THE LITTLE BOOK OF DATA 5

AVIVA INVESTORS

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.

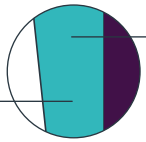
Contents

Prologue: Hold that thought

Human attention is decreasing in a data explosion

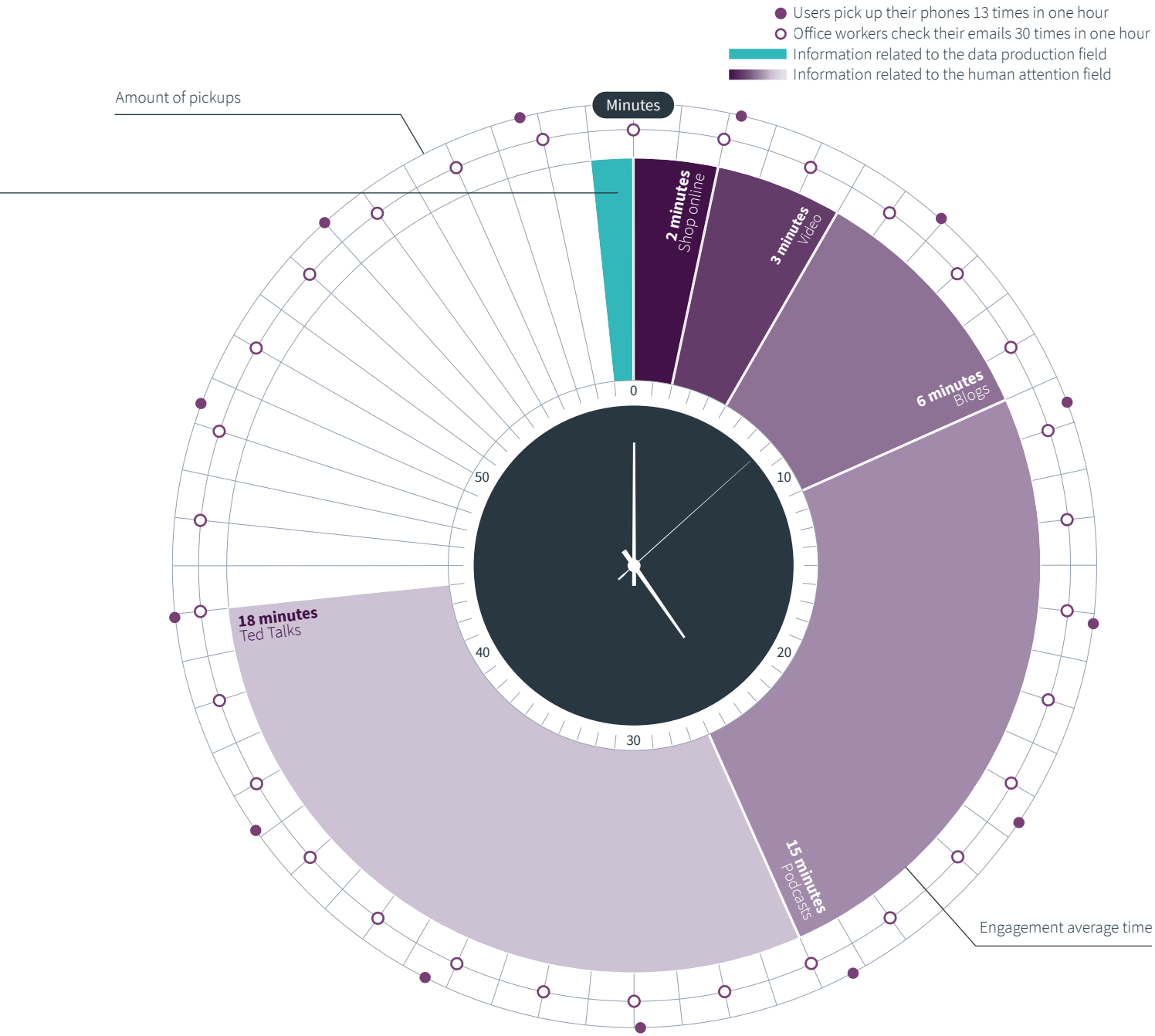
Humans process visuals 60 times faster than text, but however we access information, we are struggling to keep up. As the volume of data being shared and accessed has increased, our attention spans have diminished, meaning we are ill-equipped to process what's happening in our world. Clear and accurate 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
Minutes
2 minutes
Shop online
3 minutes
Video
6 minutes
Blogs
15 minutes
Podcasts
18 minutes
Ted Talks
0
10
20
30
40
50
Engagement average time

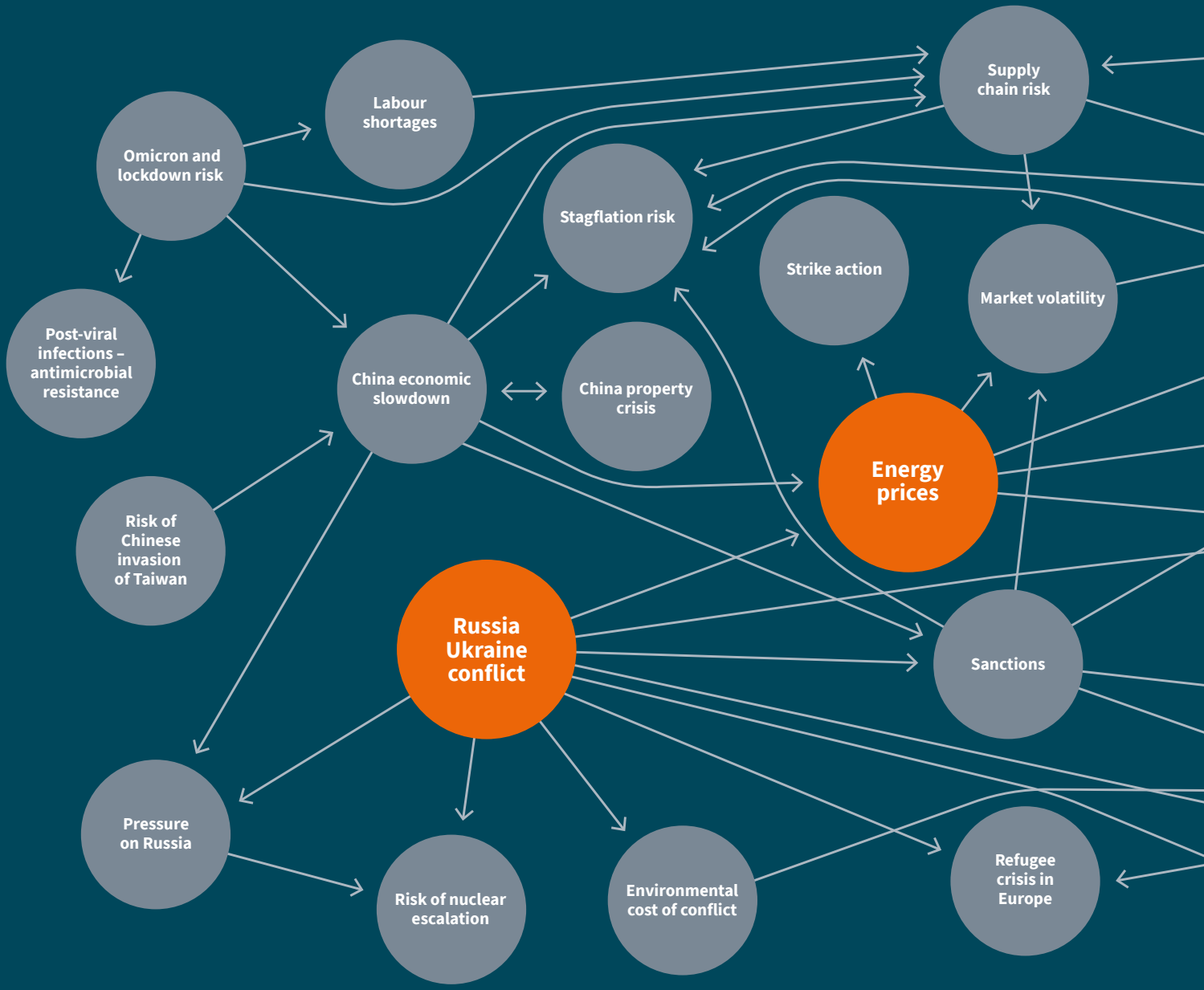

FLAMMABLE GAS 2
FINE GOLD 999,9

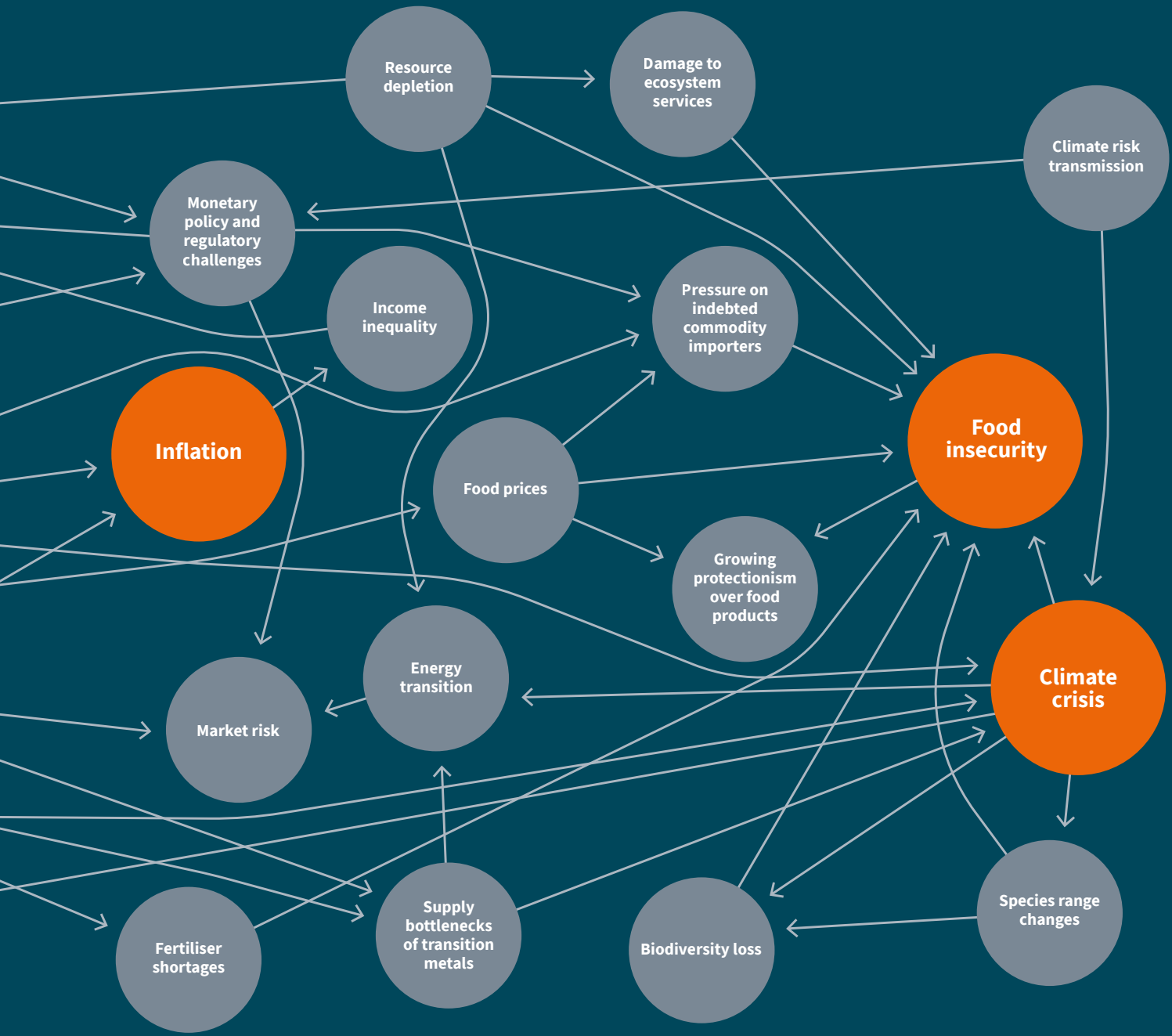
The bigger picture

Major macro and market developments

Multiple systemic shocks

Connections and feedbacks

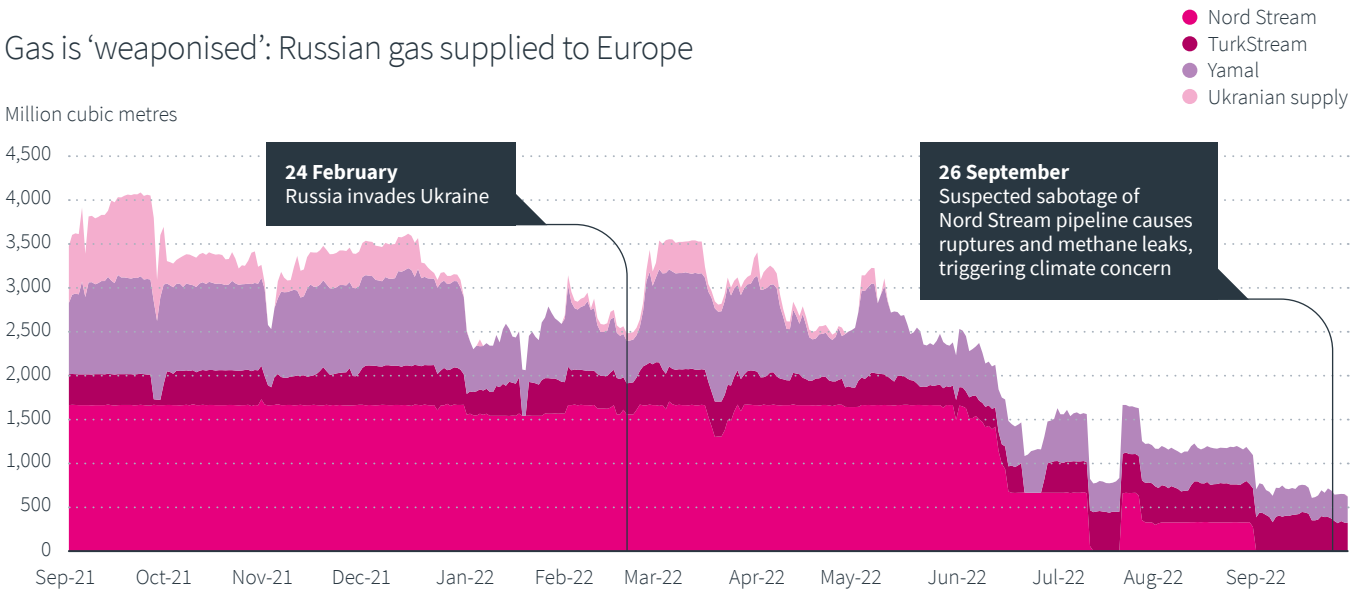



Resource depletion
Damage to ecosystem services
Climate risk transmission
Monetary policy and regulatory challenges
Income inequality
Pressure on indebted commodity importers
Inflation
Food insecurity
Food prices
Growing protectionism over food products
Energy transition
Market risk
Climate crisis
Fertiliser shortages
Supply bottlenecks of transition metals
Biodiversity loss
Species range changes

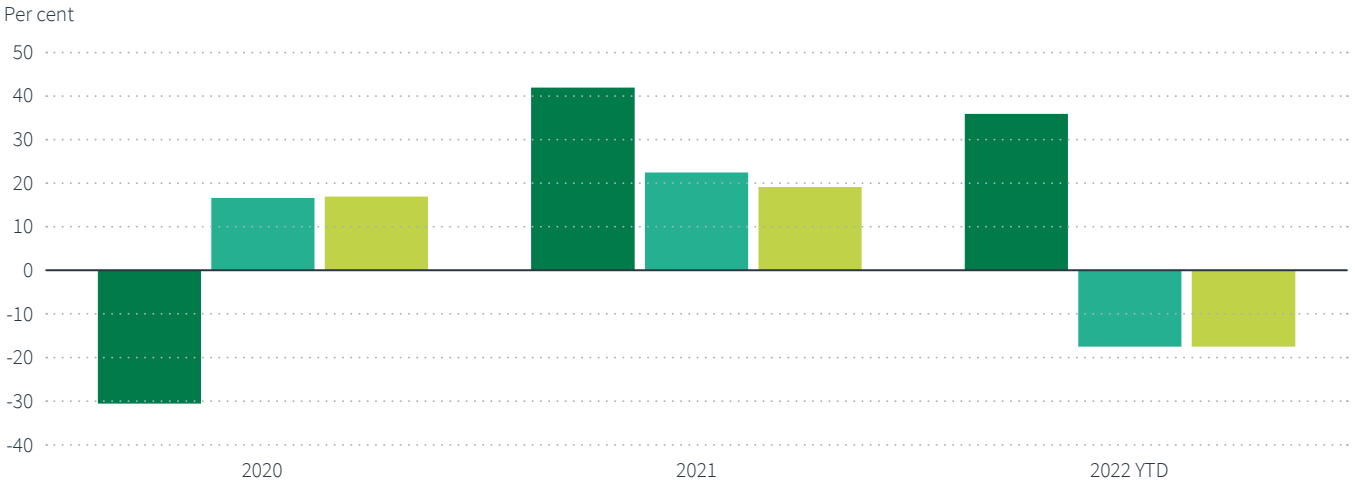
Spillovers from Russia's invasion of Ukraine

Energy sector sees multiple impacts

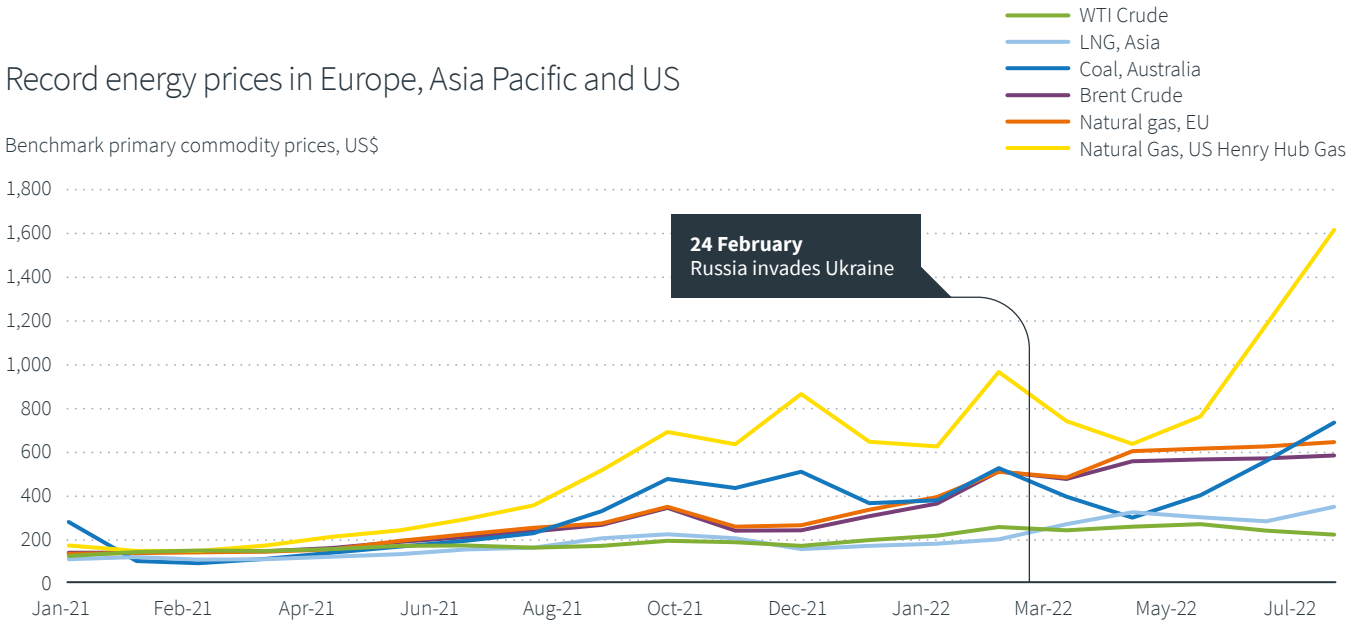
Gas is 'weaponised': Russian gas supplied to Europe



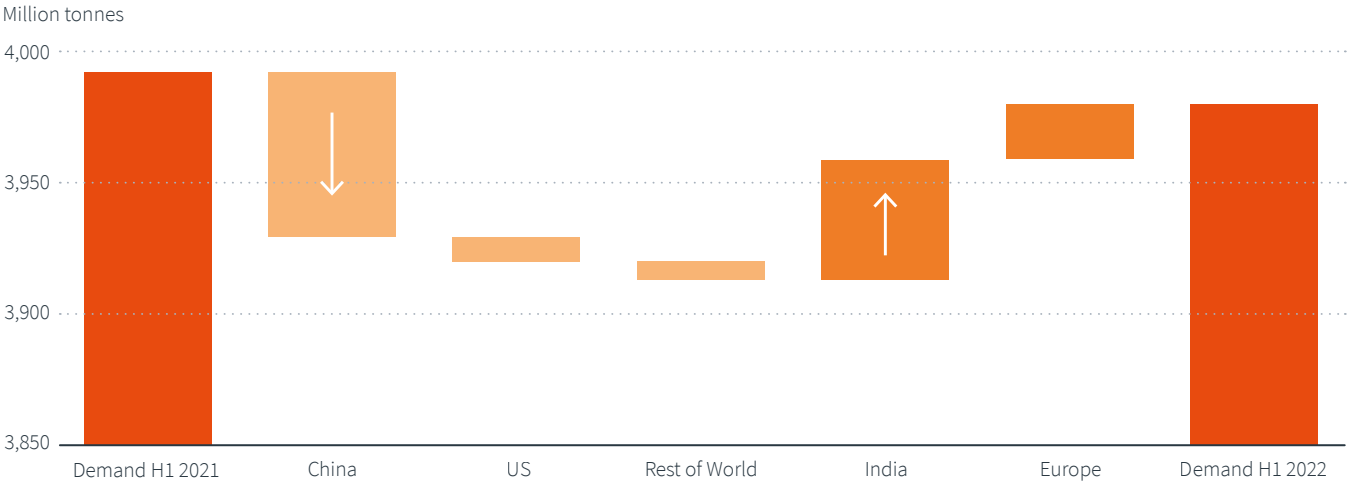
Relative energy sector equity performance



Record energy prices in Europe, Asia Pacific and US

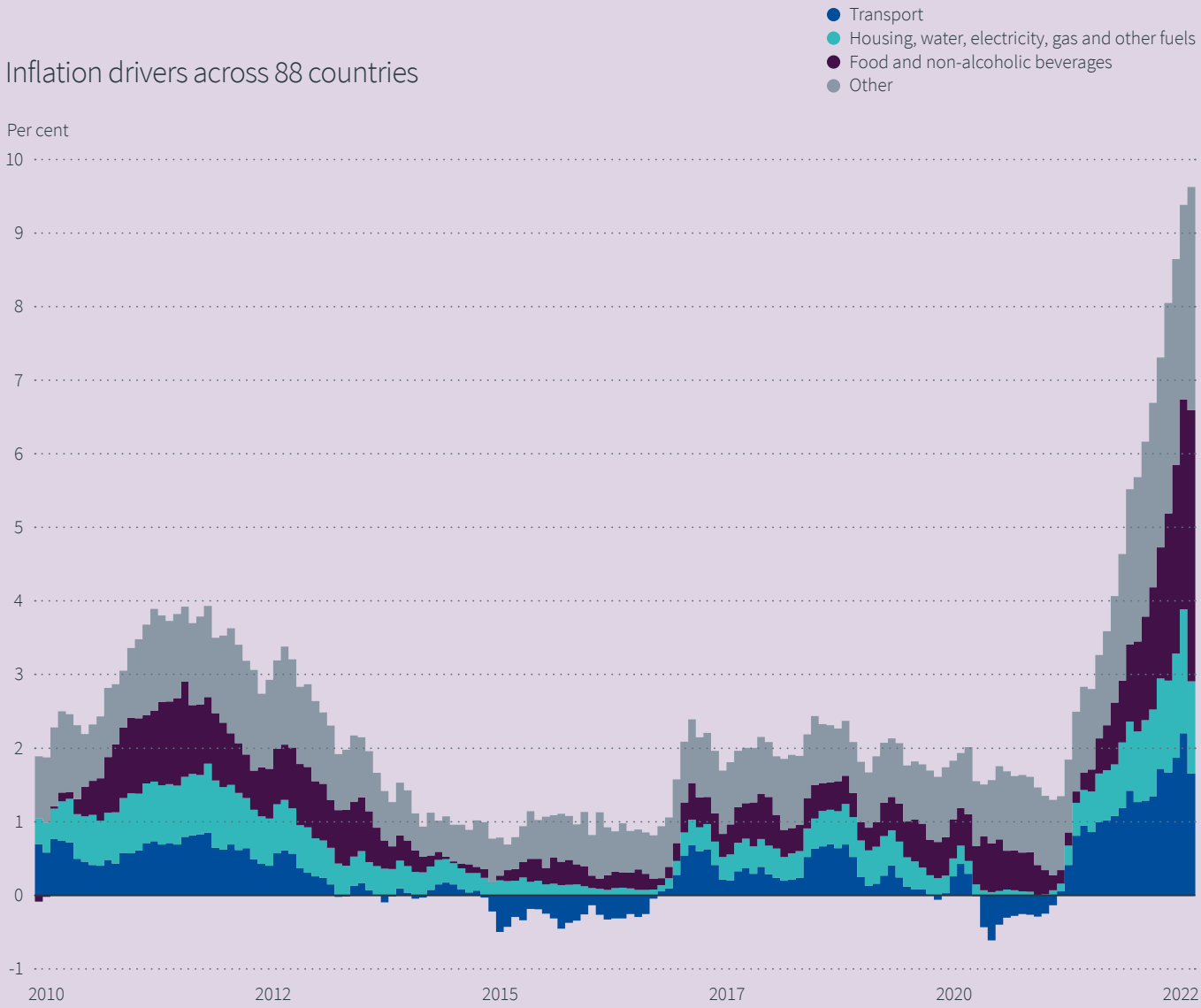


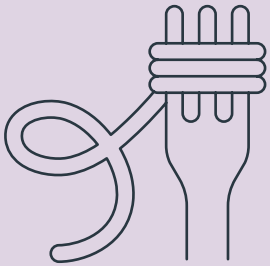
Global coal consumption: Demand rises in India and Europe



Guess who's back?

Food and energy prices drive global inflation surge





"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."

