y} = \log_a x - \log_a y$$

$$\sin^2 \alpha + \cos^2 \alpha = 1$$



$$\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$$



$$\sin 90 =$$

$$e = 2,71$$

$$S = \frac{1}{2} ah$$

$$\sqrt{5} =$$

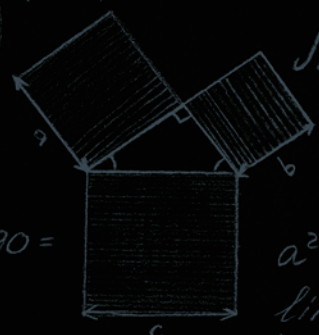
$$\infty$$

$$\sin A = \frac{a}{c}$$

$$\cos A = \frac{b}{c}$$

$$i = \sqrt{-1}$$

$$(f(x))' = \lim_{\Delta x \rightarrow 0} \frac{\Delta f}{\Delta x}$$



$$a^2 + b^2 = c^2$$

$$\lim_{x \rightarrow 2} \frac{x^2 + 3x - 10}{x - 2}$$



$$y = e^x$$

$$f(x) =$$

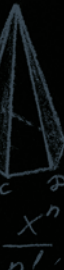


$$f(x) = \begin{cases} 0 & x = 0 \\ e^{-\frac{1}{x^2}} & x \neq 0 \end{cases}$$



$$a^2 + b^2 = c^2$$

$$\lim_{x \rightarrow 2} \frac{x^2 + 3x - 10}{x - 2}$$



$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!}$$



$$a^2 + b^2 = c^2$$

$$\lim_{x \rightarrow 2} \frac{x^2 + 3x - 10}{x - 2}$$



Sources and notes

The bigger picture

- 06-07 **Prologue: Hold that thought** Alessia Musio, et al., 'Data production & human attention: an inversely proportional relationship', IADE - Faculdade de Design, Tecnologia e Comunicação, September 4, 2021.
- 10-11 **Multiple systemic shocks** Aviva Investors, September 2022.
- 12-13 **Spillovers from Russia's invasion of Ukraine** MSCI World Energy Index, data as of August 2022; 'Primary commodity price system', IMF, accessed on September 12, 2022; Macrobond, data as of September 12, 2022; 'Coal market update - July 2022', IEA, July 2022.
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- 16-17 **Food crisis** 'Food export restrictions hurt millions in least developed countries', UNCTAD, accessed on September 12, 2022.
- 18-19 **The first battle of the post-carbon world?** Simone Fant, 'Ukraine: All lithium reserves and mineral resources in war zones', Renewable Matter, April 1, 2022. Lukas Boer, et al., 'IMF working paper: Energy transition metals', International Monetary Fund, WP/21/243, October 2021.
- 20-21 **The faltering Chinese growth engine** 'Capital flows tracker', data as of August 31, 2022. © 2020 Institute of International Finance, Inc. All rights reserved.
- 22-23 **Digital winds blow cold** 'TerraUSD/USD Coin Metrics', CNBC, data as of September 19, 2022.
- 24-25 **Taming the beast** Refinitiv Datastream, Aviva Investors, data as of September 12, 2022.
- 26-27 **In the red: Life after central bank support?** Refinitiv Datastream, Aviva Investors, data as of September 9, 2022. Note: Commodities = Bloomberg Commodity Total Return Index; US treasuries = Bank of America US Treasury Index; REITS: FTSE EPRA Nareit Global Real Estate Index; S&P 500 = S&P 500 Composite; Gold = S&P GSCI Gold Spot; MSCI EAFE = MSCI EAFE Index; MSCI EM = MSCI Emerging Markets Index; Global IG = Bloomberg Global Aggregate Investment Grade Debt; Global high yield = ICE Bank of America Developed Markets High Yield.
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- 30-31 **Post-conflict recoveries in equity markets** Elroy Dimson, et al., 'The worldwide equity premium: A smaller puzzle', in Mehra R ed., 'Handbook of investments: equity risk premium', April 7, 2006.