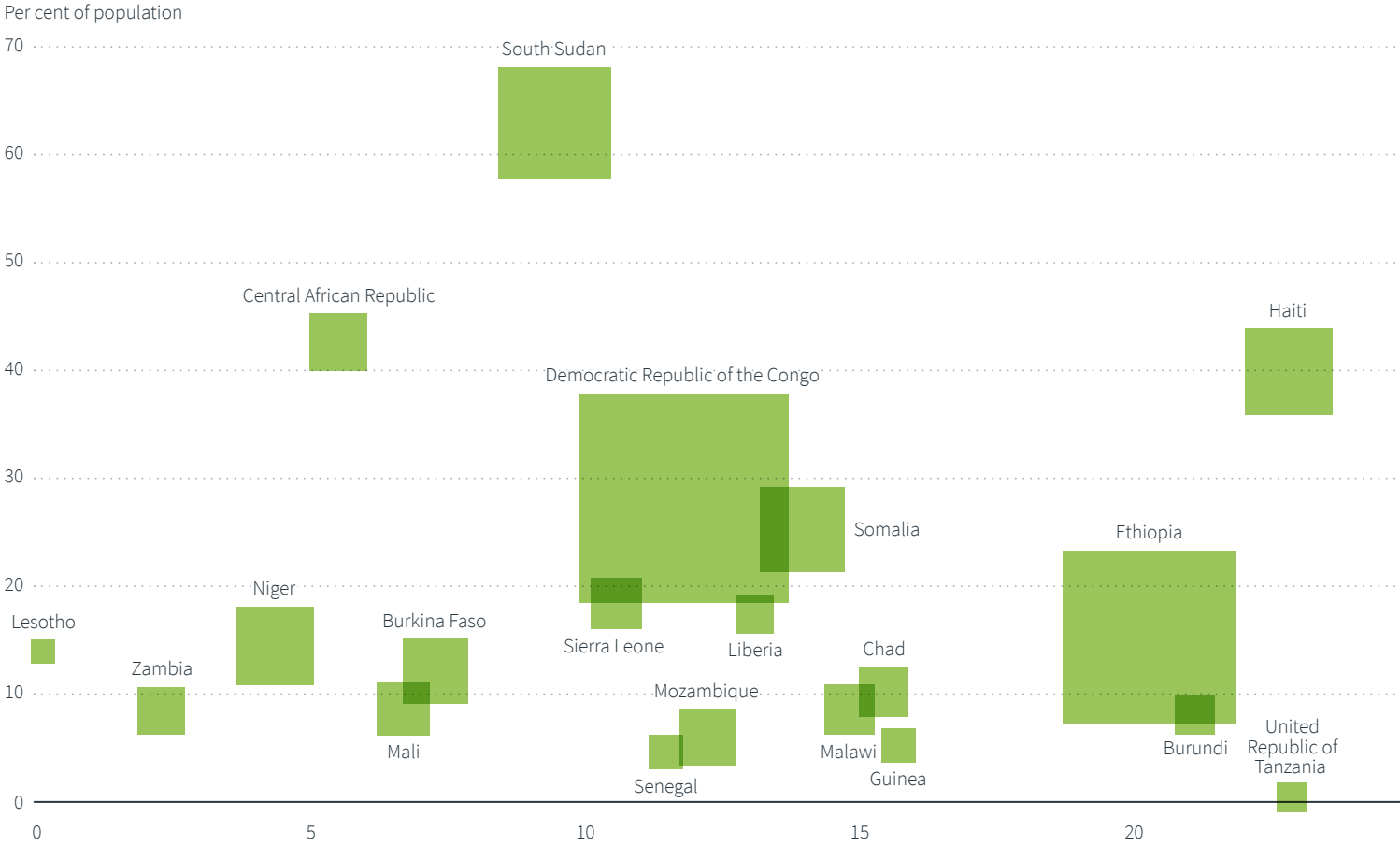
Jack Monroe
Food writer and social commentator

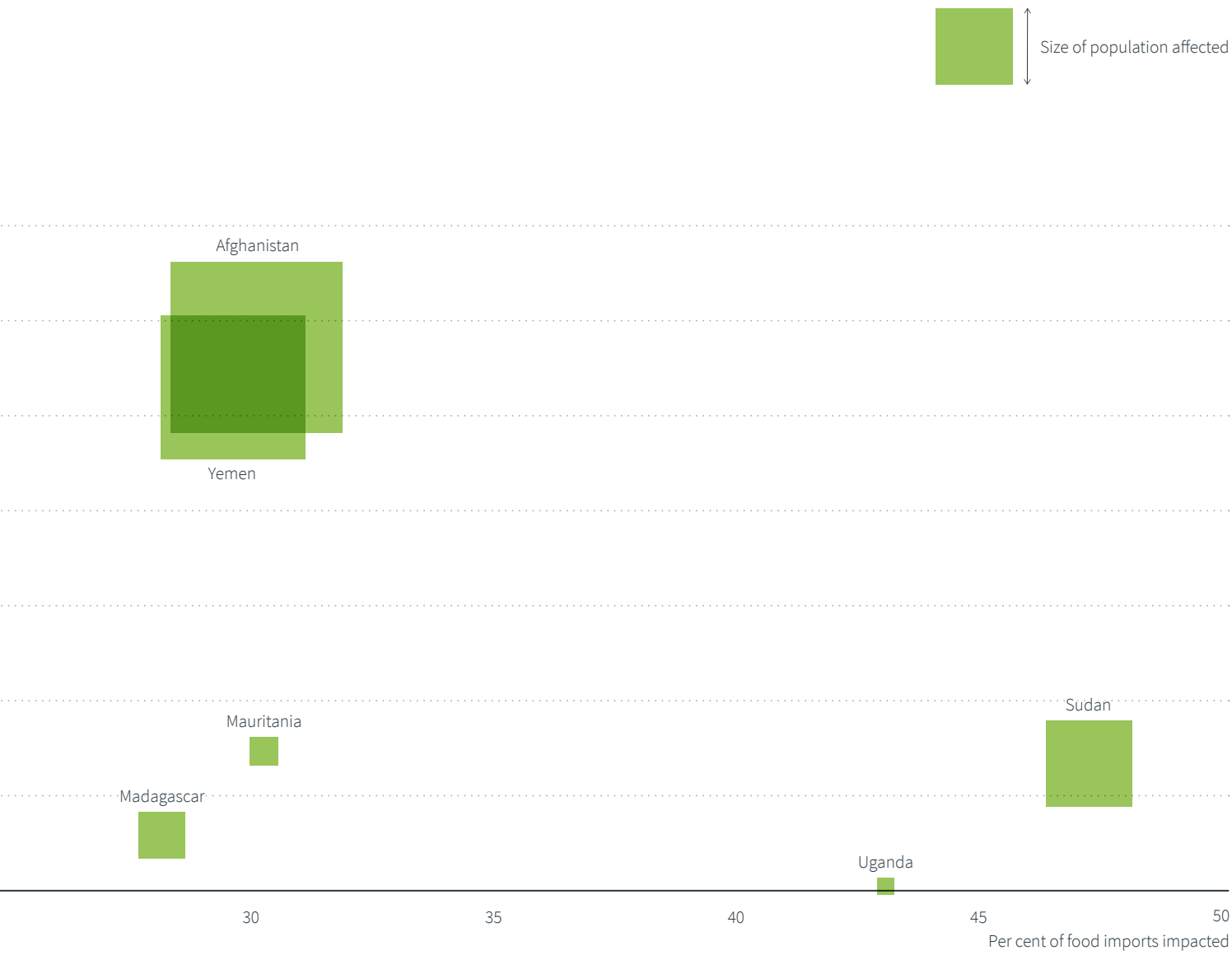
Food crisis

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

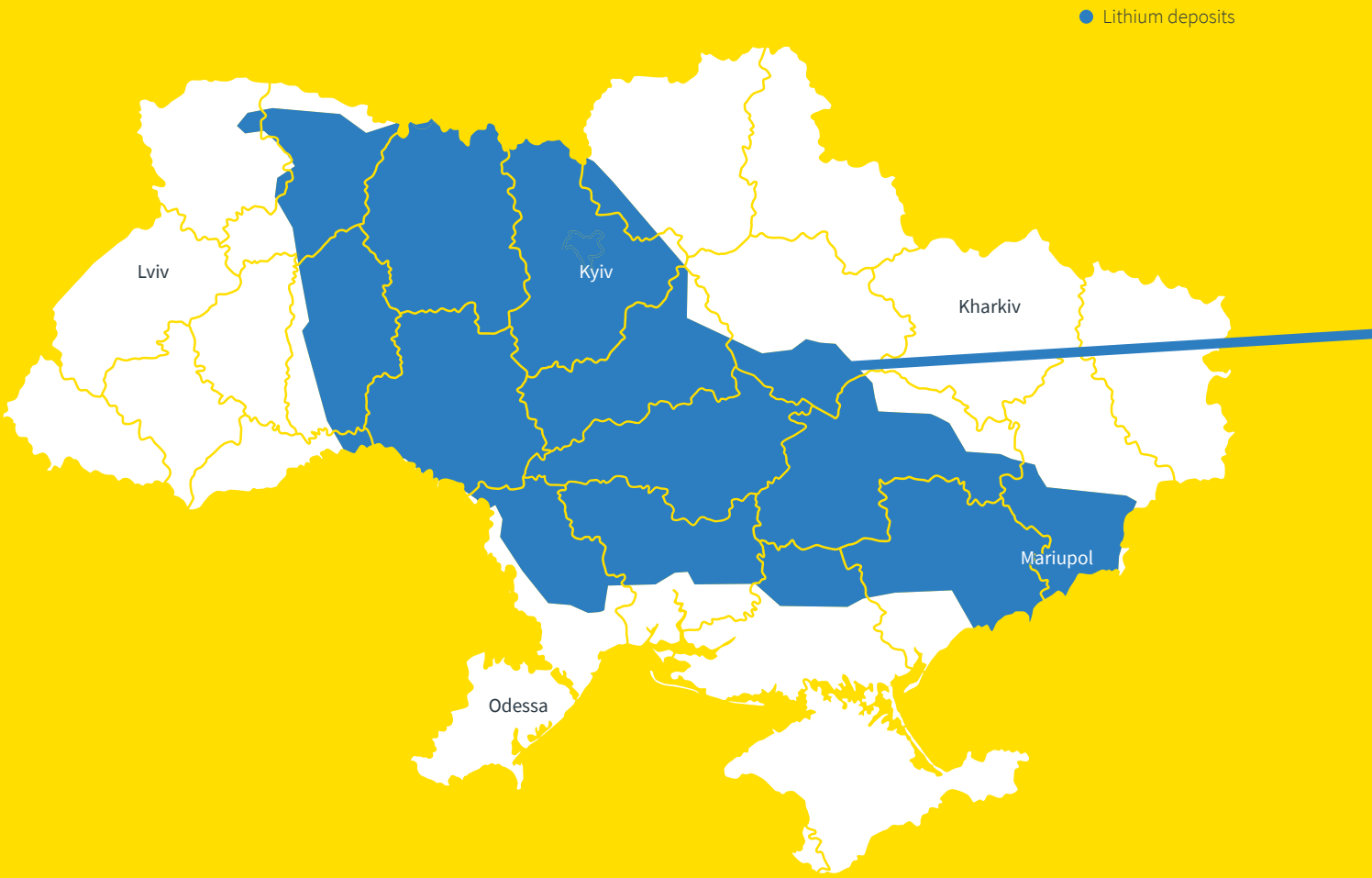


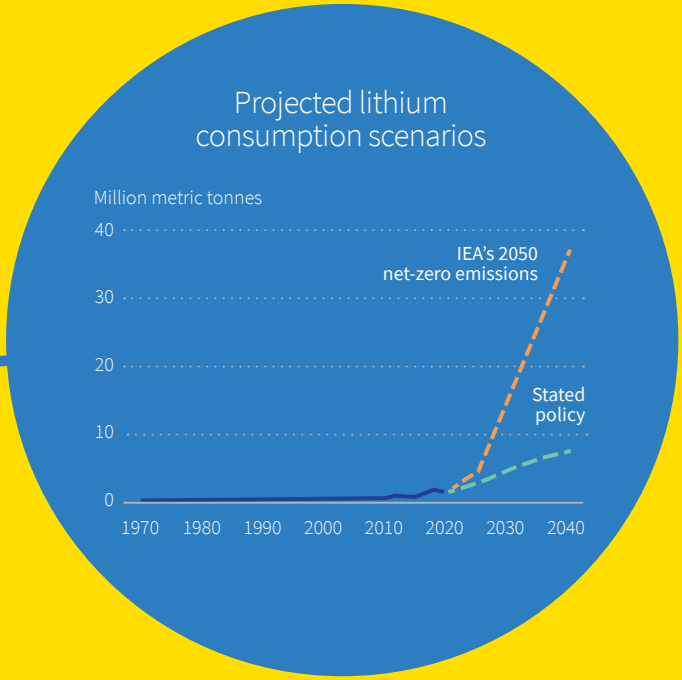

Size of population affected
Afghanistan
Yemen
Mauritania
Madagascar
Sudan
Uganda
30
35
40
45
50
Per cent of food imports impacted

The first battle of the post-carbon world?

Lithium reserves in contested zones

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





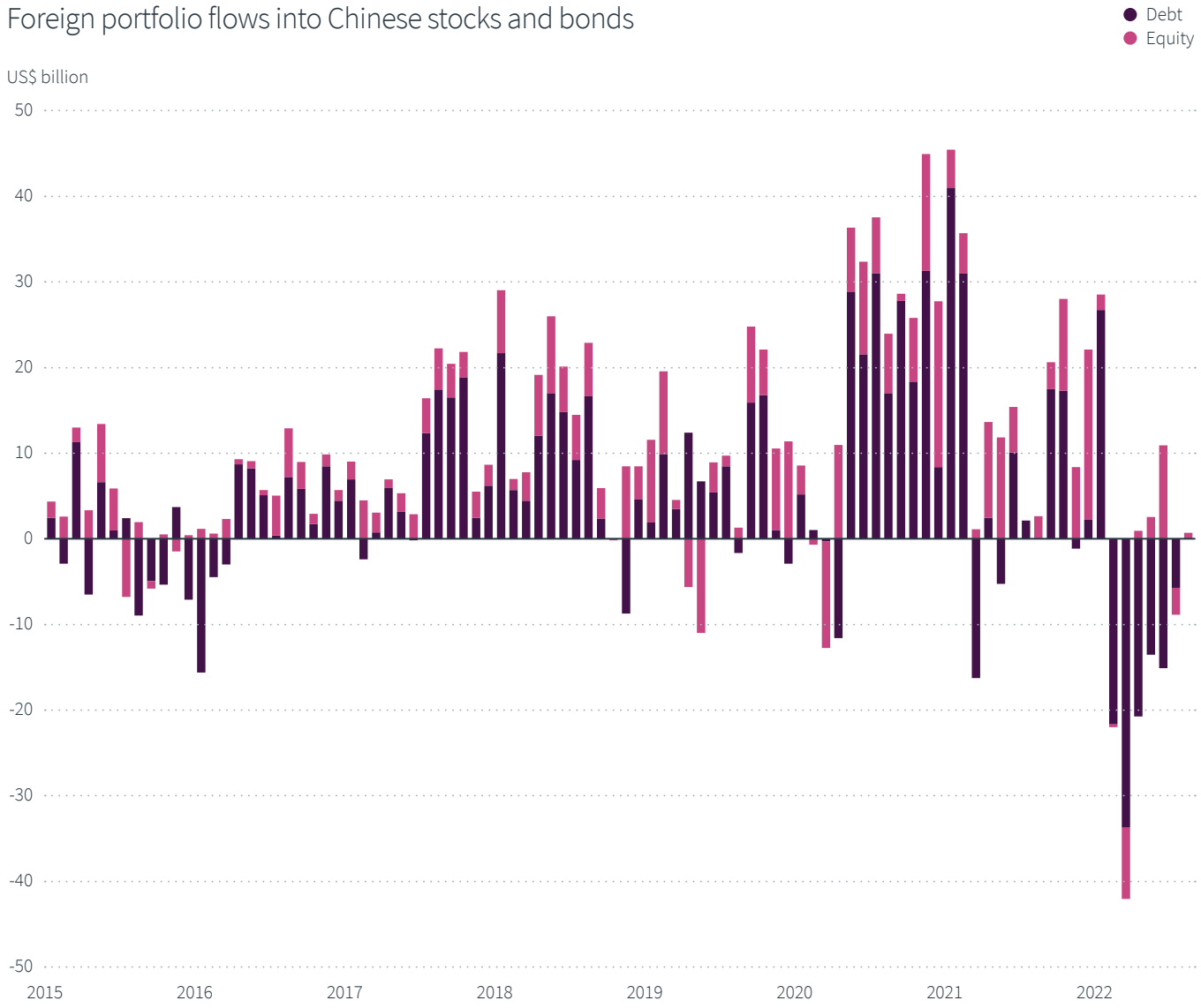
The rationale for Russia's invasion of Ukraine has many dimensions. Geologists believe Ukraine has significant undeveloped reserves of lithium, a key input for EV batteries and energy storage. Prices surged over 700 per cent between January 2021 and March 2022. They could rise further due to the drive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

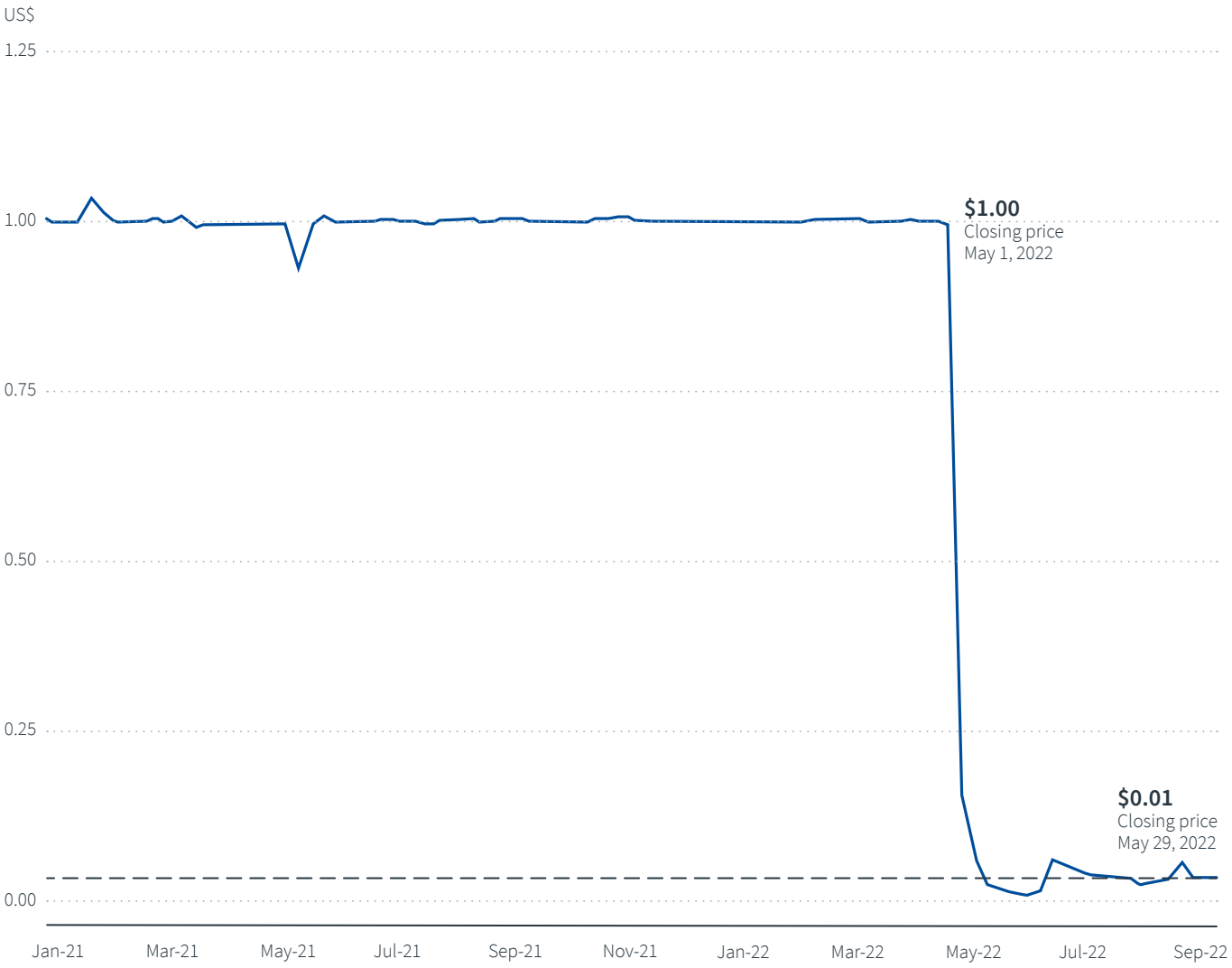
Foreign portfolio flows into Chinese stocks and bonds



Digital winds blow cold

Crypto collapse highlights risk

Value of Terra



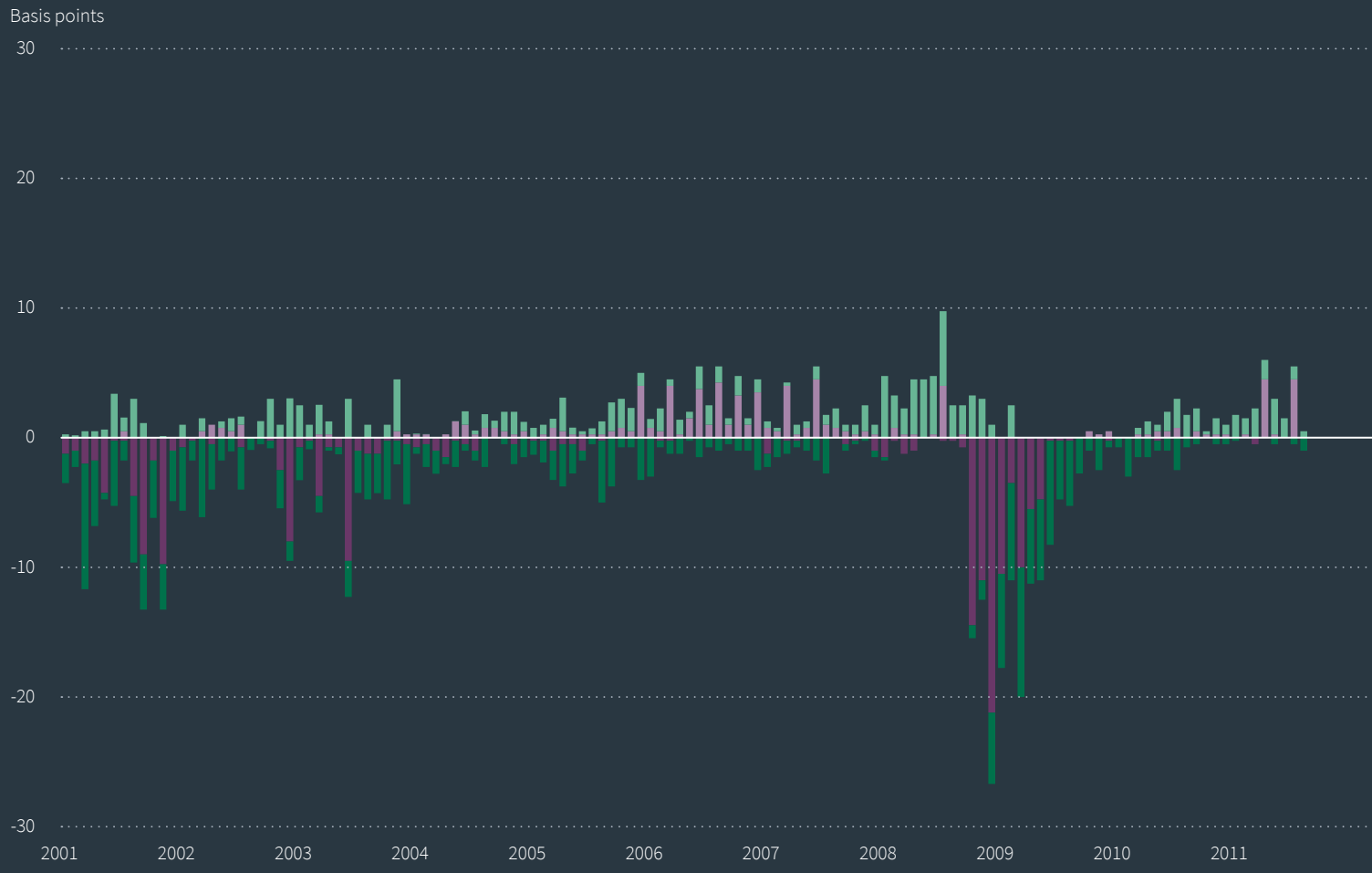
The failure of Terra, a ‘stable coin’ with an algorithmic peg to the US dollar, was likened to “a classic (bank) run” by Federal Reserve Vice Chair Lael Brainard. The slump wiped more than $1 trillion off the value of the world’s 100 largest cryptocurrencies, testing claims they can be useful for diversification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

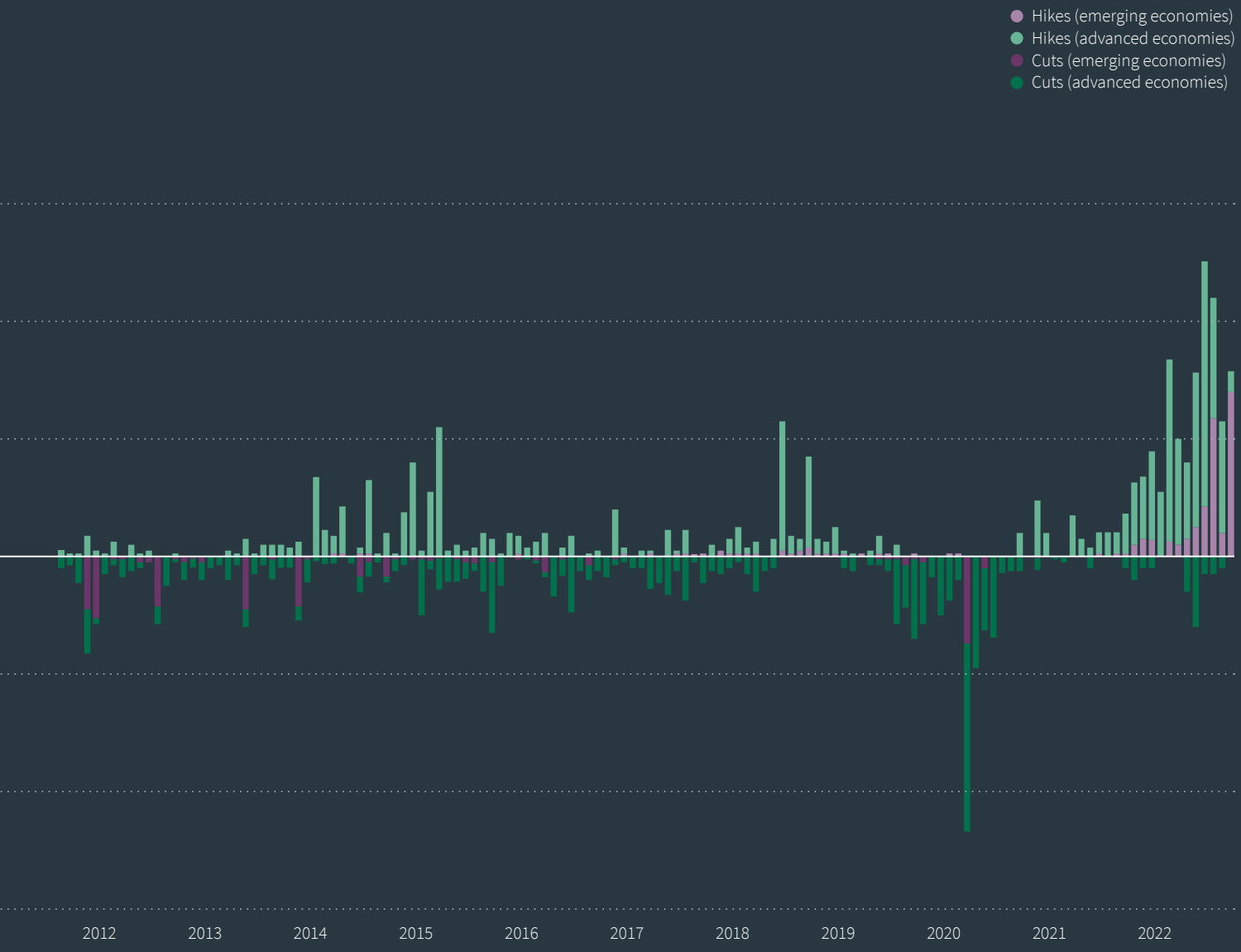
Taming the beast

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




Hikes (emerging economies)
Hikes (advanced economies)
Cuts (emerging economies)
Cuts (advanced economies)
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

Where can investors hide when inflation surges and central bank support is withdrawn? There have been few safe havens in 2022 as equities and bonds have lost ground. Commodities and real assets have been among the rare bright spots.

In the red: Life after central bank support?

Few safe havens in 2022

Asset class performance

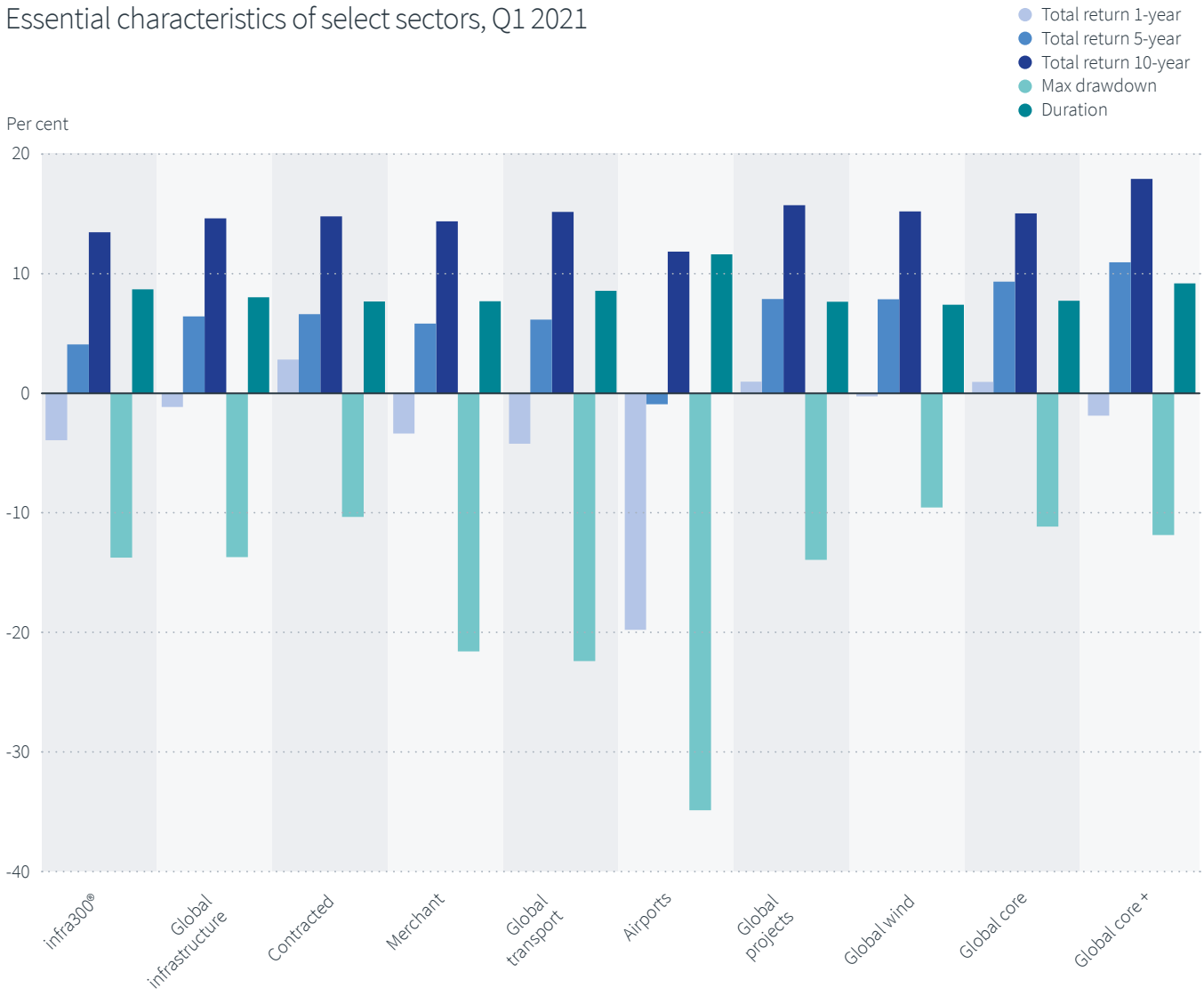
Per cent

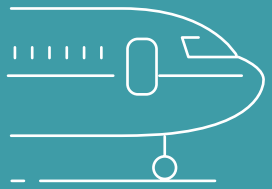
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	H1 2022
Commodities	-1.06	-9.52	-17.01	-24.66	11.77	1.70	-11.25	7.69	-3.12	27.11	18.44
US Treasuries	2.17	-3.35	6.02	0.83	1.13	2.43	0.81	6.99	8.22	-2.38	-9.19
REITS	28.65	4.39	15.89	0.06	4.99	11.42	-4.74	23.06	-8.18	27.21	-20.35
Cash	0.11	0.07	0.03	0.05	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

Seeking shelter

Risk and reward in unlisted infrastructure

Essential characteristics of select sectors, Q1 2021





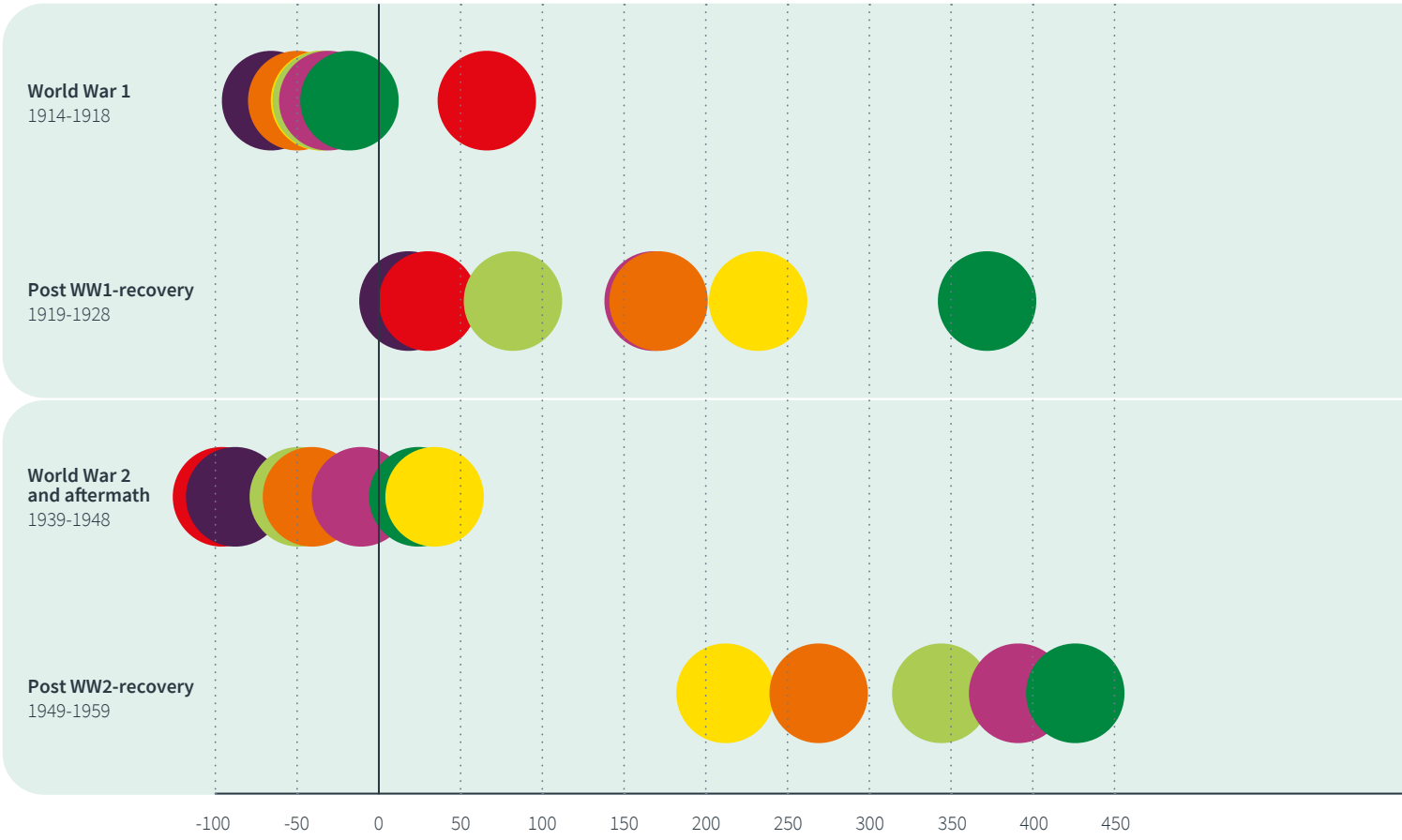
Quality infrastructure assets with inflation linkage are highly sought after in stormy times, with some – like renewable energy facilities – generating higher returns than expected in 2022. But past studies show assets with direct market exposure, like airports, can be more volatile than many realise.

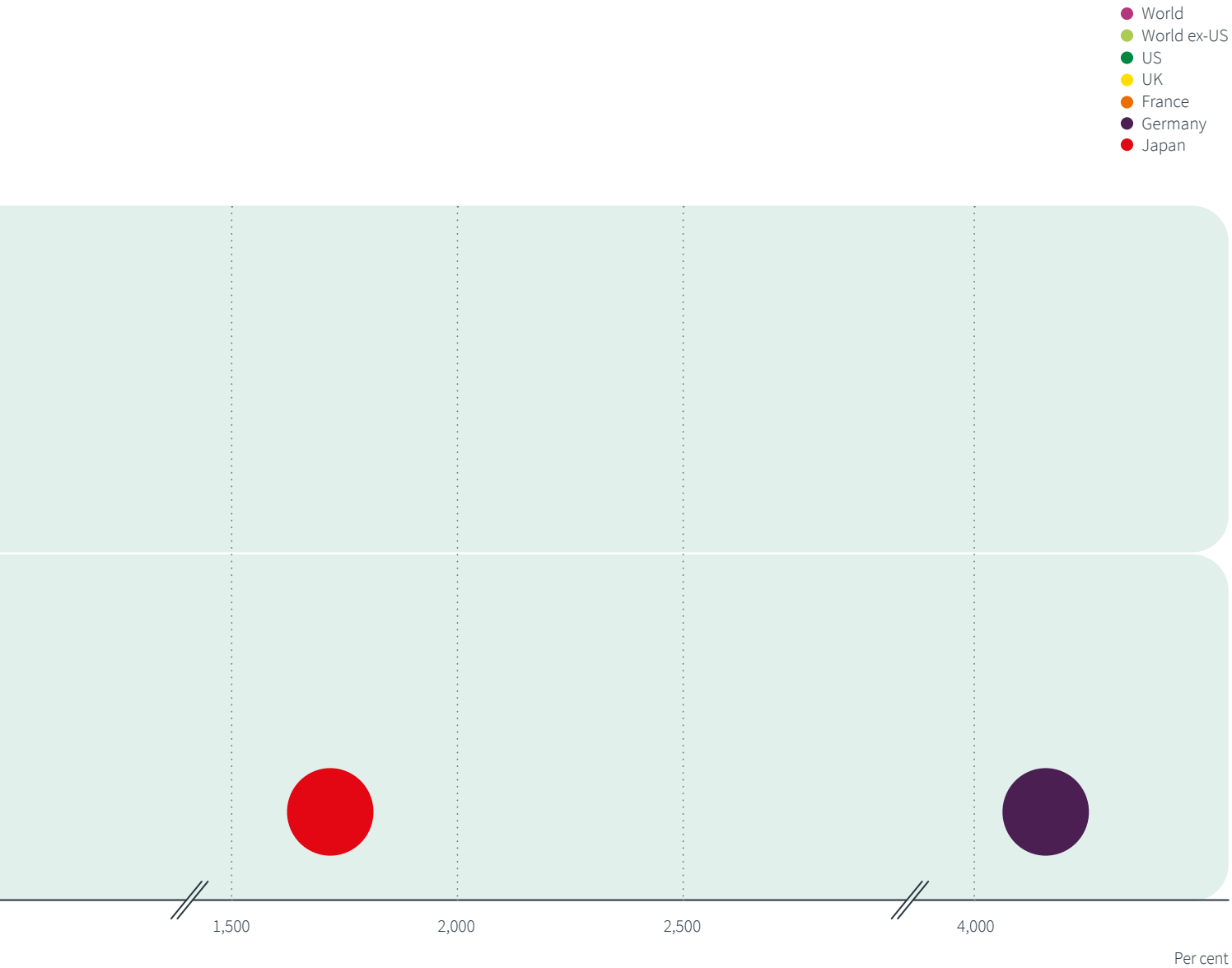
Post-conflict recoveries in equity markets

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
1,500
2,000
2,500
4,000
Per cent

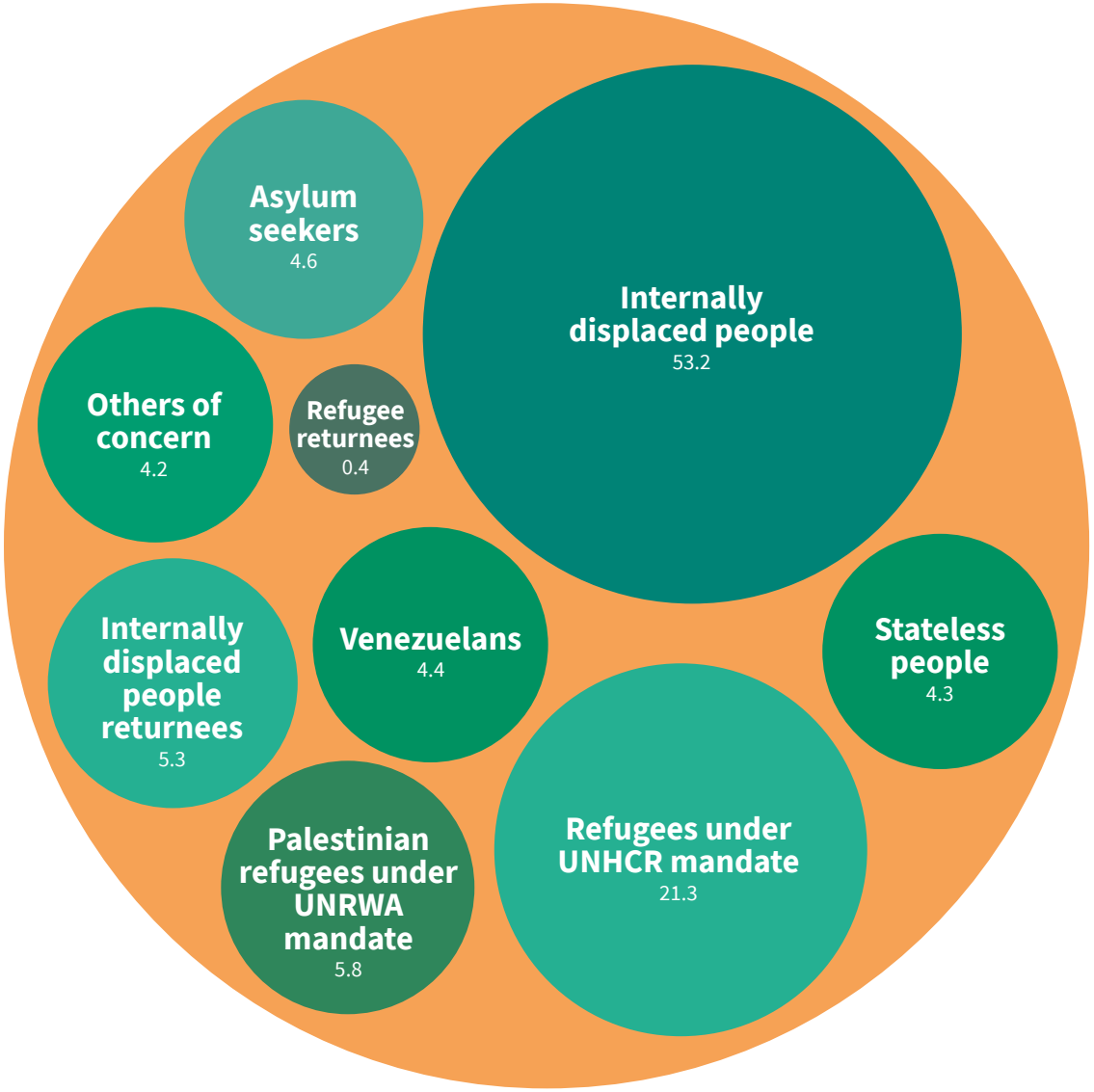
Conflict

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

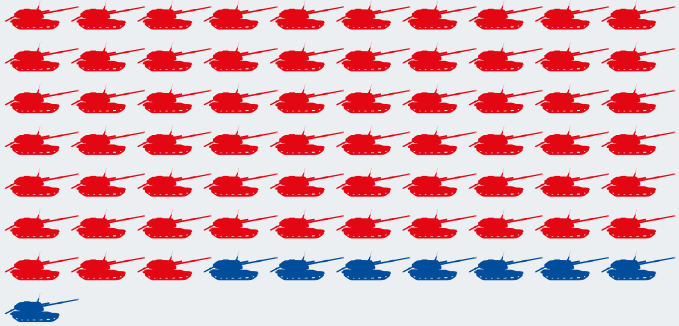
1,040,000
88,000

1 = 5,000 soldiers

Tanks

6,300
800

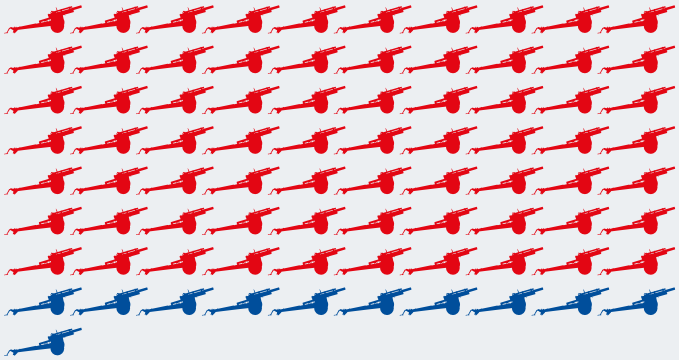
1 = 100 tanks



Artillery pieces

7,000
1,100

1 = 100 artillery pieces



China
Taiwan

Aircraft carriers

1
0

Destroyers

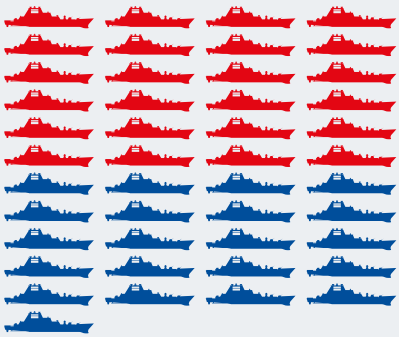
32
21

1 = 2 destroyers

Frigates

48
41

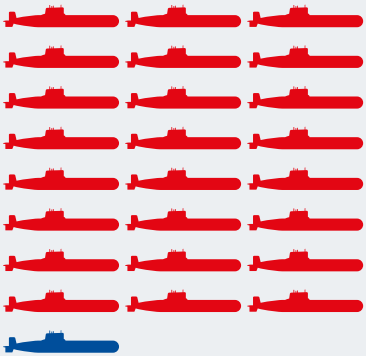
1 = 2 frigates



Submarines

71
2

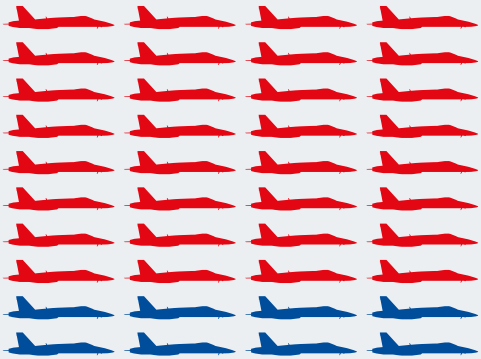
1 = 3 submarines



Fighter planes

1,600
400

1 = 50 fighter planes



Bombers

450
0

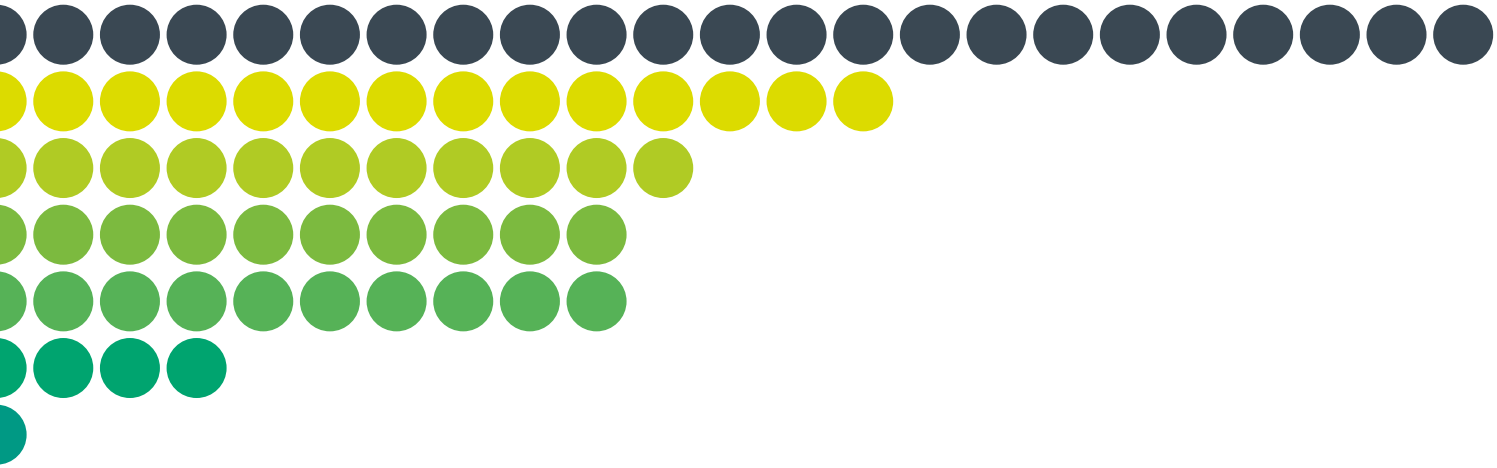
1 = 20 bombers

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.

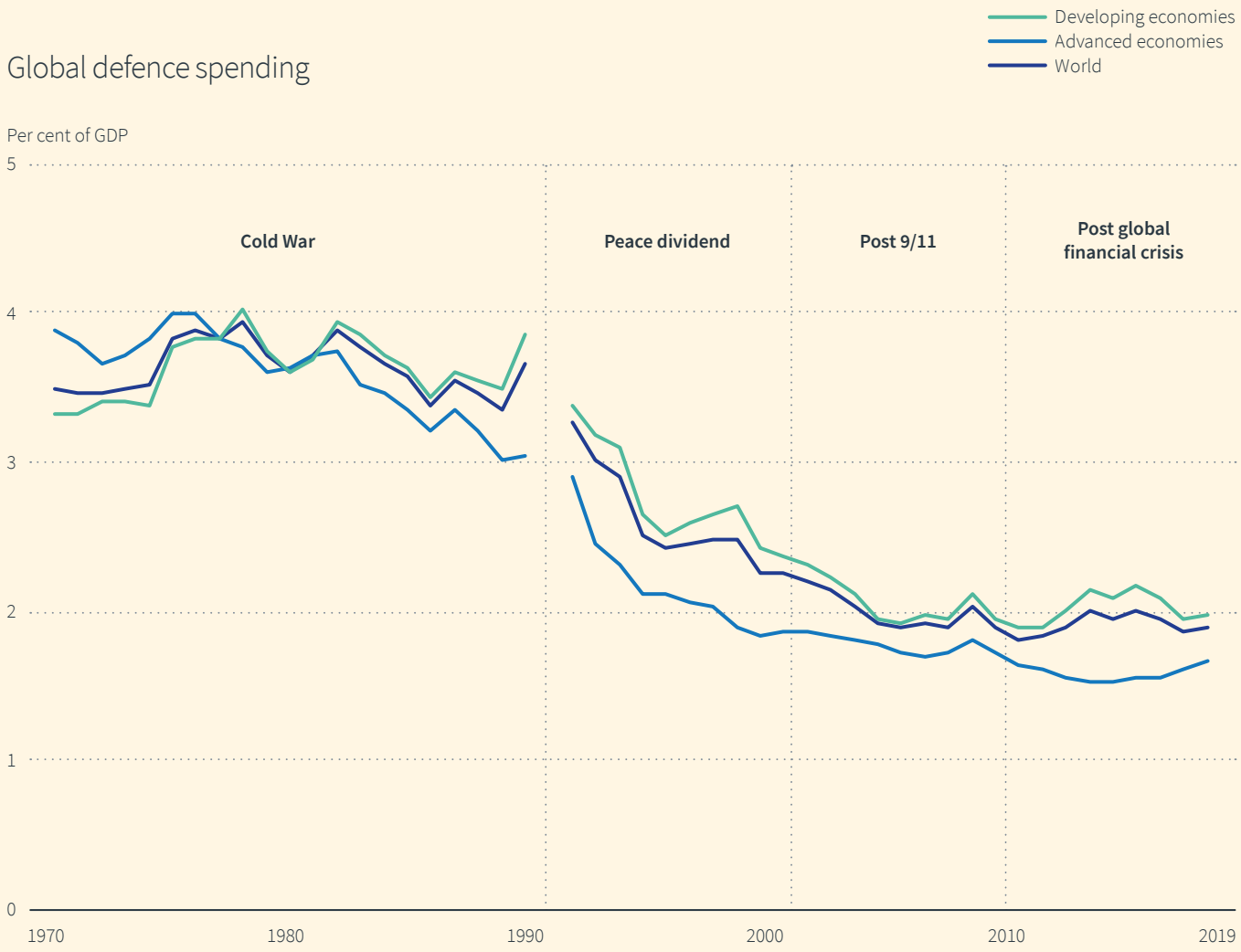
Annual emissions: US Department of Defense versus selected countries (million Mt CO_2e)



What happened to the peace dividend?