Conflict

- 34-35 **Fighting, shouting, fleeing** 'Global trends force displacement in 2021', UNHCR, June 16, 2022. Note: Refugees under UNHCR mandate = Refugees and people in refugee-like situations; Stateless people = While in total UNHCR reports 4.3 million stateless people, 1.3 million are also forcibly displaced from Myanmar. These 1.3 million are only counted as forcibly displaced when calculating the total population of concern to UNHCR to avoid double counting; Internally displaced people returnee = Only included in UNHCR's population of concern for a period of 12 months; Refugee returnees = Only included in UNHCR's population of concern for a period of 12 months.
- 36-37 **The quest for home** 'Ukraine refugee situation', Operational Data Portal, data as of September 5, 2022. Note: Figures reflect cross-border movements, not individuals. An additional 105,000 people moved to the Russian Federation from the Donetsk and Luhansk regions between 18 and 23 February. Movements back to Ukraine may not necessarily indicate sustainable returns as the situation remains volatile and unpredictable.

- 38-39 The dragon and the black bear** 'Annual report to congress: Military and security developments involving the People's Republic of China', Office of the Secretary of Defense, 2021.
- 40-41 Combat is costing the earth** Neta C. Crawford, 'Pentagon fuel use, climate change, and the costs of war', Watson Institute for International and Public Affairs at Brown University, November 13, 2019. Hannah Ritchie, Max Roser and Pablo Rosado, 'CO₂ and greenhouse gas emissions', Our World in Data, August 2020.
- 42 What happened to the peace dividend?** Benedict Clements, et al., 'Military spending in the post-pandemic era', International Monetary Fund, Summer 2021. Note: Based on IMF classification. Military expenditure as a percentage of GDP is calculated as the unweighted country average within each country group. Data for 1991 is not available due to the breakup of the former Soviet Union. Advanced economies = The IMF World Economic Outlook classifies 39 economies as "advanced" based on factors including high per capita income, exports of diversified goods and services, and greater integration into the global financial system. Developing economies = Remaining countries are classified as "emerging market and developing" economies.
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Case no.	Heat and hot water fuel	LCTs installed and energy efficiency standard	Upfront cost (£)	Energy costs (exc. vehicle fuel costs) (£/yr)	Energy costs saved (£/yr)	Energy costs (inc. vehicle fuel costs) (£/yr)	Residual CO ₂ emissions (lifetime TCO ₂)
Case 1	Gas	Baseline case (no EE improvement) + old gas boiler	0	2,118	N/a	2,816	94
Case 2	Gas	Baseline case (no EE improvement) + modern gas boiler	0	1,874	245	2,572	73
Case 3	Gas	Energy efficiency upgrade (EE4) + modern gas boiler	4,285	1,749	370	2,447	62
Case 4	Gas	EE4 + electric vehicle	5,285	2,048	71	2,048	65
Case 5	Gas	EE4 + solar panels	10,615	978	1,141	1,676	40
Case 6	Gas	EE4 + solar panels + battery	16,497	374	1,744	1,072	45
Case 7	Gas	EE4 + electric vehicle + solar panels	11,615	1,277	842	1,277	48

Sources and notes (cont'd)

Case no.	Heat and hot water fuel	Lcts installed and energy efficiency standard	Upfront cost (£)	Energy costs (exc. vehicle fuel costs) (£/yr)	Energy costs saved (£/yr)	Energy costs (inc. vehicle fuel costs) (£/yr)	Residual CO ₂ emissions (lifetime TCO ₂)
Case 8	Gas	EE4 + electric vehicle + battery	11,167	1,599	519	1,599	71
Case 9	Gas	EE4 + electric vehicle + solar panels + battery	17,497	459	1,660	459	48
Case 10	Electricity	EE4 + heat pump	13,699	1,794	325	2,492	17
Case 11	Electricity	EE4 + heat pump + solar panels	20,029	861	1,257	1,559	3
Case 12	Electricity	EE4 + heat pump + electric vehicle	14,699	2,392	-273	2,392	25
Case 13	Electricity	EE4 + heat pump + electric vehicle + solar panels	21,029	1,459	660	1,459	8
Case 14	Electricity	EE4 + heat pump + solar panels + smart battery	29,713	240	1,879	938	3
Case 15	Electricity	EE4 + heat pump + electric vehicle + smart battery	24,383	1,417	701	1,417	25
Case 16	Electricity	EE4 + heat pump + electric vehicle + solar panels + smart battery	30,713	507	1,611	507	8
Case 17	Electricity	EE4 + heat pump + electric vehicle + solar panels + smart battery (policy costs moved)	30,713	383	1,735	383	8

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