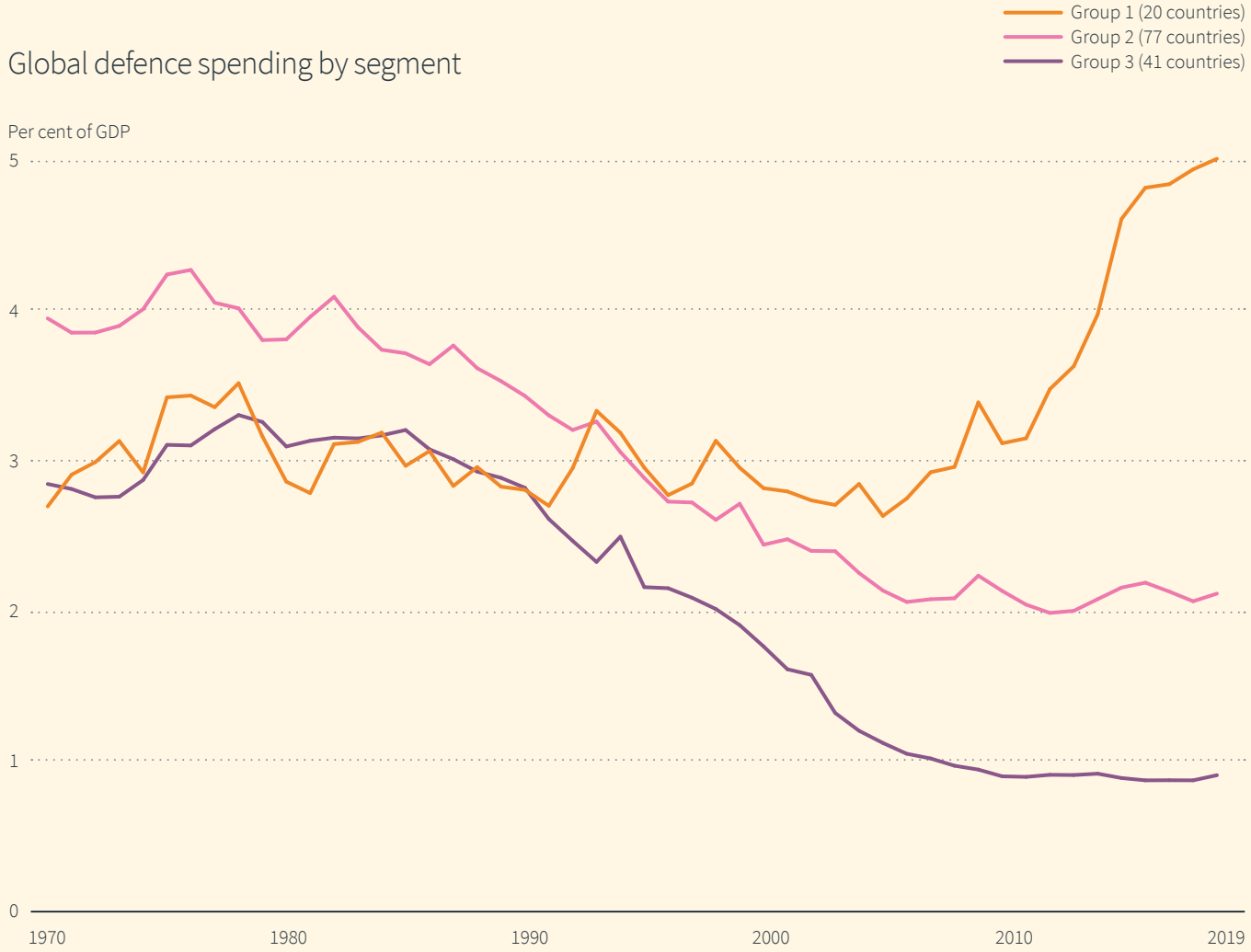
Spending for defending

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



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

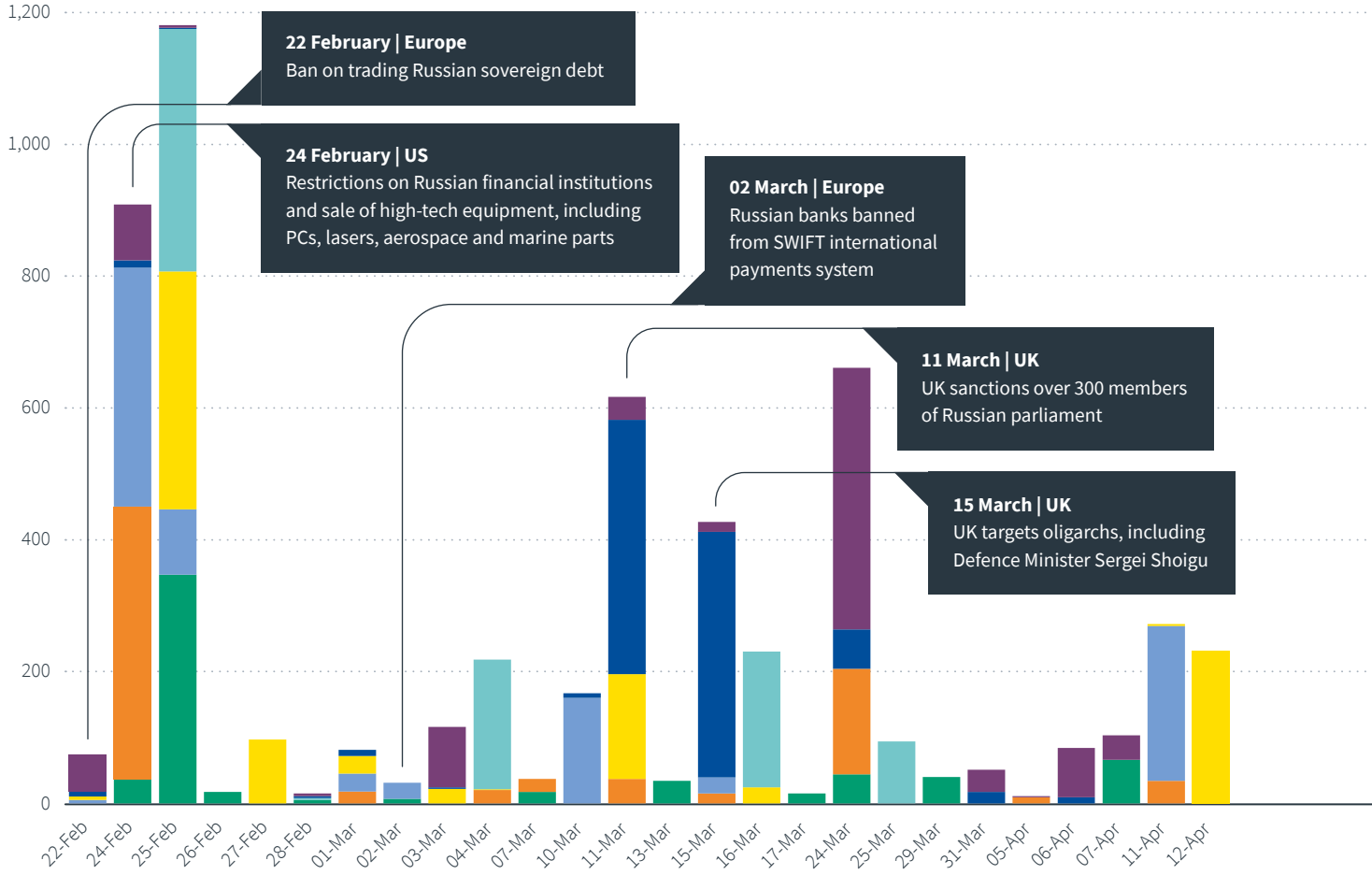

China
41
UK
1
US
2
South Korea
3
Turkey
16
India
10
Others
21

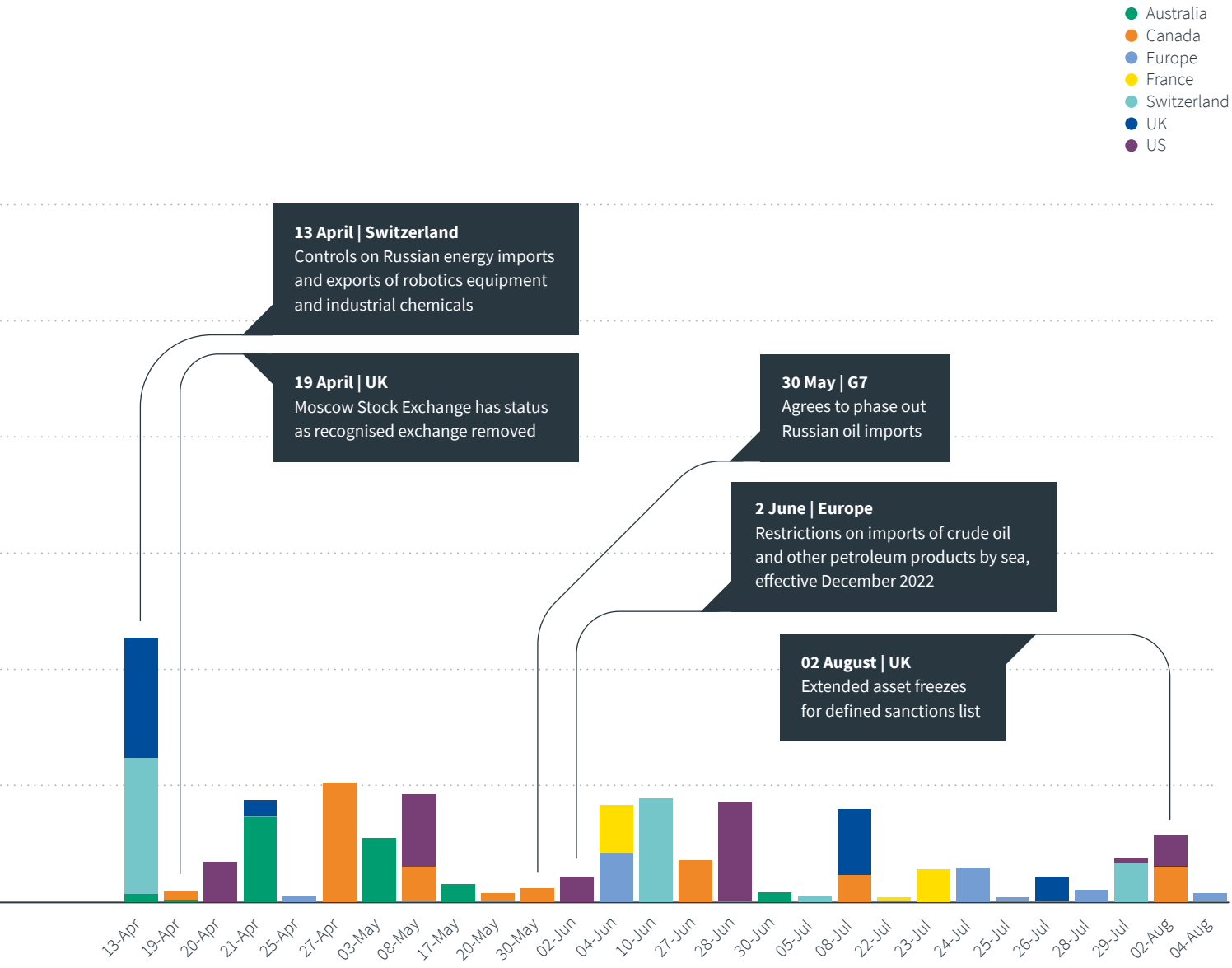
The economic front line

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
13 April | Switzerland
Controls on Russian energy imports and exports of robotics equipment and industrial chemicals
19 April | UK
Moscow Stock Exchange has status as recognised exchange removed
30 May | G7
Agrees to phase out Russian oil imports
2 June | Europe
Restrictions on imports of crude oil and other petroleum products by sea, effective December 2022
02 August | UK
Extended asset freezes for defined sanctions list
13-Apr
19-Apr
20-Apr
21-Apr
25-Apr
27-Apr
03-May
08-May
17-May
20-May
30-May
02-Jun
04-Jun
10-Jun
27-Jun
28-Jun
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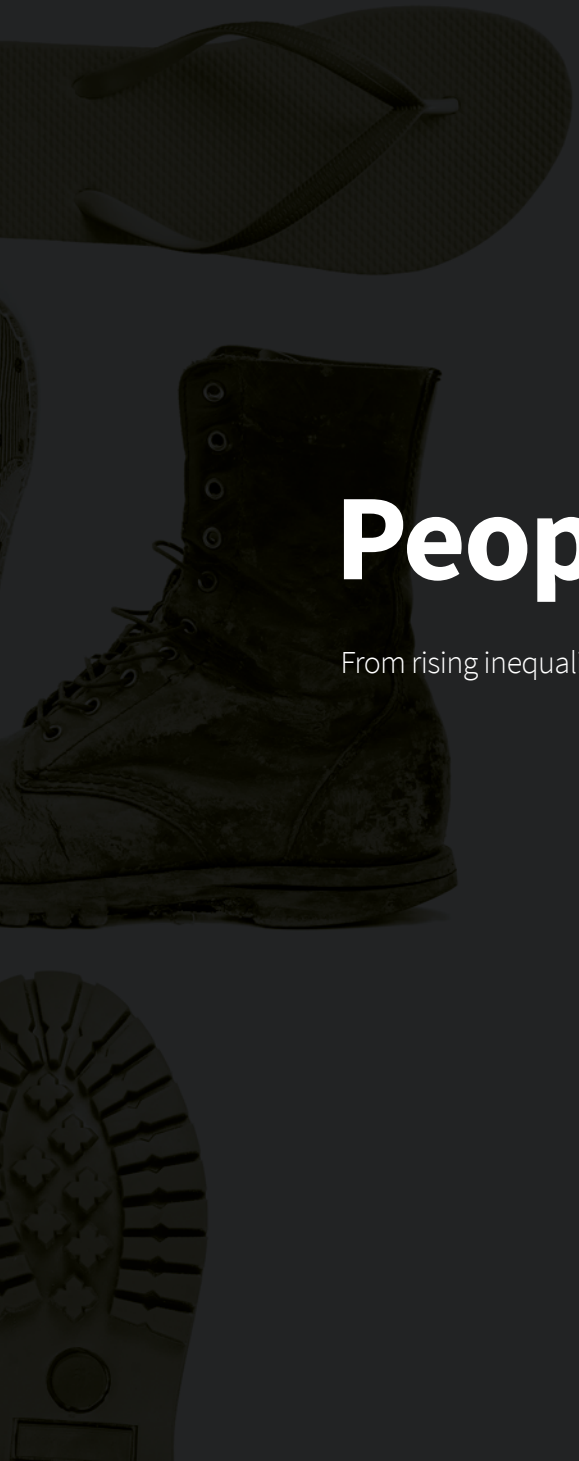
29-Jul
02-Aug
04-Aug



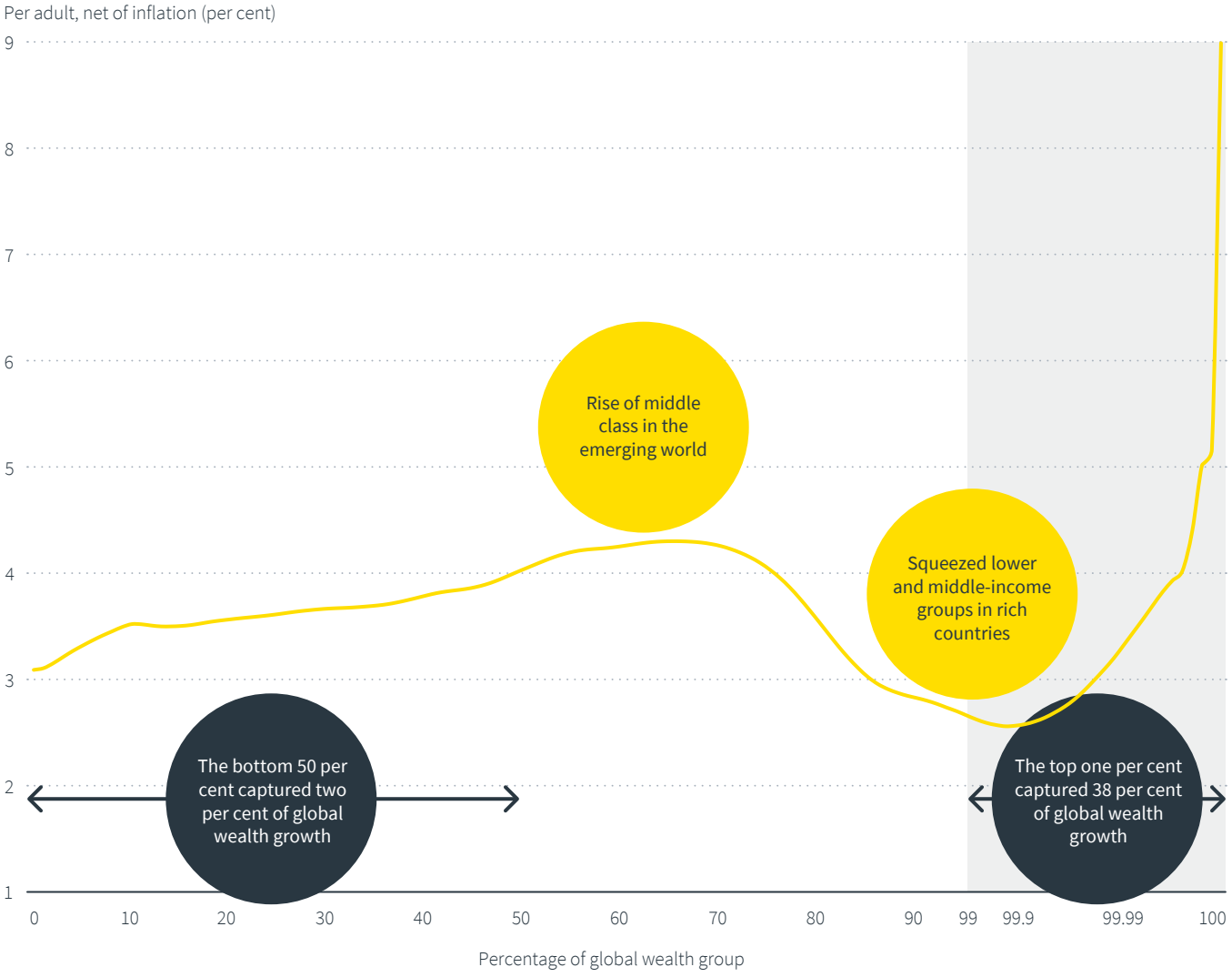
People

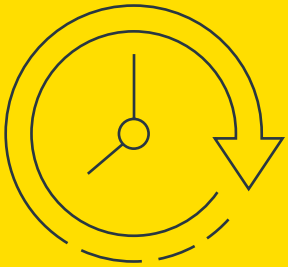
From rising inequality to a demographic bust

Boom times for some

The explosion of private wealth

Average adult annual wealth growth rate, 1995-2021





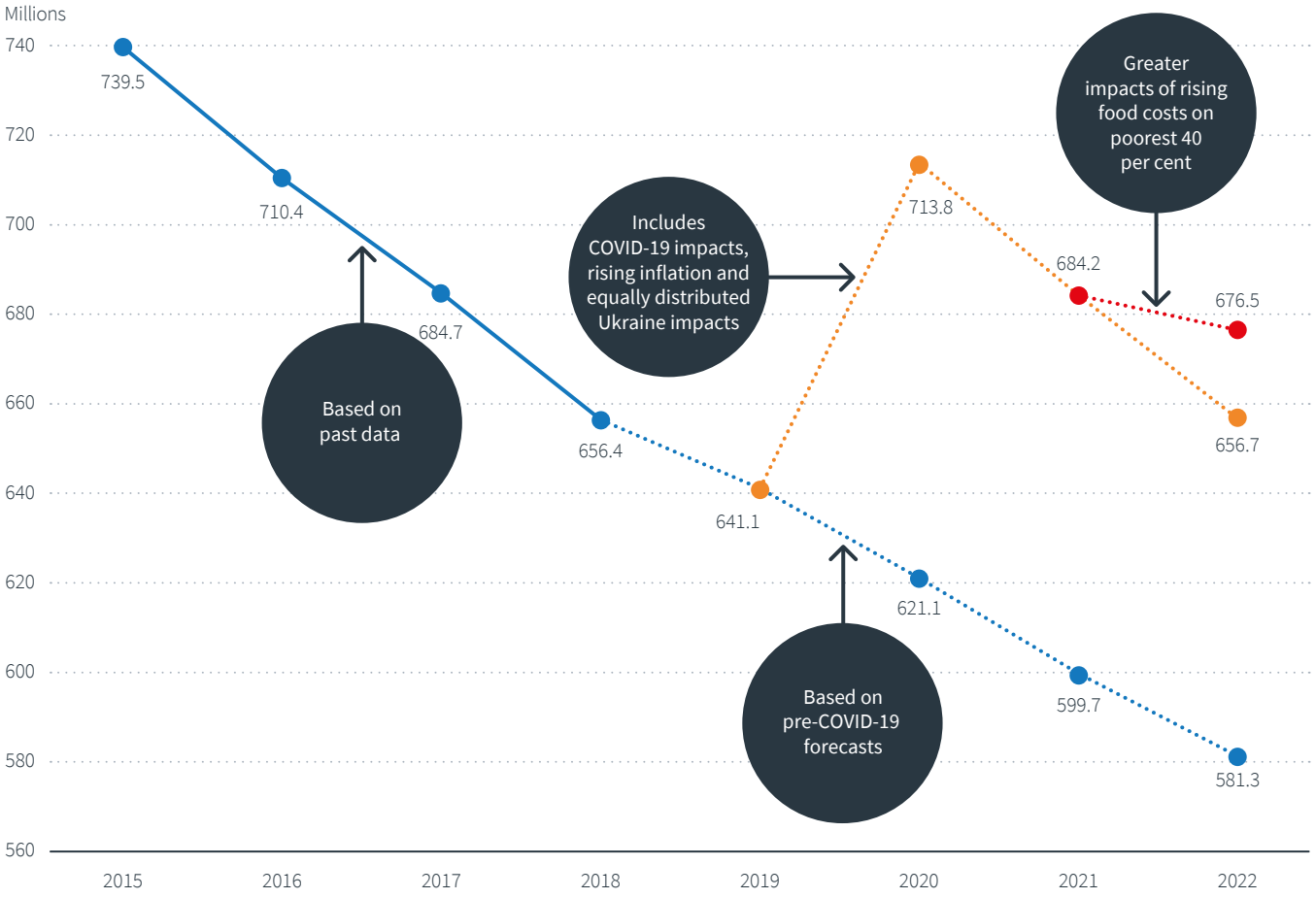
The world's richest one per cent have taken a large slice of the wealth accumulated since the mid-1990s, whereas the bottom 50 per cent have captured a meagre amount. These divergent outcomes continued during COVID-19; while millions struggled, a new billionaire was created about every 26 hours.

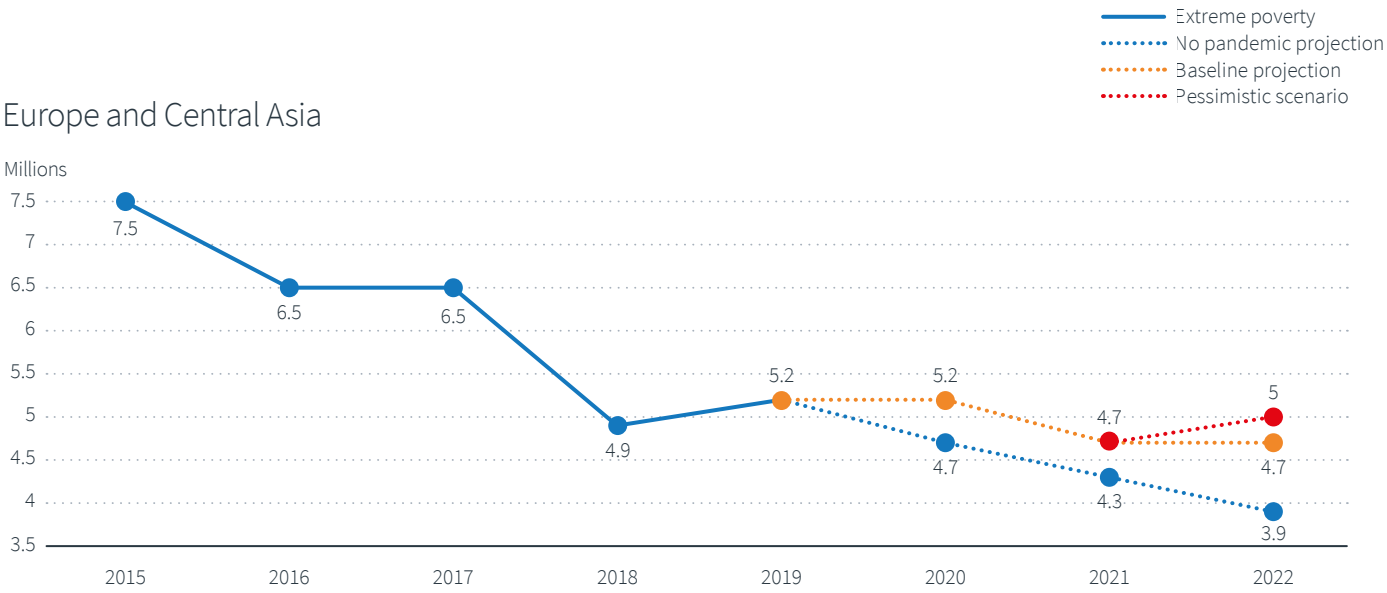
Extreme poverty for others

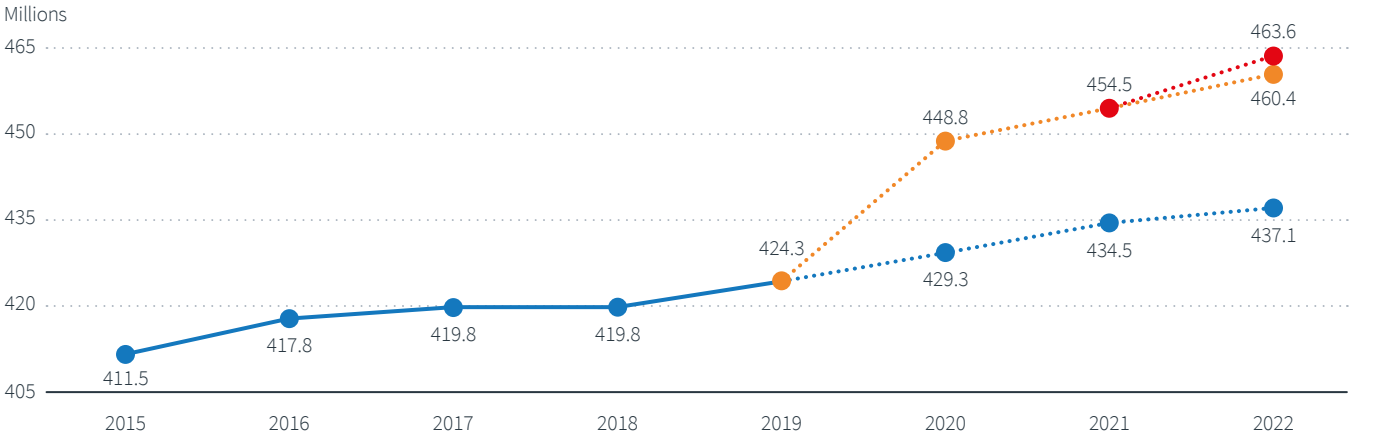
Living on less than $2 per day

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




Extreme poverty
No pandemic projection
Baseline projection
Pessimistic scenario
Europe and Central Asia
Millions
7.5
7
6.5
6
5.5
5
4.5
4
3.5
7.5
6.5
6.5
4.9
5.2
5.2
4.7
4.3
3.9
4.7
5
4.7
2015
2016
2017
2018
2019
2020
2021
2022

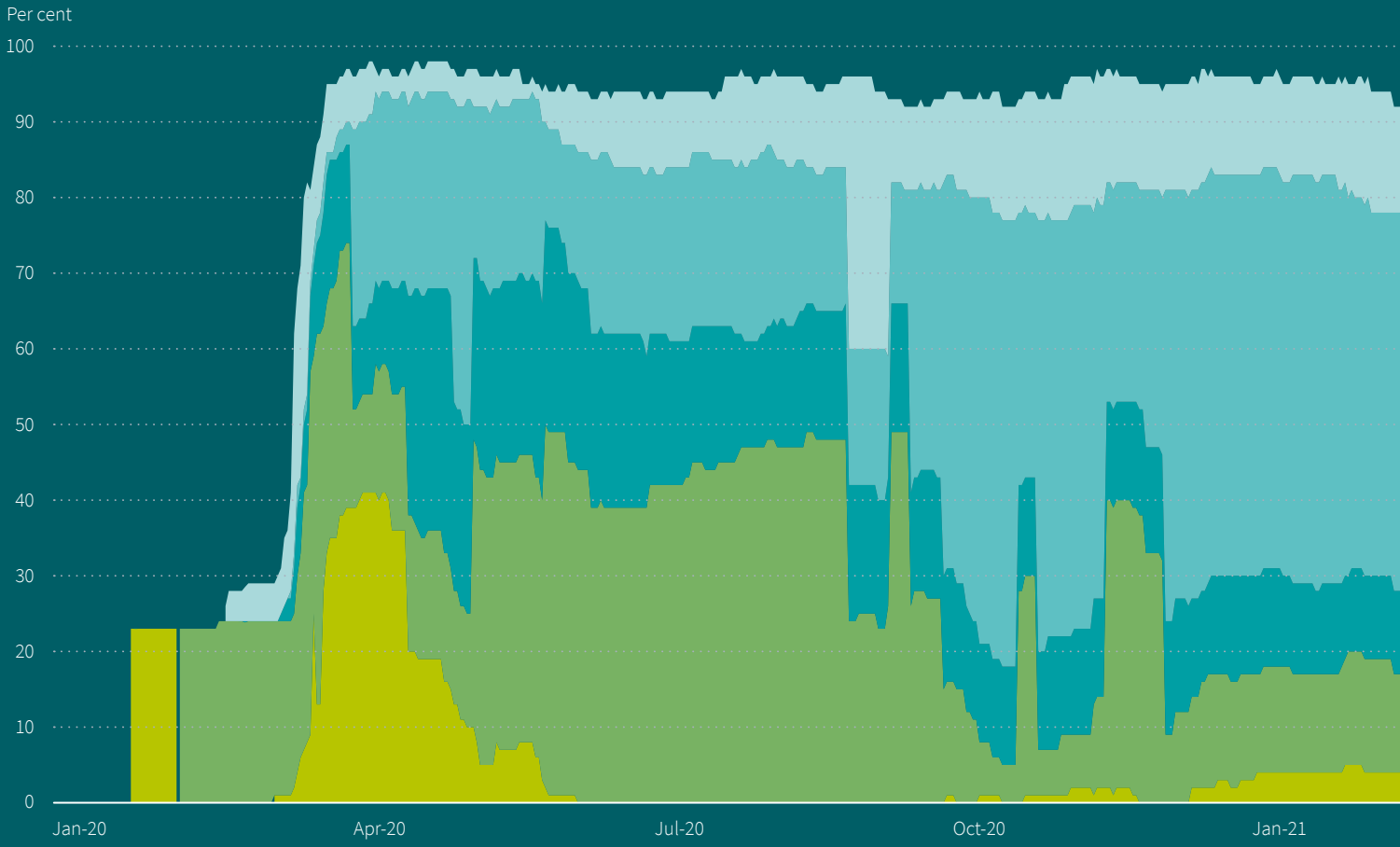

Sub-Saharan Africa
Millions
465
450
435
420
405
411.5
417.8
419.8
419.8
424.3
448.8
454.5
463.6
460.4
429.3
434.5
437.1
2015
2016
2017
2018
2019
2020
2021
2022

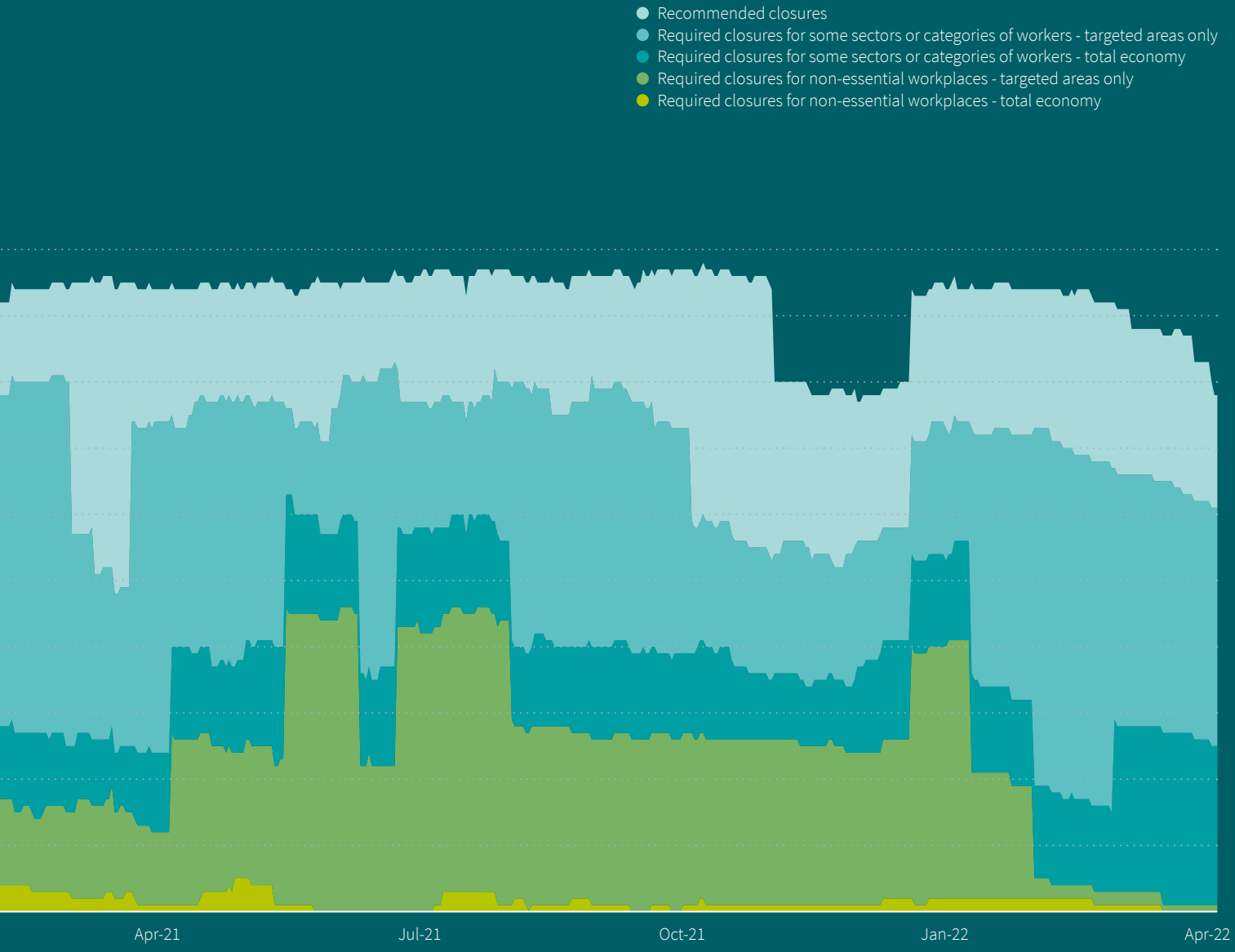
No escaping COVID-19

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

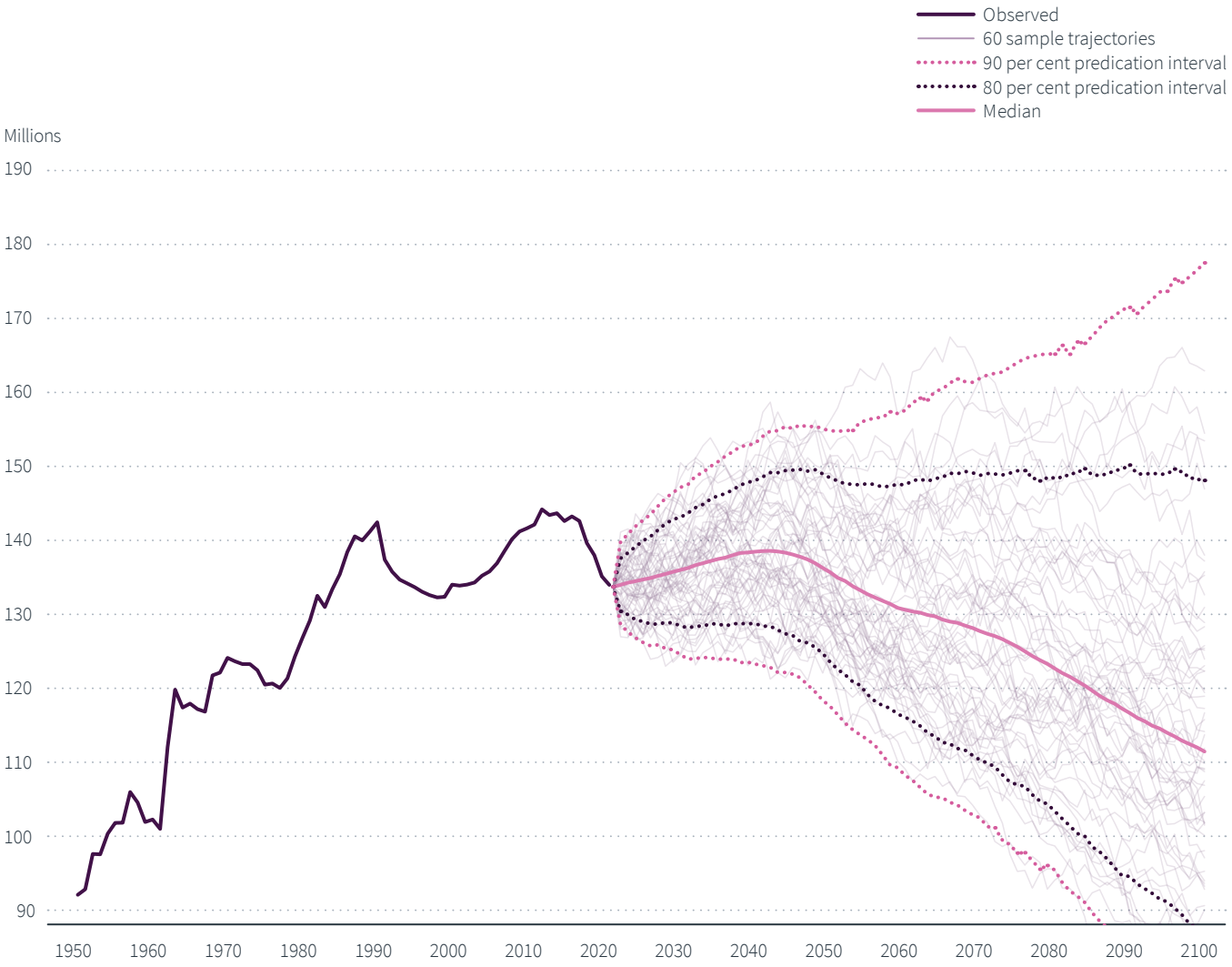



Recommended closures
Required closures for some sectors or categories of workers - targeted areas only
Required closures for some sectors or categories of workers - total economy
Required closures for non-essential workplaces - targeted areas only
Required closures for non-essential workplaces - total economy
Apr-21
Jul-21
Oct-21
Jan-22
Apr-22

The baby bust?

A junction for life on earth

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



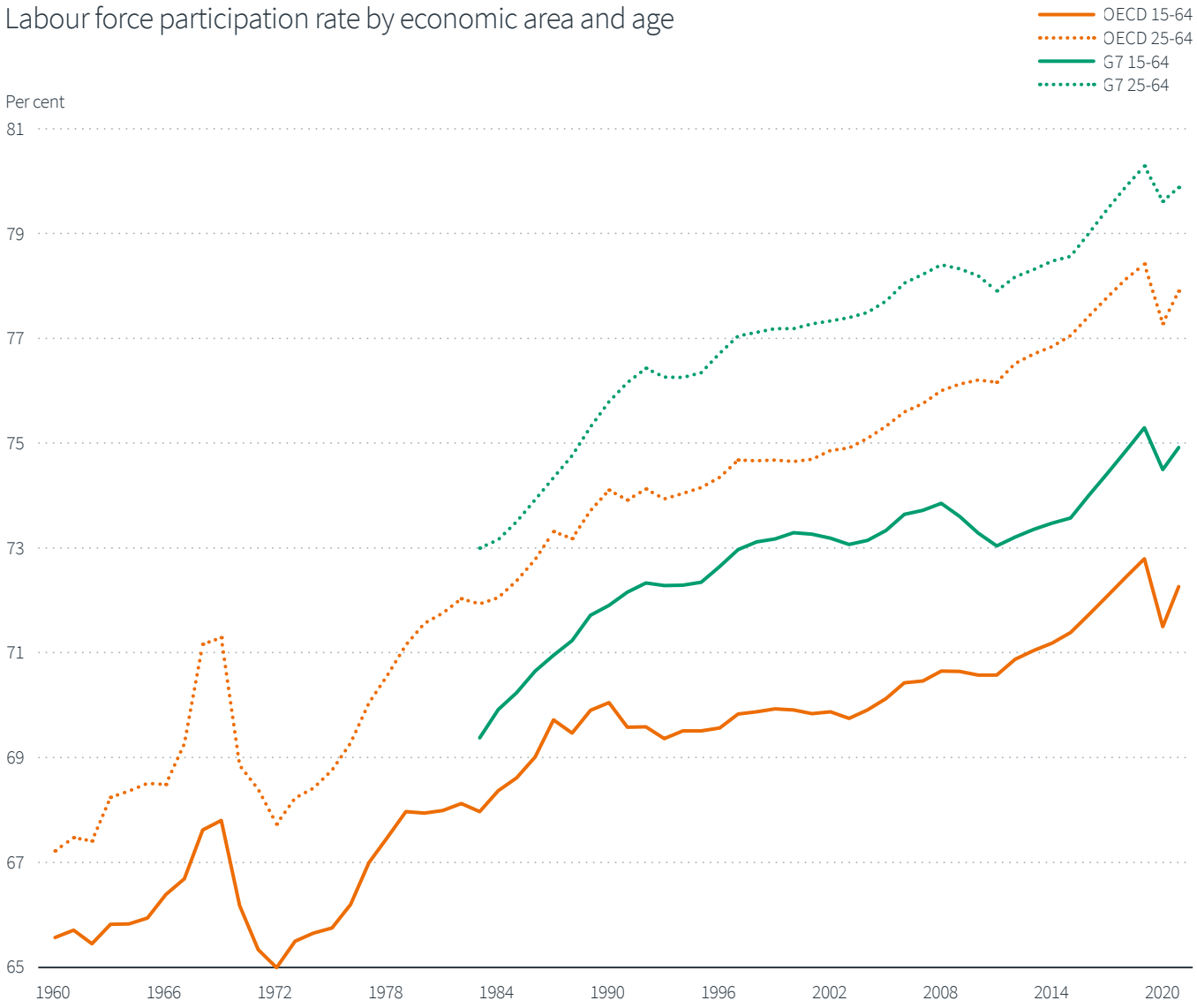
Population forecasting is hard. Pre-pandemic, global population growth was slowing across all income groups everywhere, with births in many high- and upper-middle-income countries below replacement rates. Now areas that experienced rigid lockdowns are reporting births slumping, which could take the population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

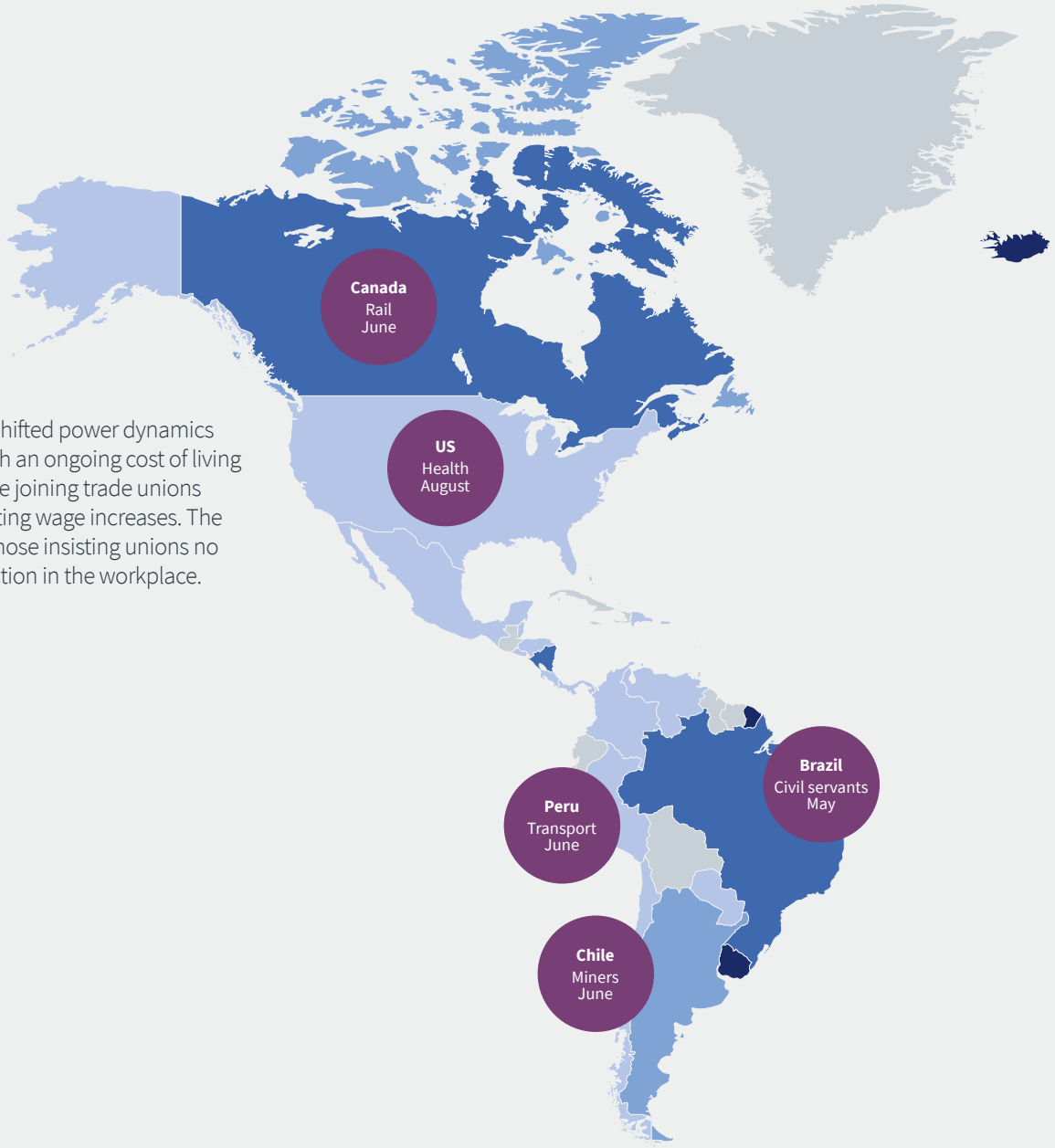
Labour force participation rate by economic area and age



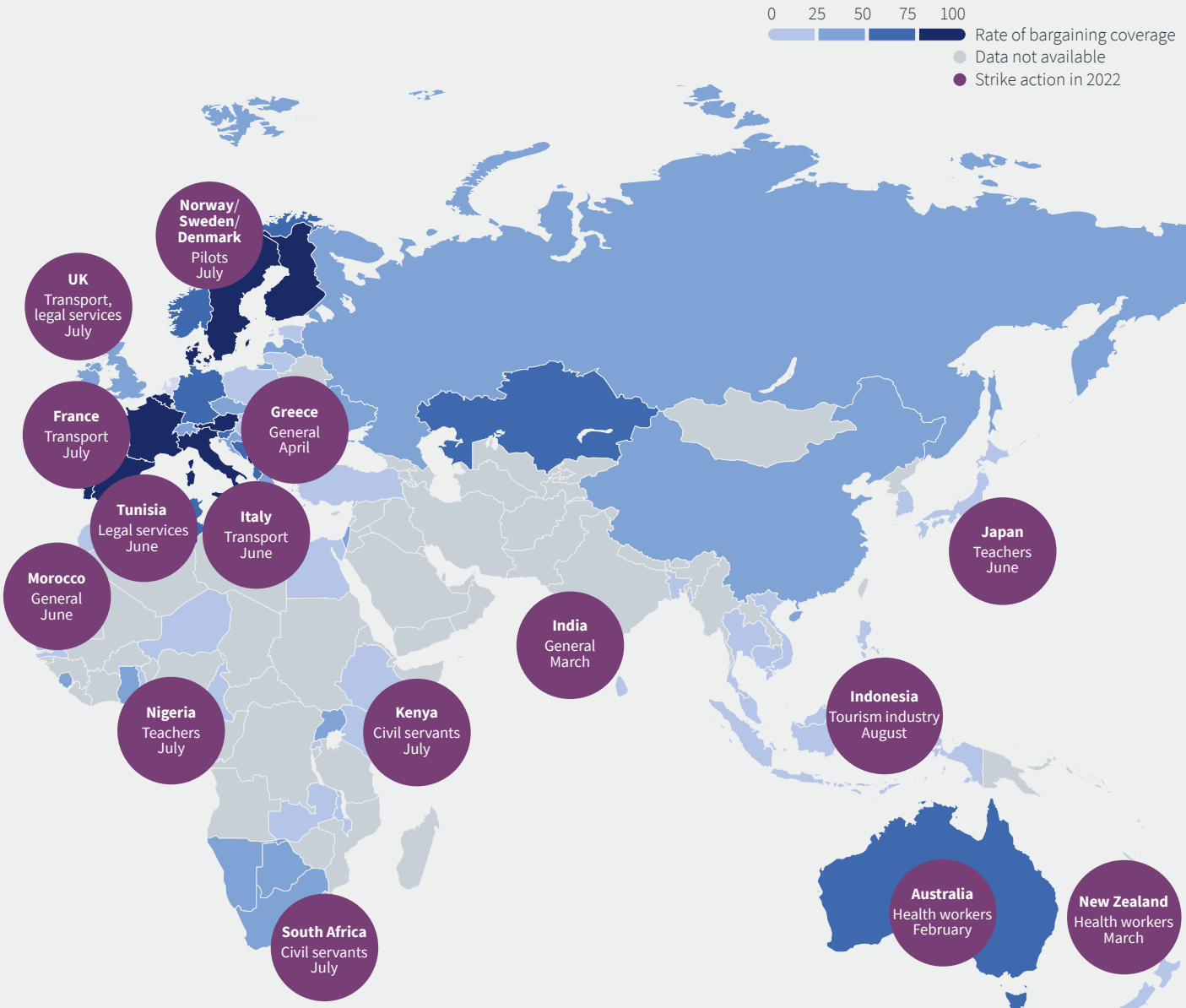
Collective bargaining is back

Unions trigger strike action

Percentage of bargaining coverage and selected coordinated strike action



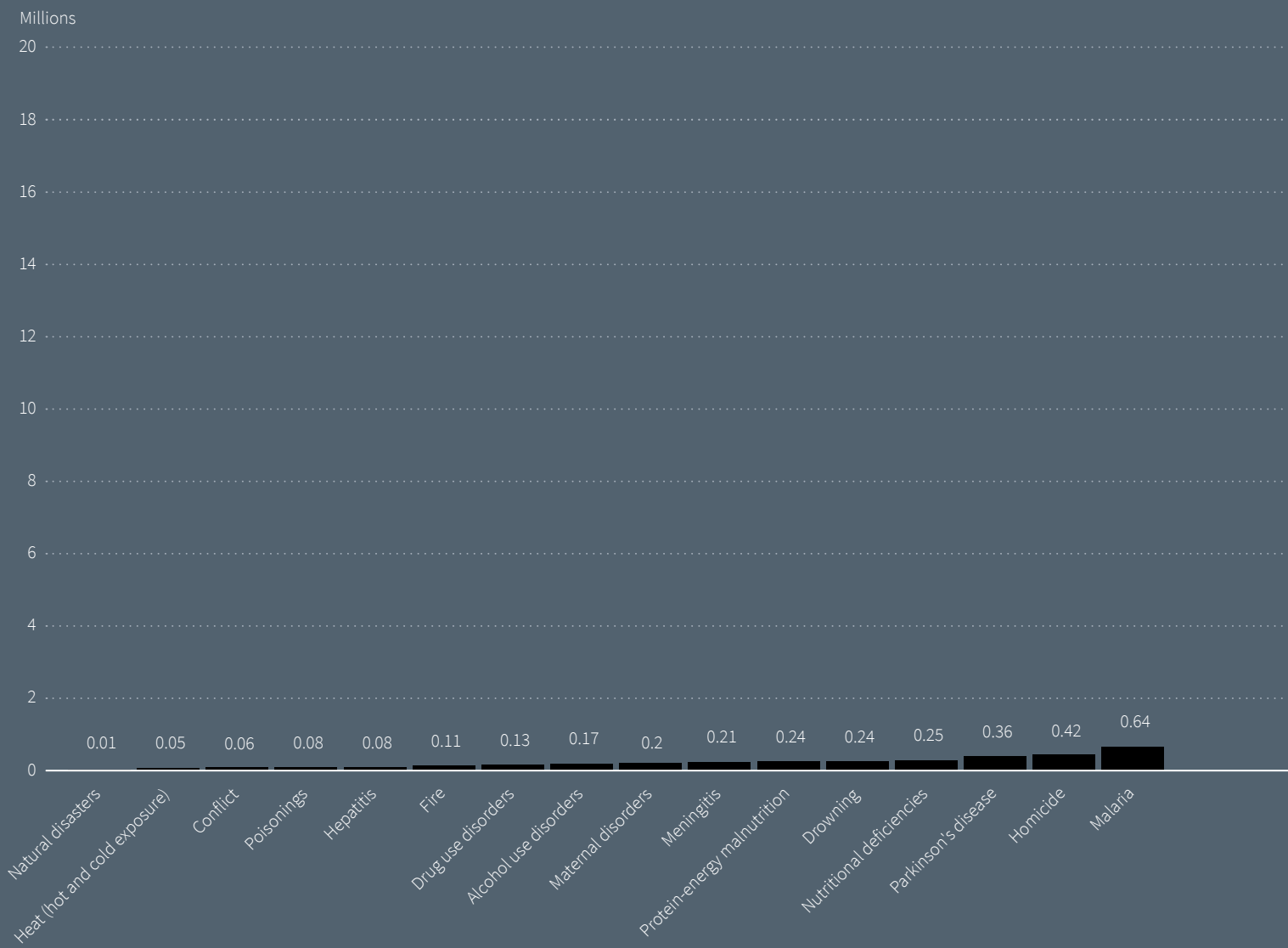
A shortage of talent has shifted power dynamics in the labour market. With an ongoing cost of living squeeze, more people are joining trade unions to press for inflation-busting wage increases. The strikes have blindsided those insisting unions no longer have a useful function in the workplace.

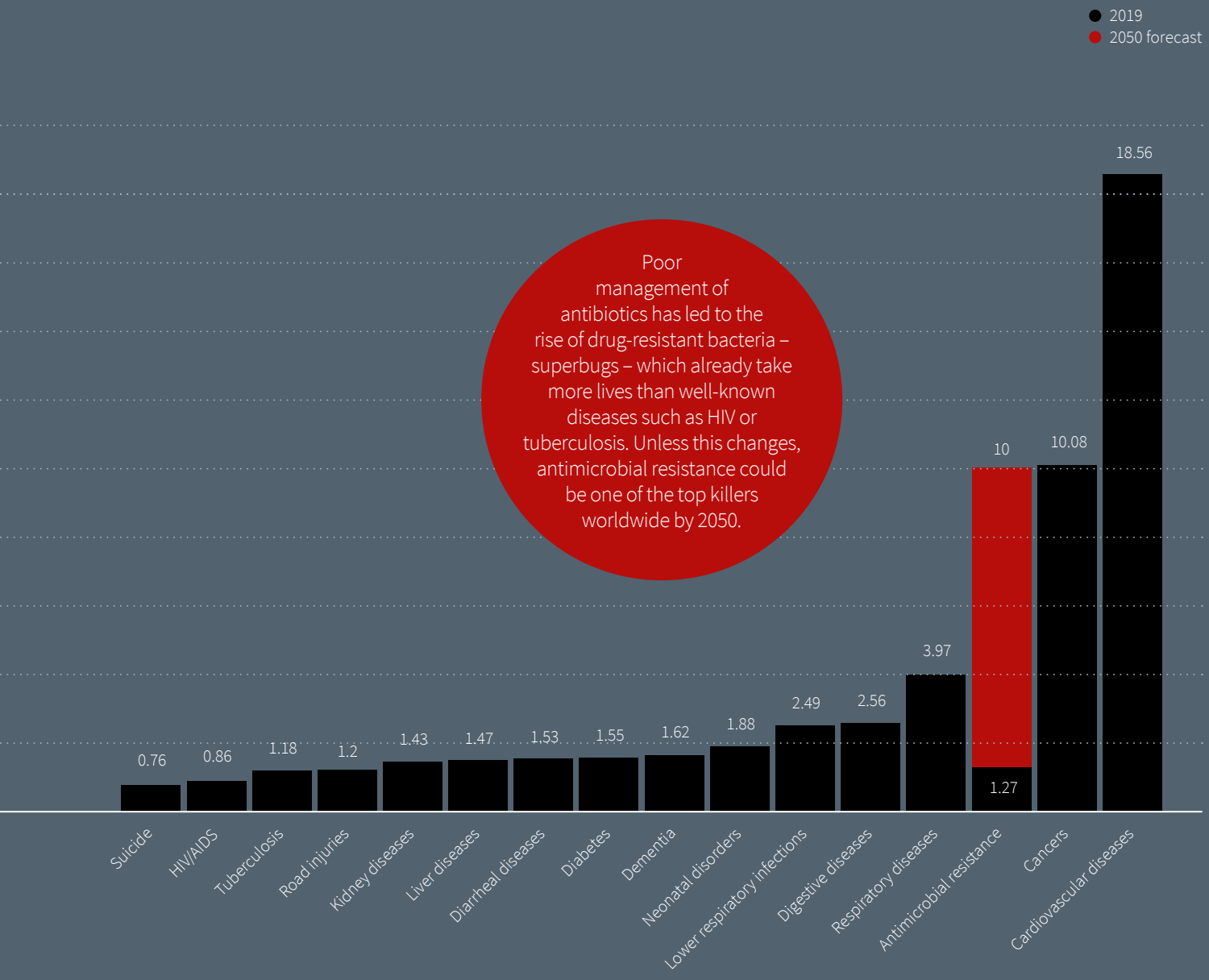

0 25 50 75 100
Rate of bargaining coverage
Data not available
Strike action in 2022
Norway/ Sweden/ Denmark
Pilots
July
UK
Transport, legal services
July
France
Transport
July
Greece
General
April
Tunisia
Legal services
June
Italy
Transport
June
Morocco
General
June
Nigeria
Teachers
July
Kenya
Civil servants
July
South Africa
Civil servants
July
India
General
March
Japan
Teachers
June
Indonesia
Tourism industry
August
Australia
Health workers
February
New Zealand
Health workers
March

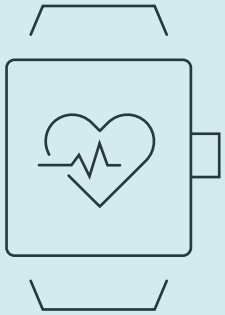
Drugs and superbugs

Deaths from antimicrobial resistance compared with other mortality factors

Number of deaths by cause




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.
0.76
0.86
1.18
1.2
1.43
1.47
1.53
1.55
1.62
1.88
2.49
2.56
3.97
10
1.27
10.08
18.56
Suicide
HIV/AIDS
Tuberculosis
Road injuries
Kidney diseases
Liver diseases
Diarrheal diseases
Diabetes
Dementia
Neonatal disorders
Lower respiratory infections
Digestive diseases
Respiratory diseases
Antimicrobial resistance
Cancers
Cardiovascular diseases

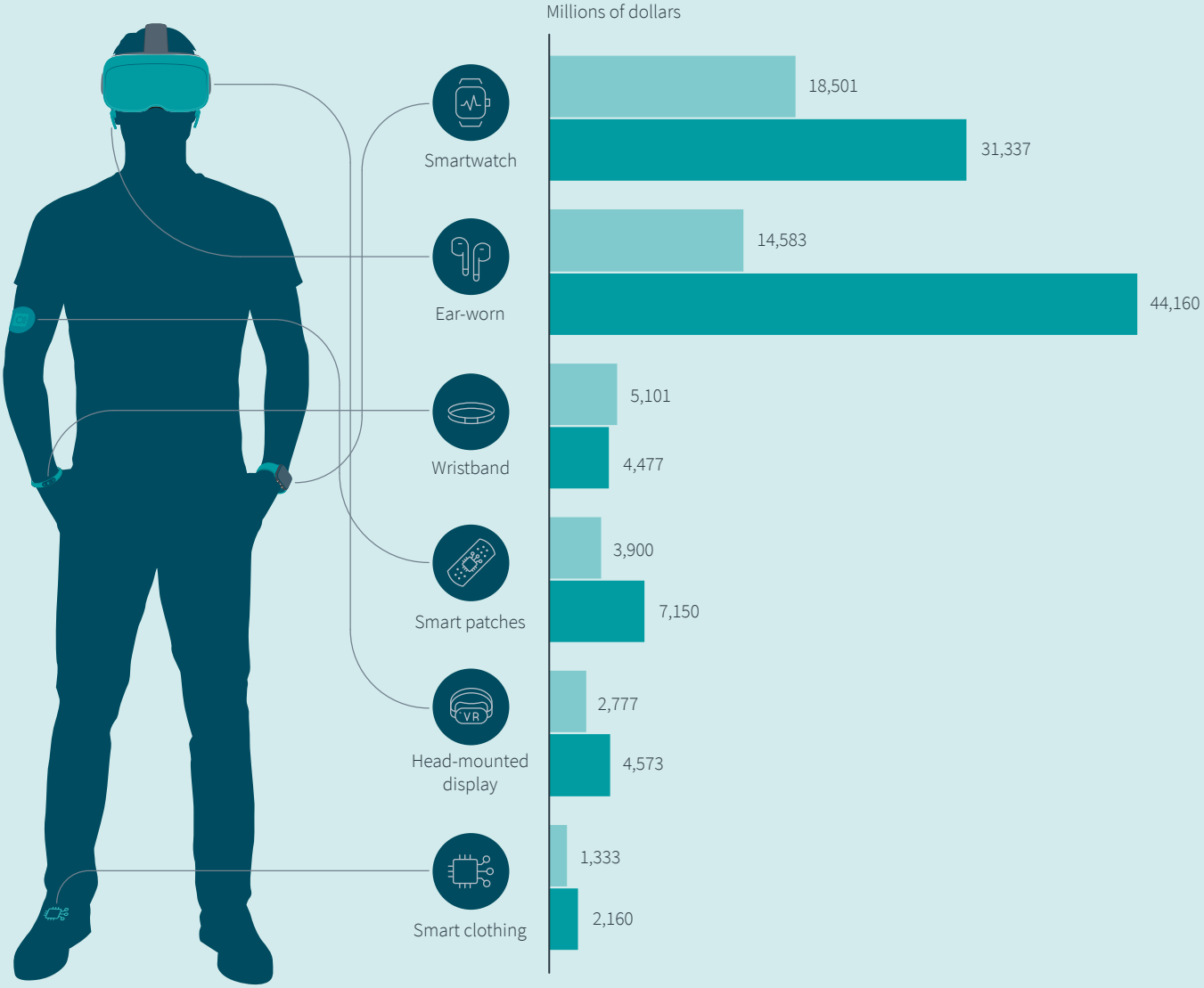


Interest in wearable devices that deliver information on essentials like heart rate, blood pressure and sleep continues to grow. It's a small step towards the next healthcare industry goal: personalised medicine.

Taking control

Monitoring personalised health information

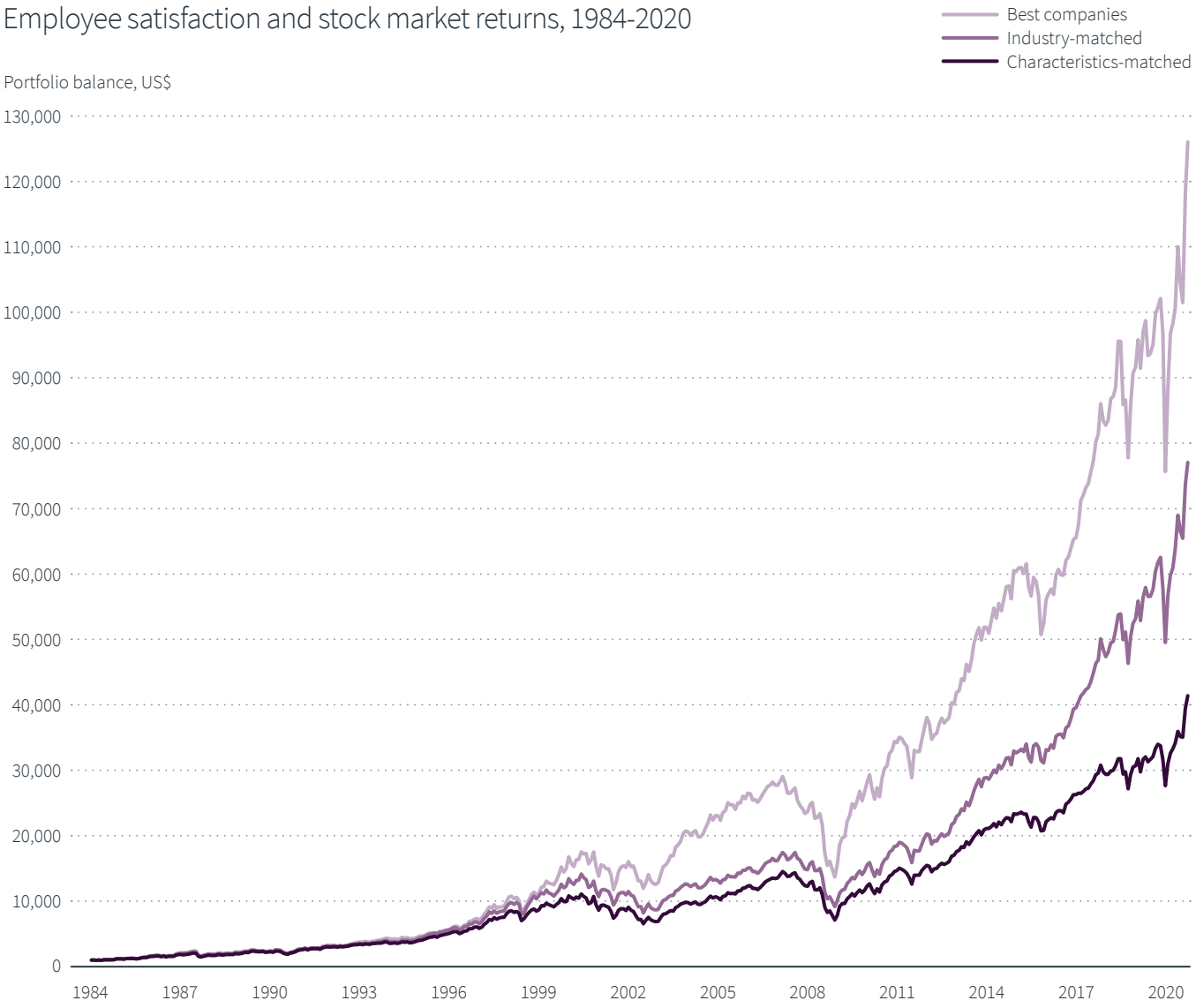
Worldwide wearable devices end-user spending



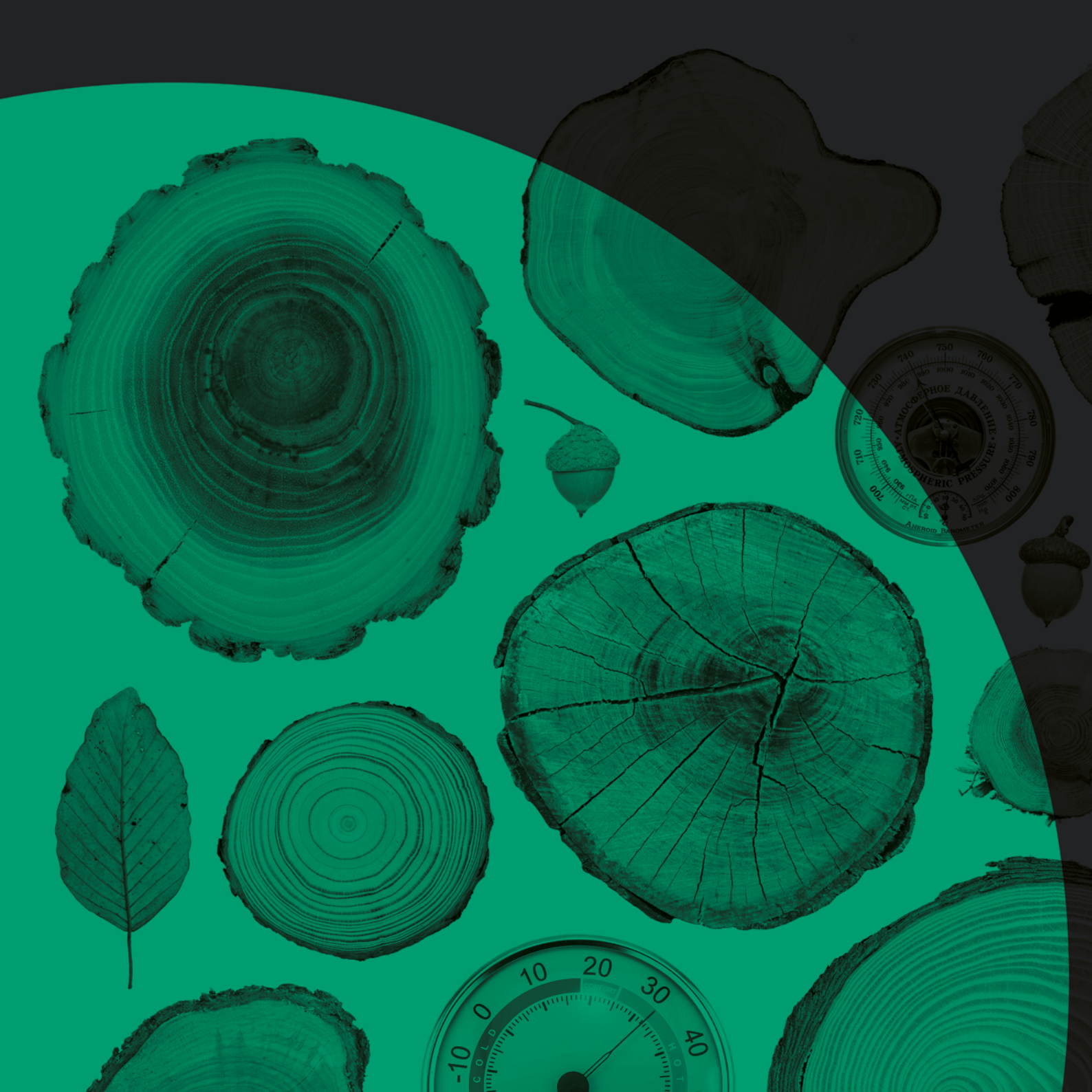
Fair's fair

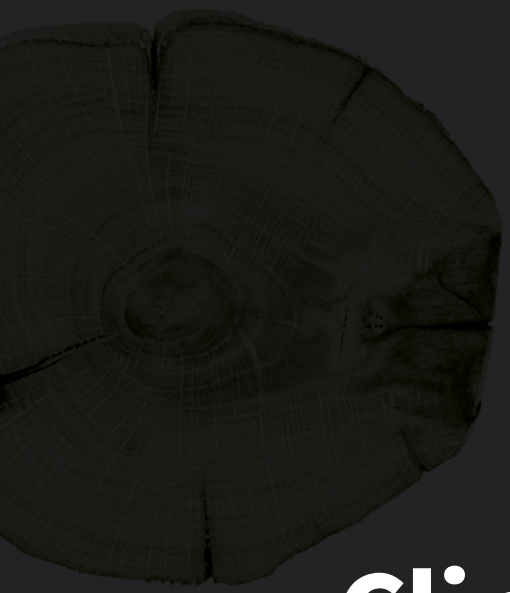
Could better treatment in the workplace be a win-win?

Employee satisfaction and stock market returns, 1984-2020



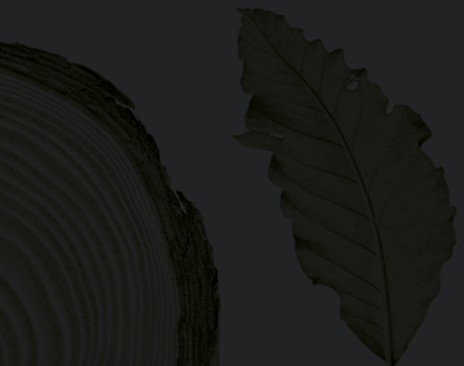
Happy employees may be more productive ones, suggests research from Hamid Boustanifar and Young Dae Kang. Their study of US companies ranked among *Fortune* magazine's Best Places to Work between 1984 and 2020 showed these firms consistently generated excess returns and fared particularly well during crises.


АТМОСФЕРНОЕ ДАВЛЕНИЕ
ATMOSPHERIC PRESSURE
ANEROID BAROMETER
-10
0
10
20
30
40
COLD
HOT



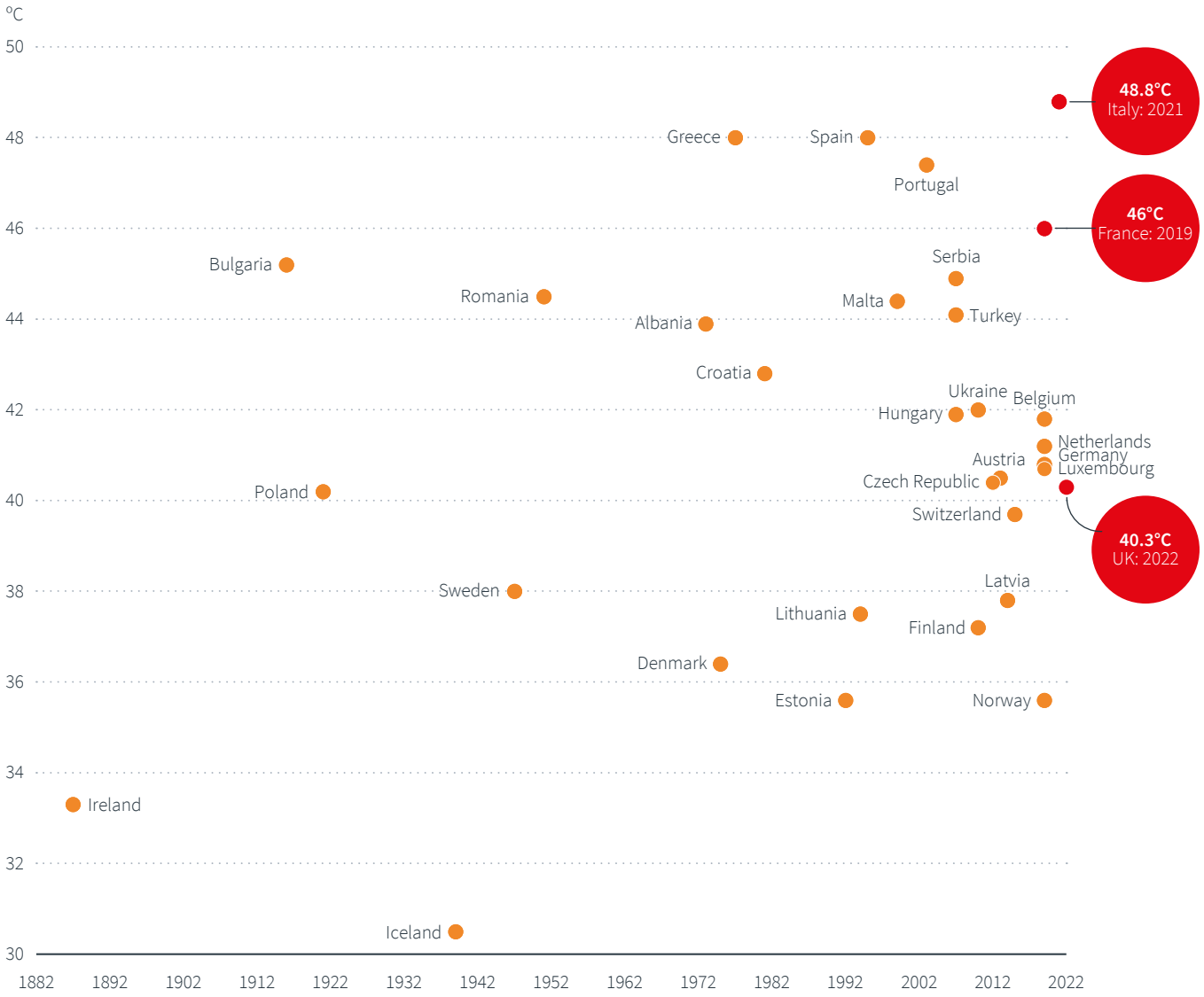
Climate

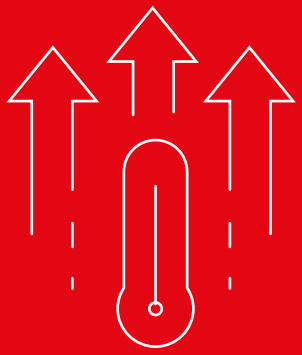
As temperatures and natural disasters surge, make no mistake: this is an emergency



Mercury rising

Record high temperatures in Europe





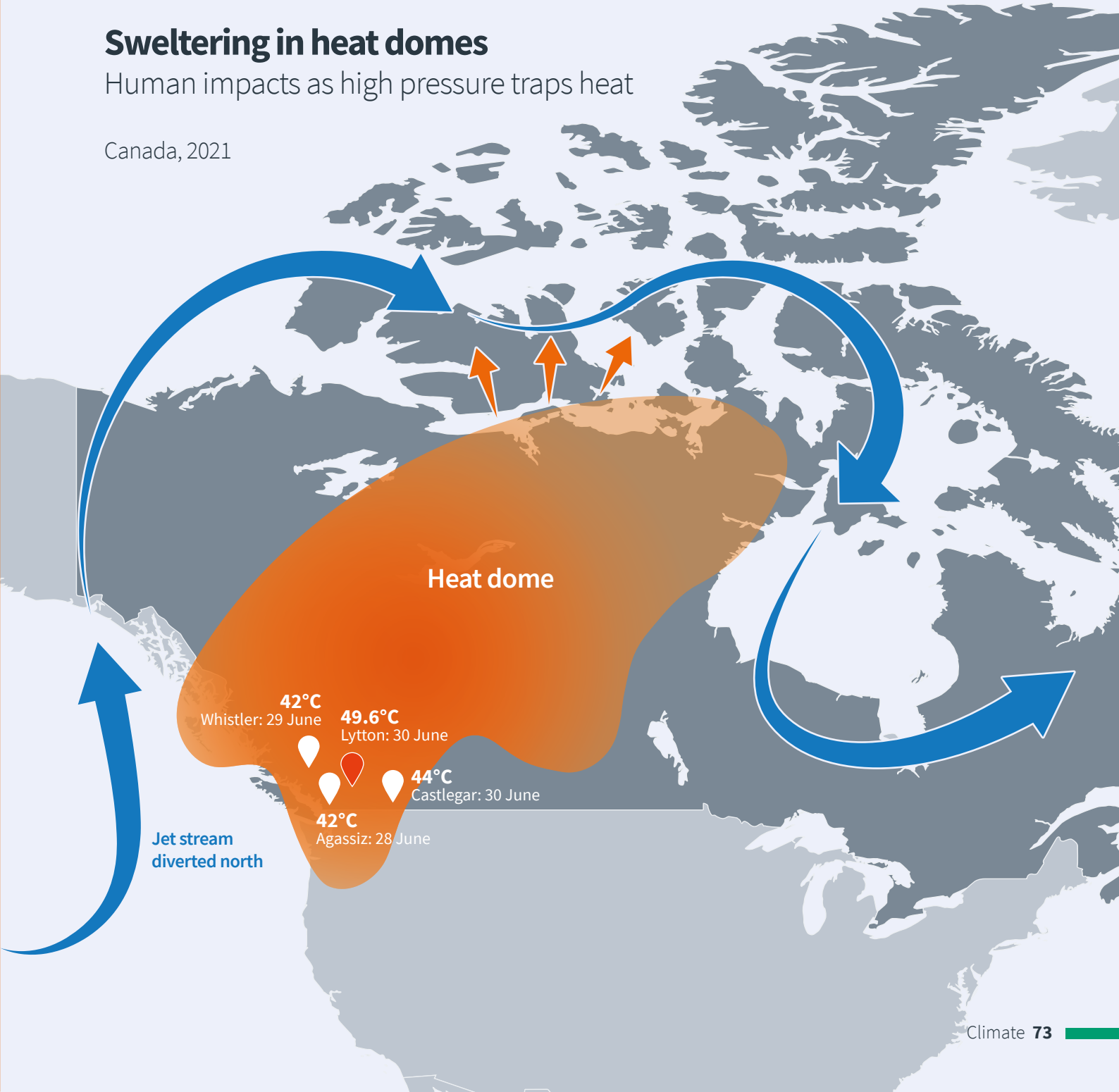
Climate change is leading to more frequent and extreme heatwaves across Europe: 19 countries have hit record high temperatures over the last decade, and ten since 2019.

One phenomenon contributing to higher temperatures is the formation of heat domes, which occur when heat is trapped by a layer of atmospheric high pressure. The heat dome that formed over Canada and the US in 2021 sent northerly temperatures in excess of 40°C over 100 times.

Sweltering in heat domes

Human impacts as high pressure traps heat

Canada, 2021

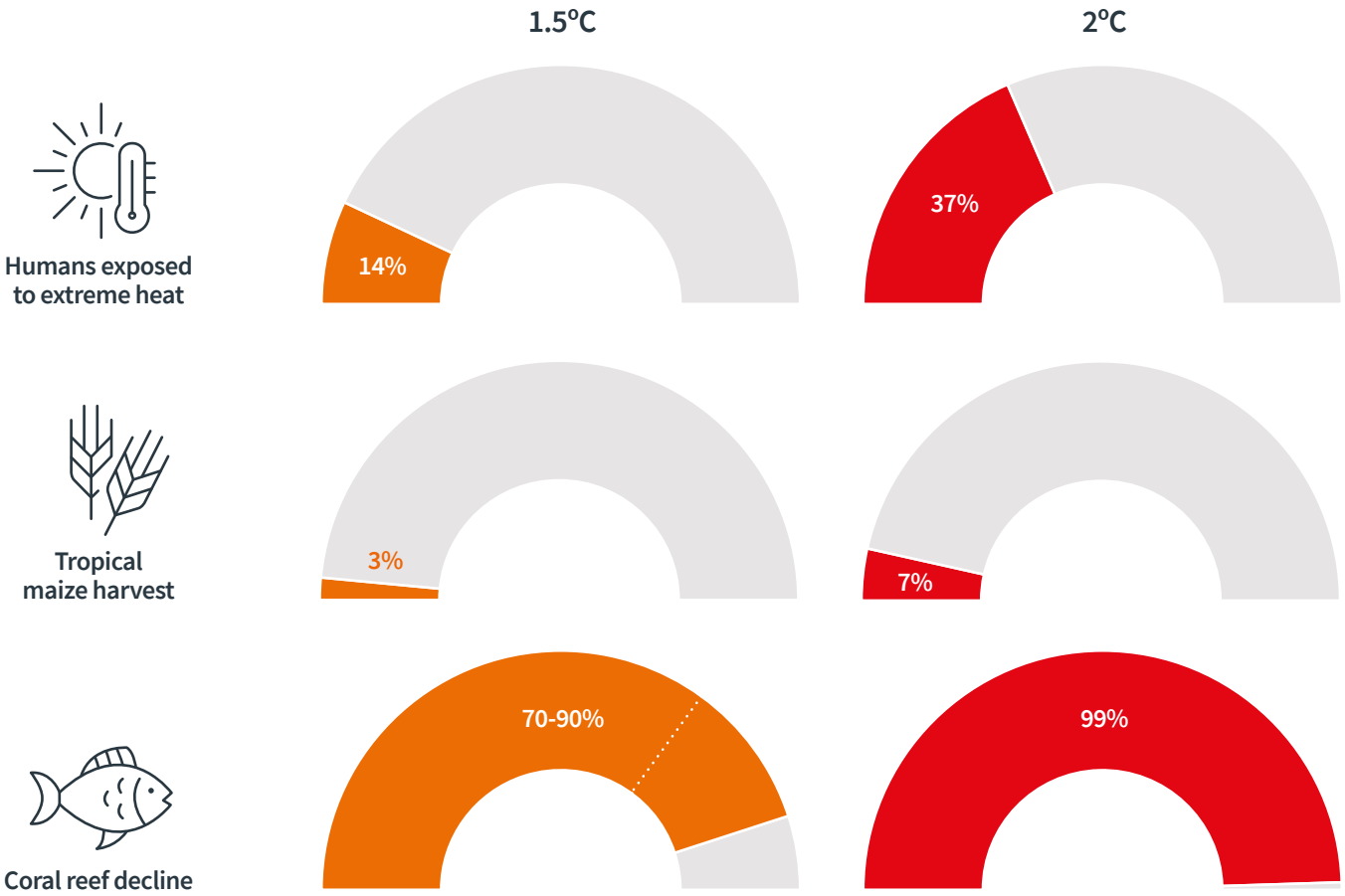


Small number, big impact

Why 0.5°C makes a world of difference

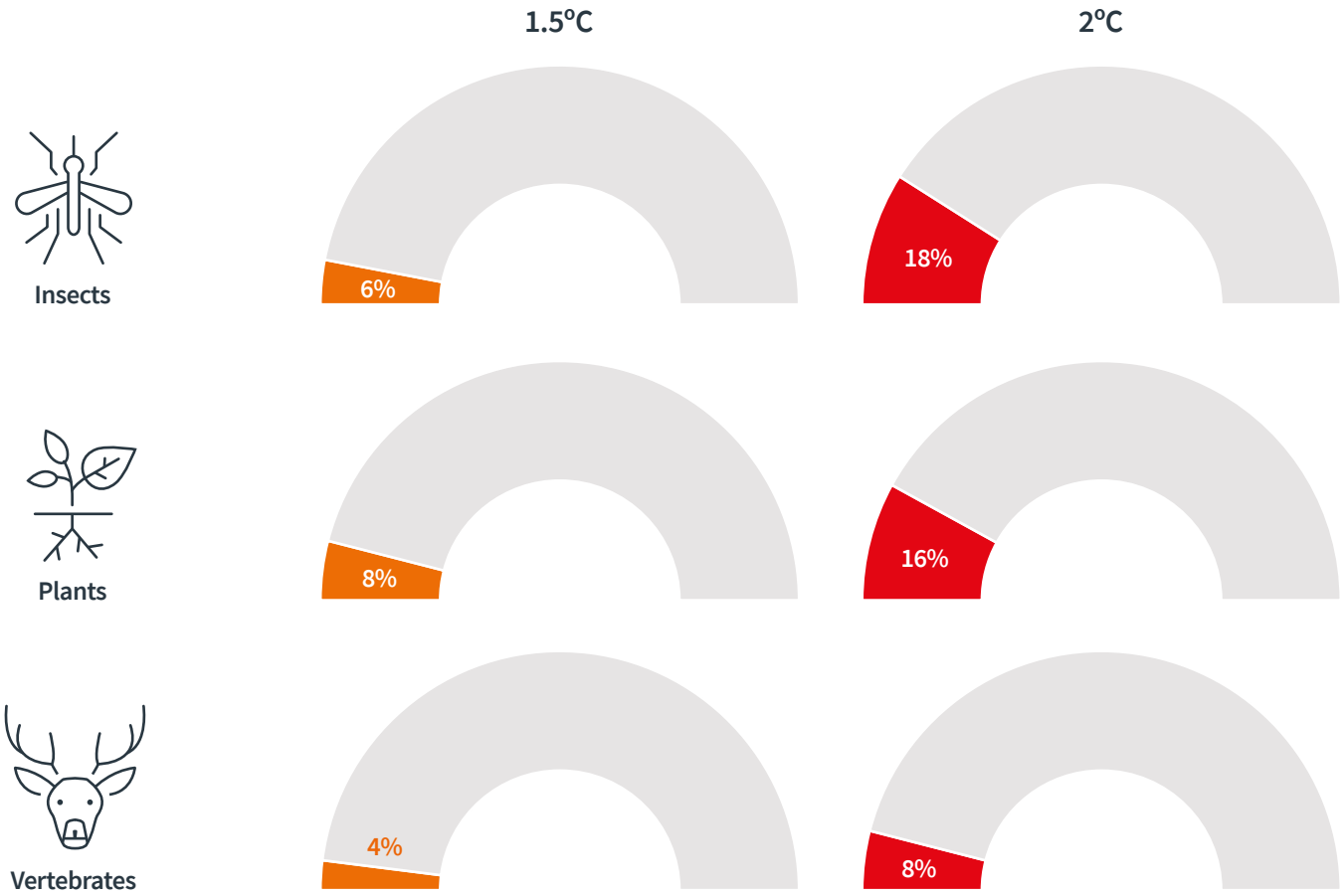
What difference might a 0.5-degree increase in average global temperatures make? How hard should we strive to cap the increase? These are questions for everyone. Contributors to the IPCC have grappled with them and concluded a small headline difference might change things a lot. In the frame: the resilience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

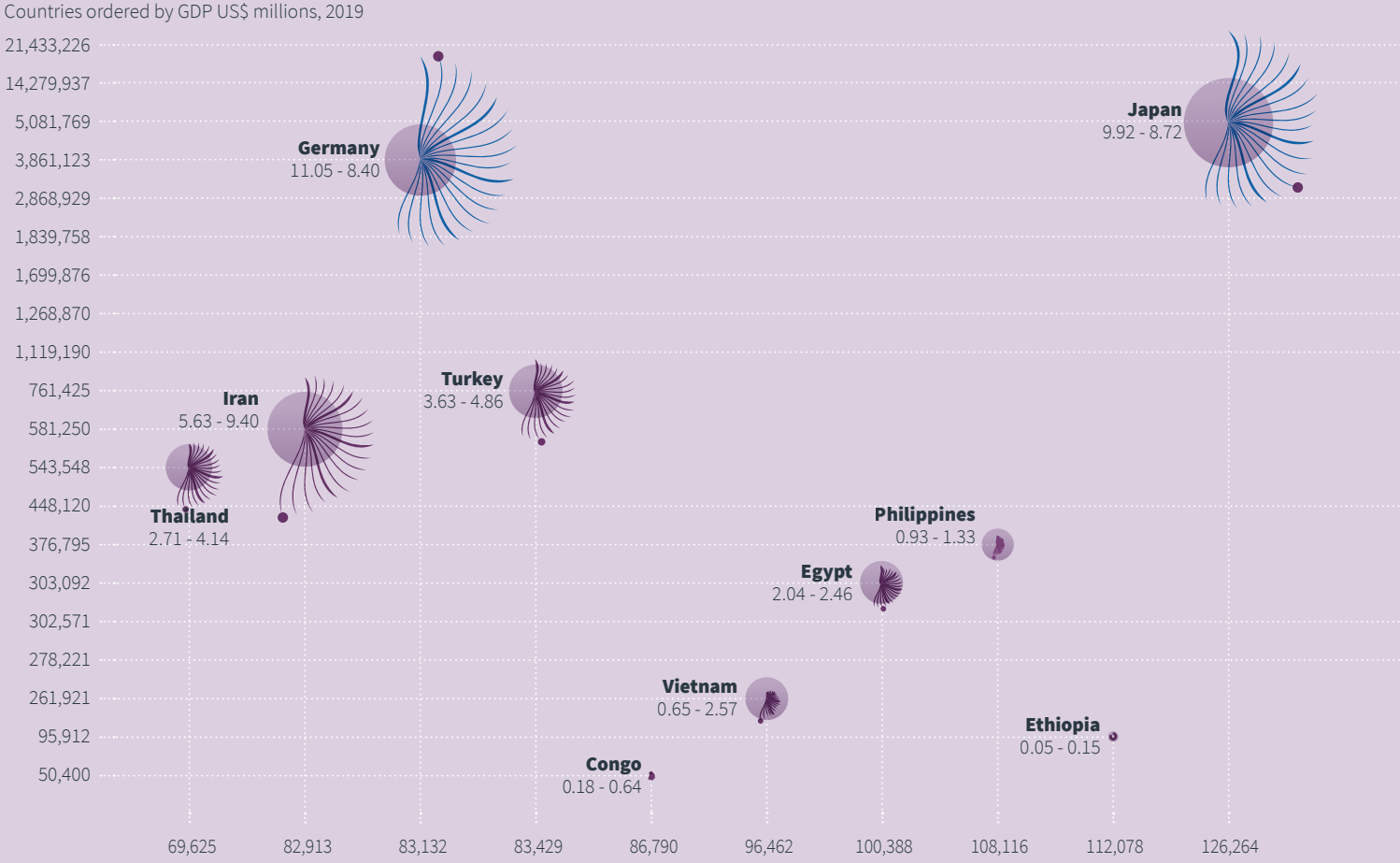


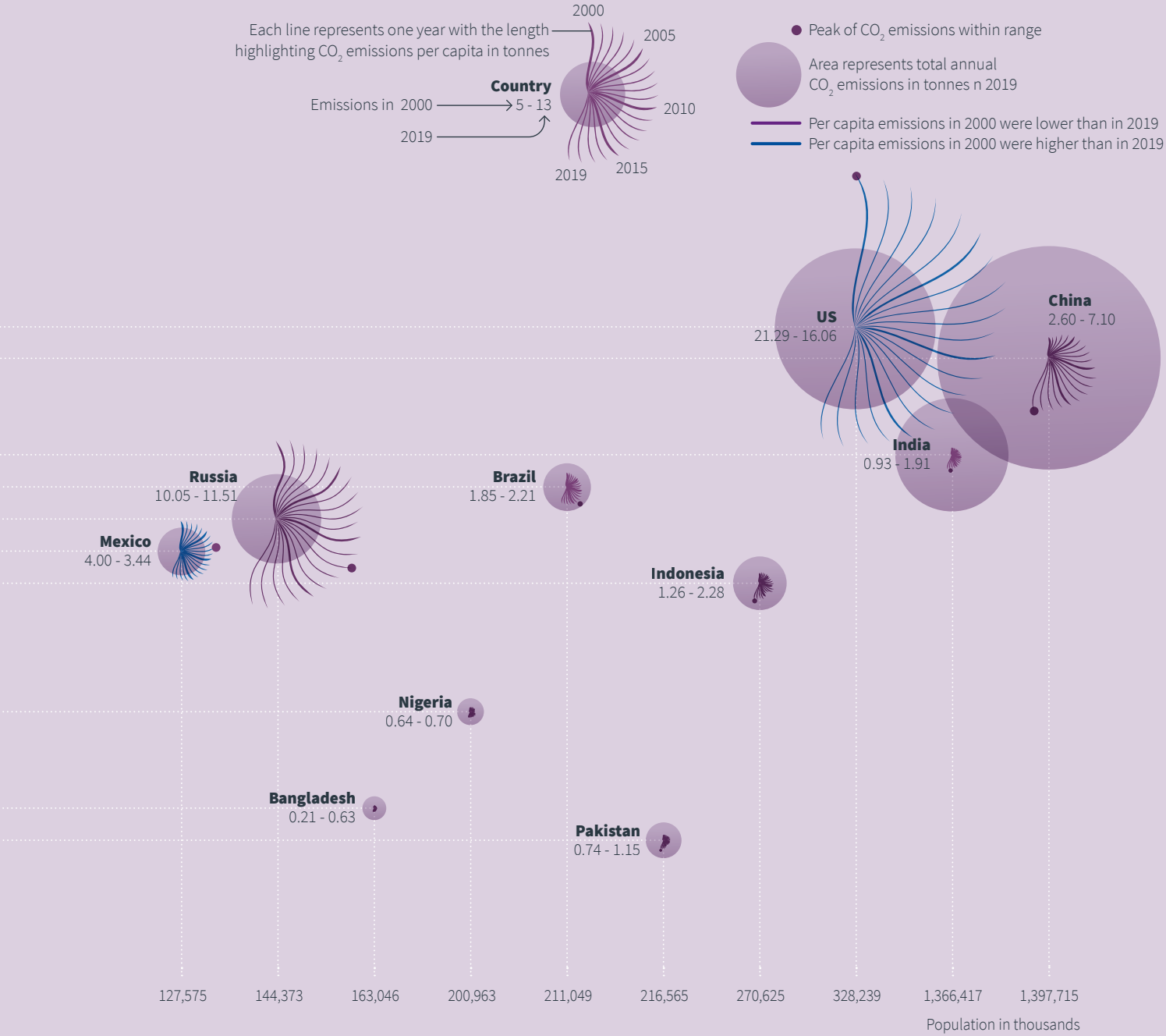
Who are the giant polluters?

Contemplating scale and emissions trajectory

The visualisation shows data on total annual and per capita CO_2 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 CO_2 emissions) to 20+ (high per capita CO_2 emissions).

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



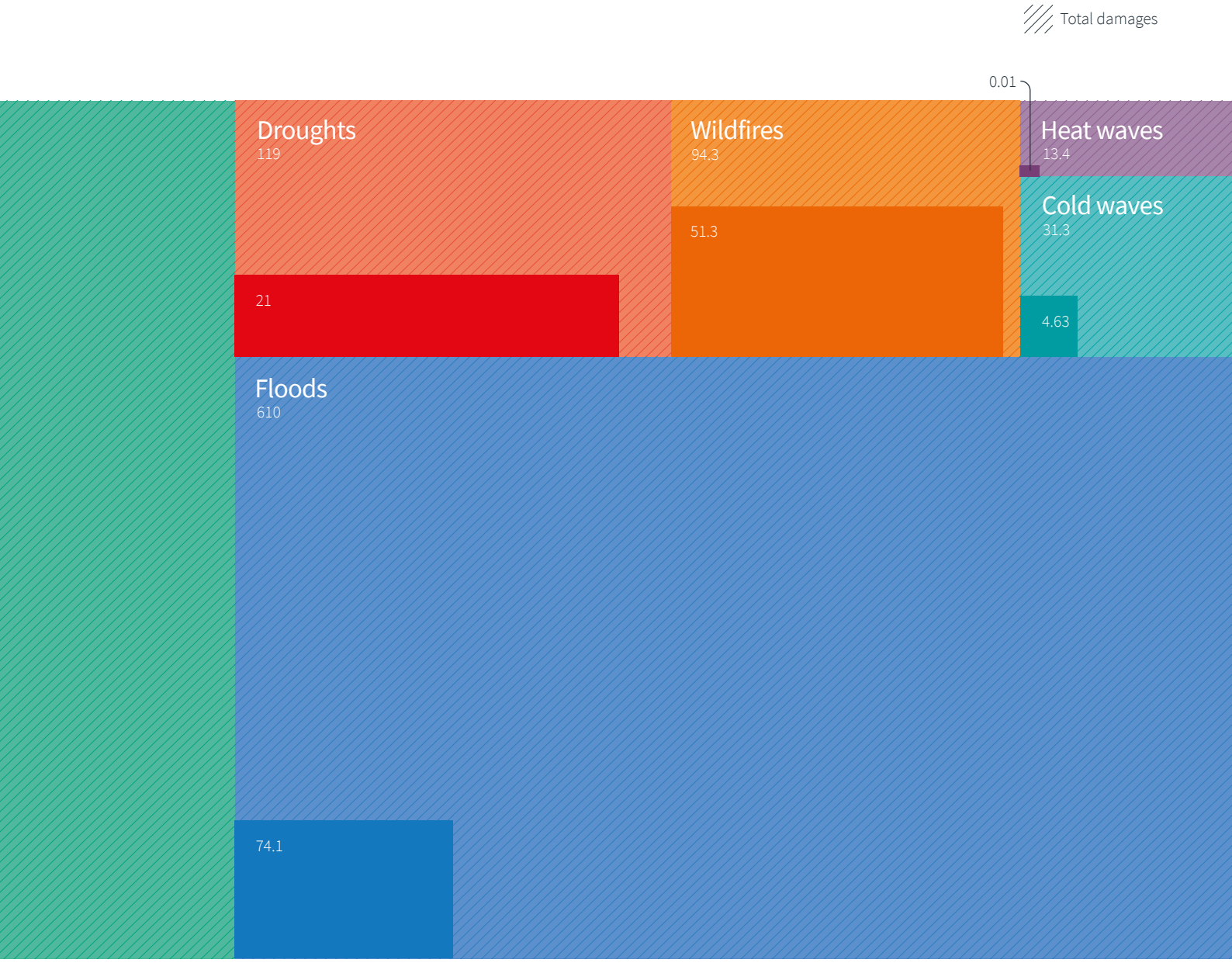

Each line represents one year with the length highlighting CO_2 emissions per capita in tonnes
2000
2005
2010
2015
2019
Country
Emissions in 2000
5 - 13
2019
Peak of CO_2 emissions within range
Area represents total annual CO_2 emissions in tonnes n 2019
Per capita emissions in 2000 were lower than in 2019
Per capita emissions in 2000 were higher than in 2019
US
21.29 - 16.06
China
2.60 - 7.10
India
0.93 - 1.91
Russia
10.05 - 11.51
Brazil
1.85 - 2.21
Mexico
4.00 - 3.44
Indonesia
1.26 - 2.28
Nigeria
0.64 - 0.70
Bangladesh
0.21 - 0.63
Pakistan
0.74 - 1.15
127,575
144,373
163,046
200,963
211,049
216,565
270,625
328,239
1,366,417
1,397,715
Population in thousands

Acts of God or consequences of man?

Extent of protection from extreme climate events

Insured and total damages, 2000-2022

US$ billions

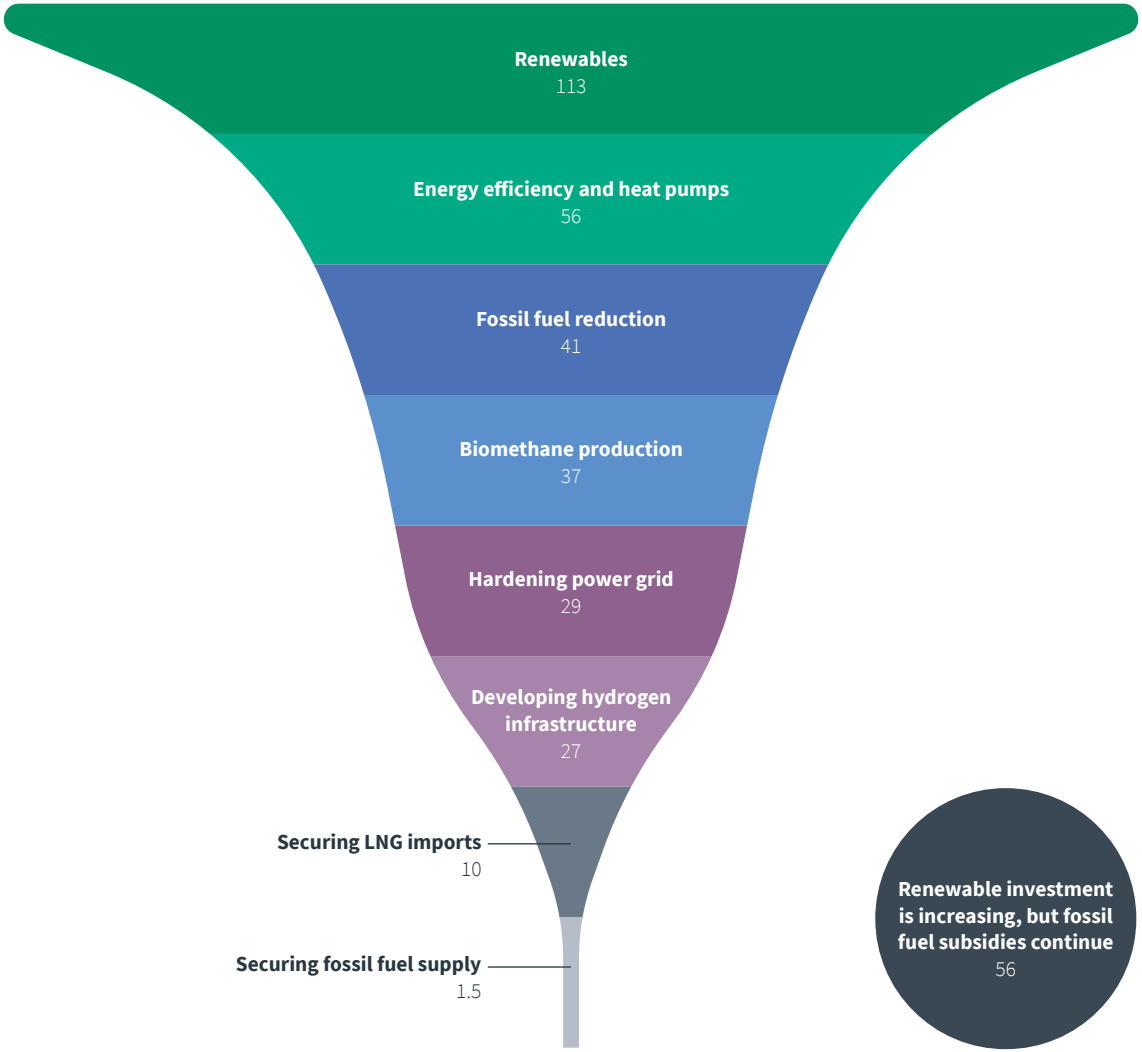

Total damages
0.01
Droughts
119
Wildfires
94.3
Heat waves
13.4
Cold waves
31.3
51.3
21
4.63
Floods
610
74.1

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

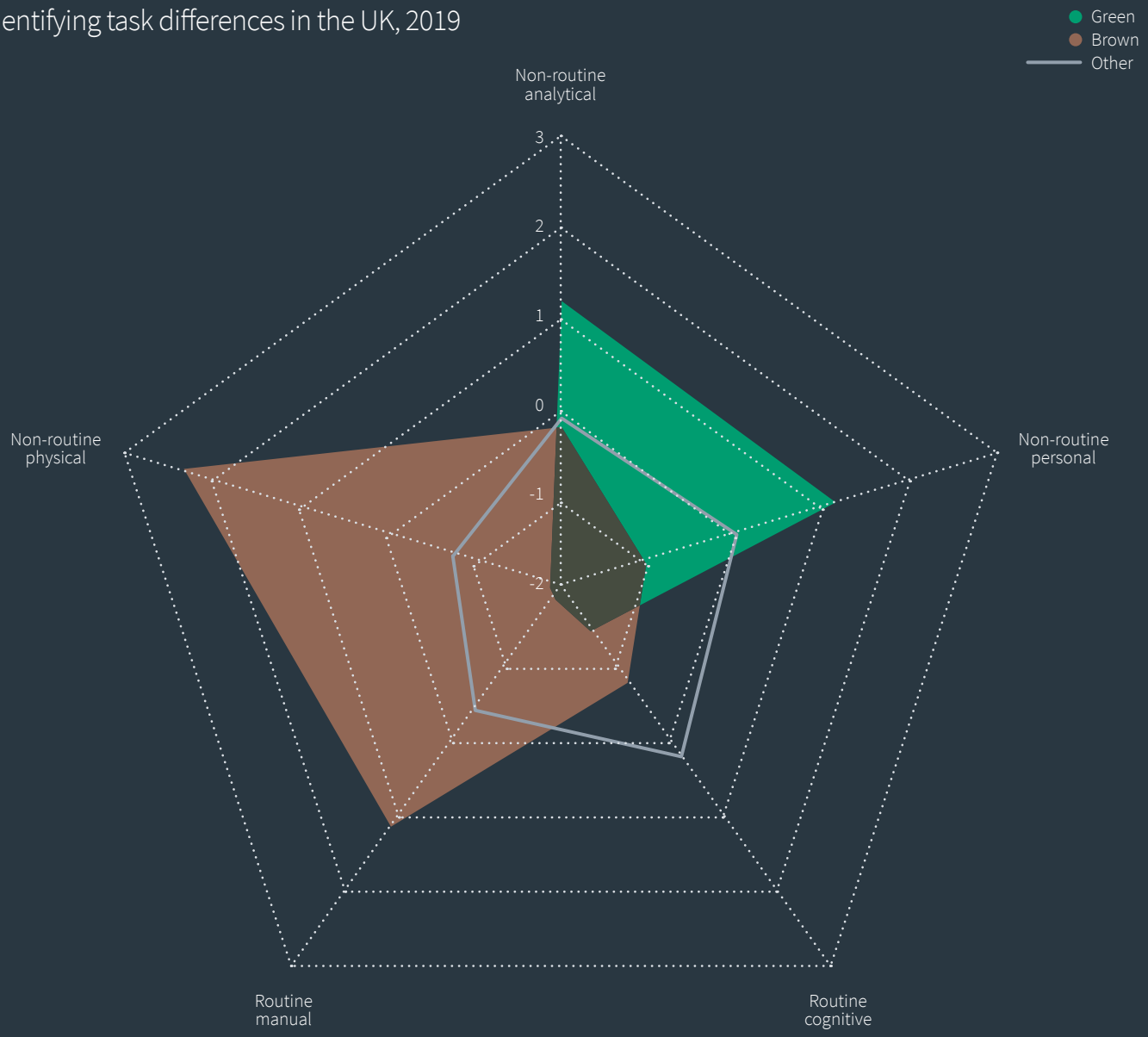
REPowerEU strategic investment target, 2027-2030 (€bn)



The world of work is changing

Assessing the nature of green and brown jobs

Identifying task differences in the UK, 2019

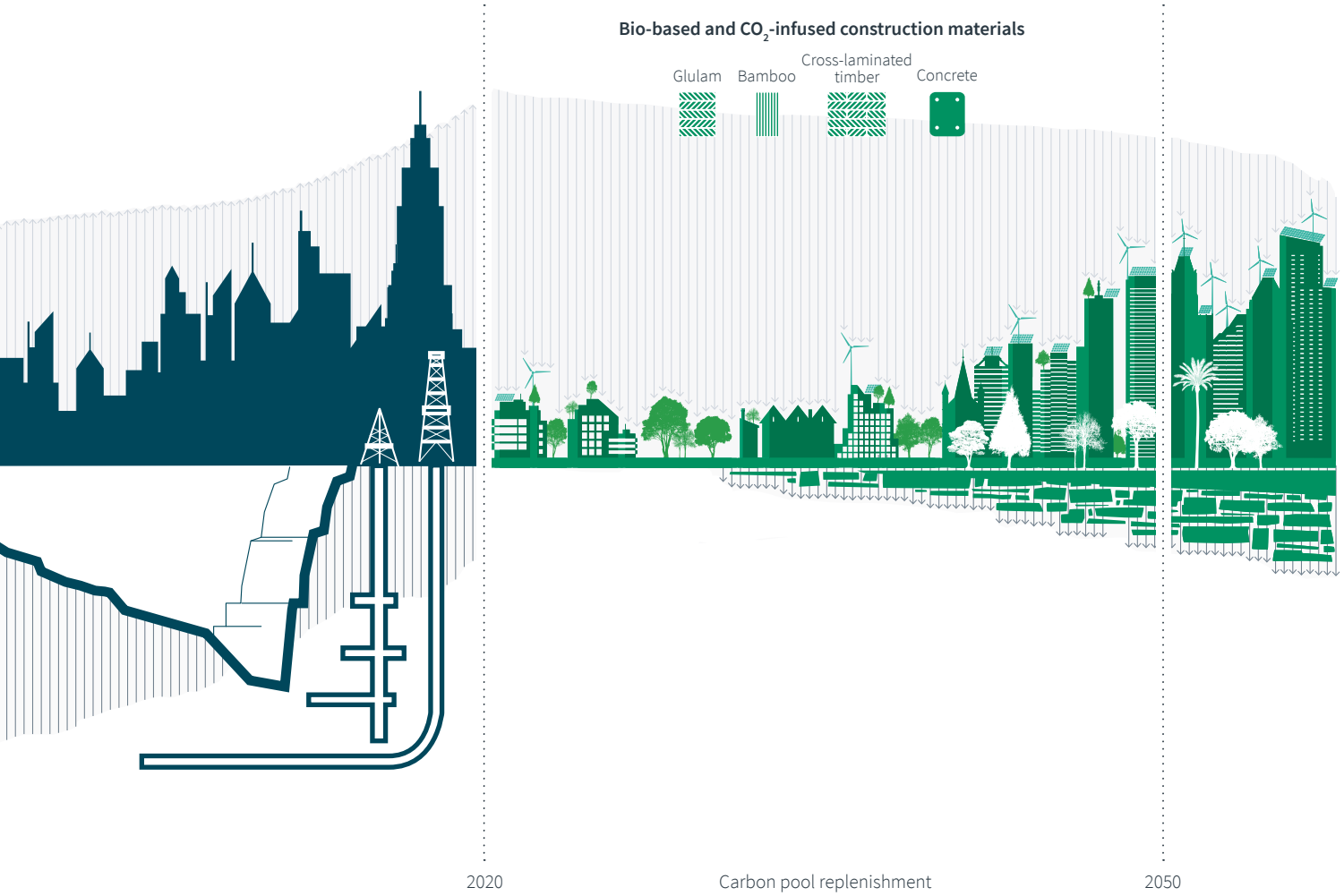


What could the energy transition mean for the job market? There will be growth in some sectors and contraction in others, but employment in many industries will not fit neatly into a binary ‘green or brown’ classification. Instead, it might be helpful to think about how the nature of work could change.

Rethinking the carbon cycle

Sustainable building materials could trap carbon

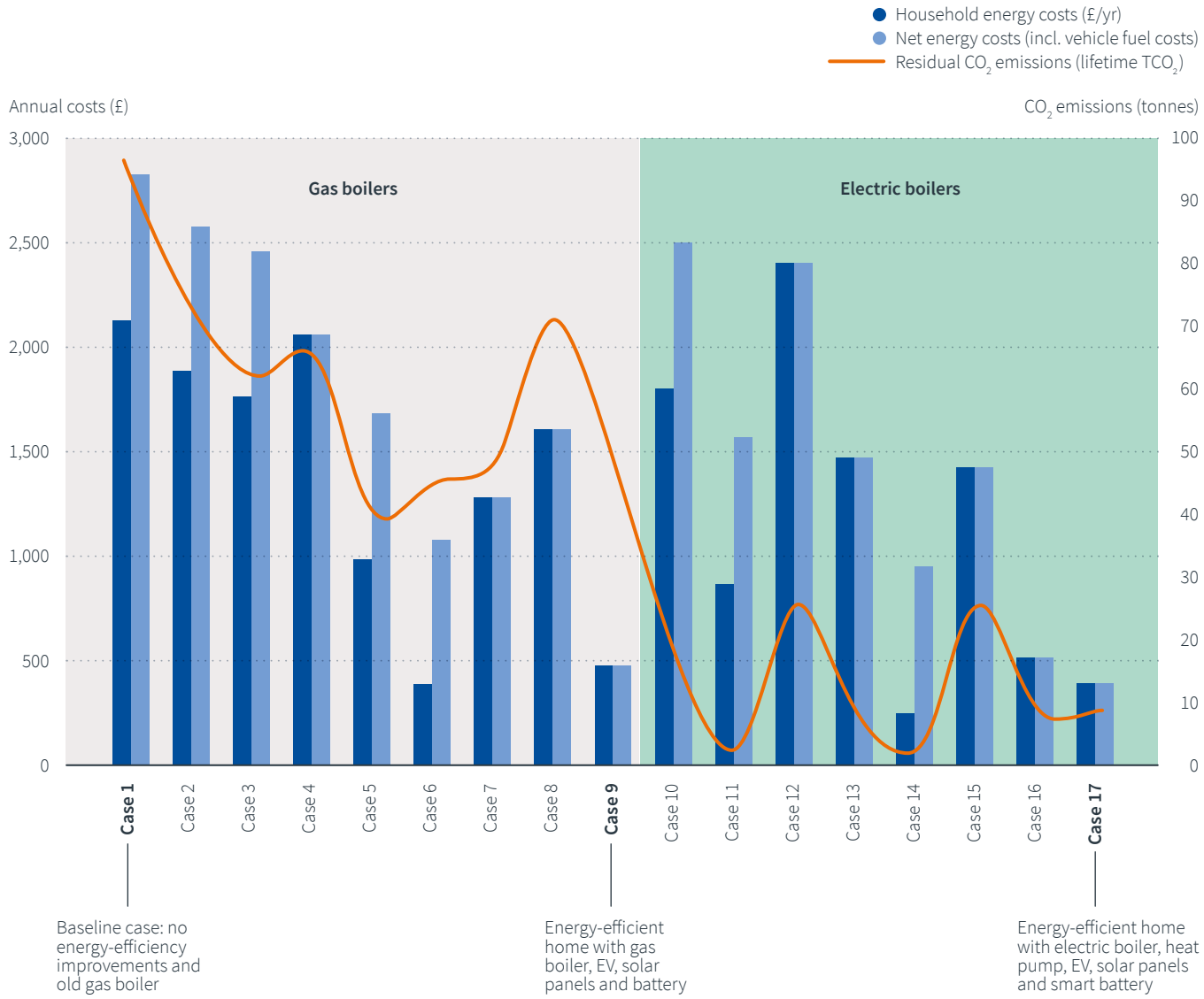
Bio-based construction materials could trap carbon and replenish the land carbon pool. Researchers are also exploring ways to use captured CO_2 as an ingredient in concrete: CO_2 can be added in the form of aggregates or injected during mixing.


Bio-based and CO_2-infused construction materials
Glulam
Bamboo
Cross-laminated timber
Concrete
2020
Carbon pool replenishment
2050

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.

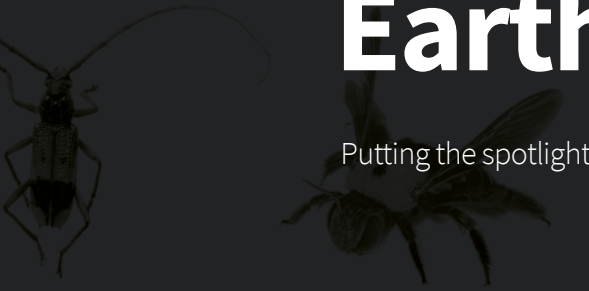
Making positive changes to decarbonise

Emissions savings from different technology combinations



Earth

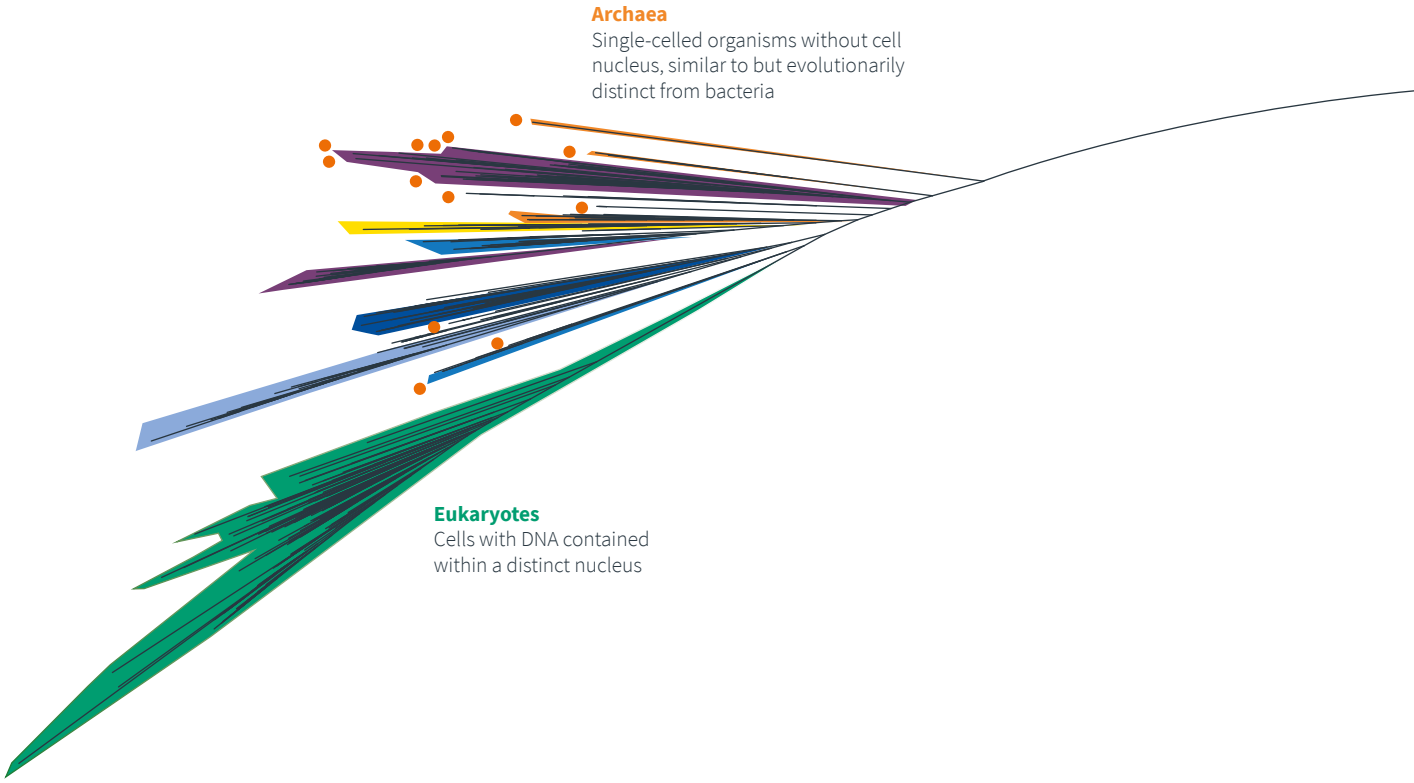
Putting the spotlight on natural capital

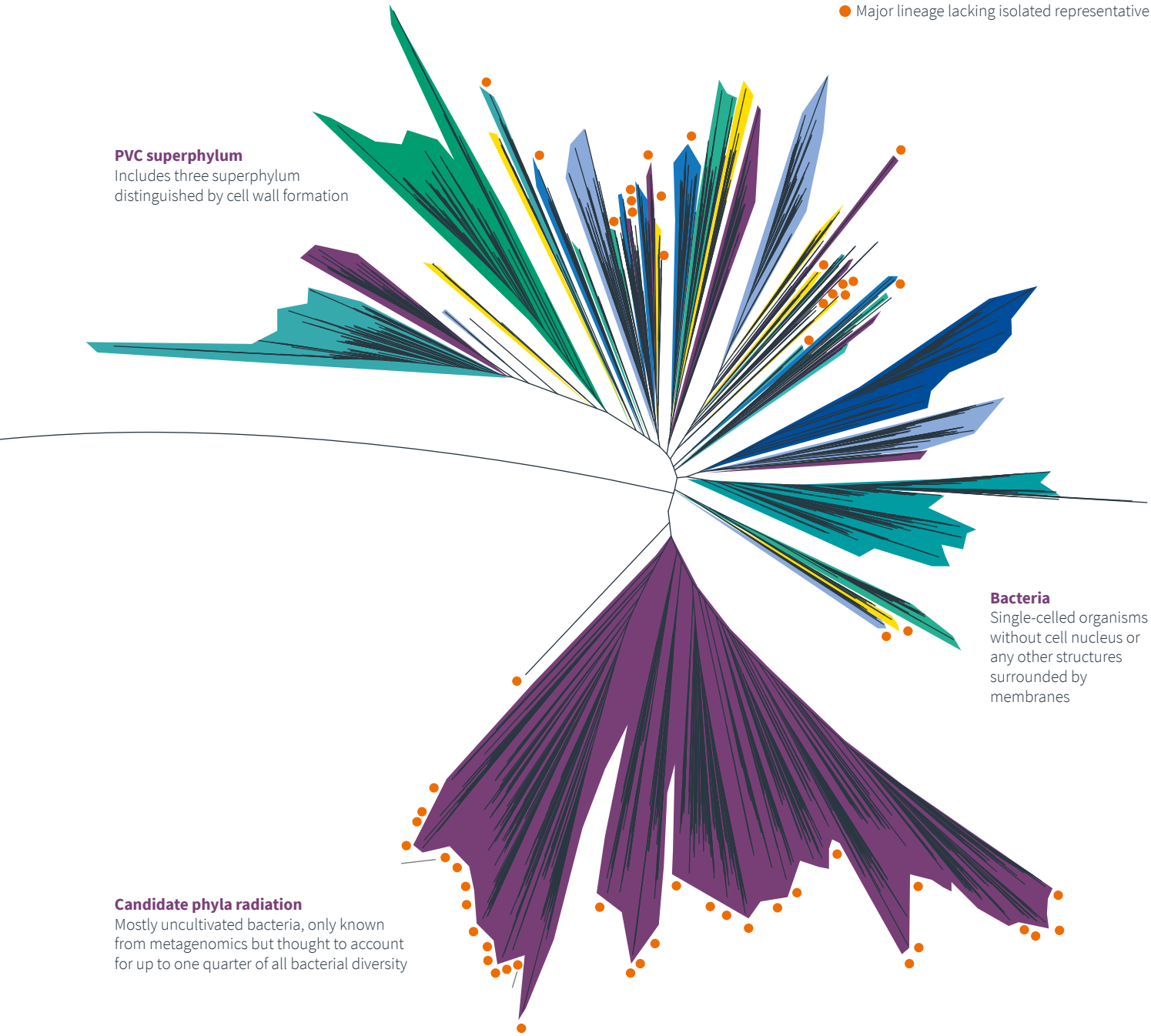


Still learning about our planet

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.

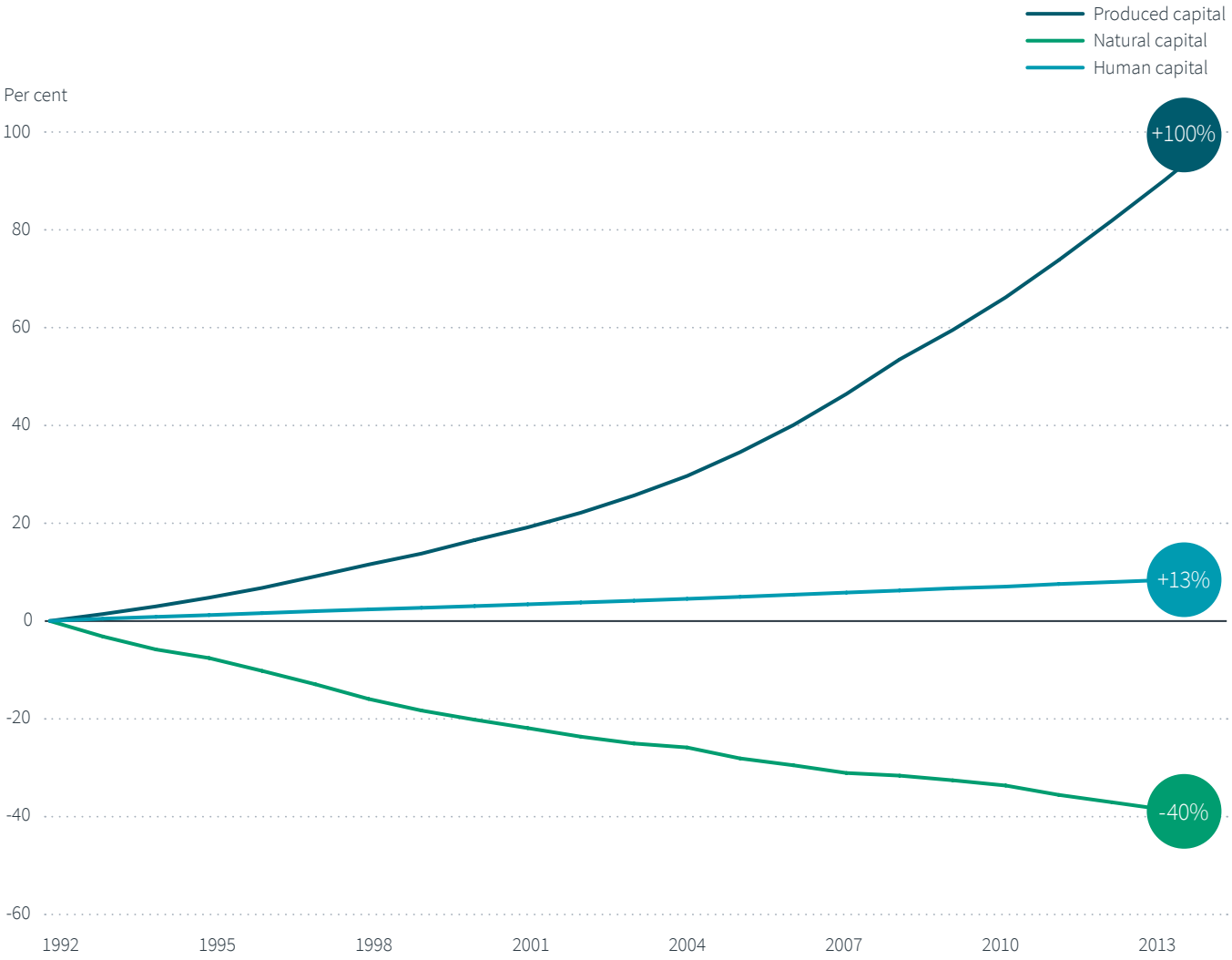



Major lineage lacking isolated representative
PVC superphylum
Includes three superphylum distinguished by cell wall formation
Bacteria
Single-celled organisms without cell nucleus or any other structures surrounded by membranes
Candidate phyla radiation
Mostly uncultivated bacteria, only known from metagenomics 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

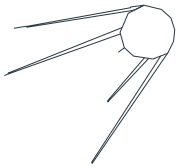
Dispersal of plastic debris

Million metric tonnes

1950
2m Mt

1907
Bakelite, first fully synthetic material, arrives

1957
Sputnik 1, first artificial satellite, sends plastic into space



2000
213m Mt

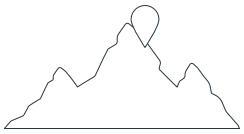
2017
438m Mt

2022
UN Environment Assembly pledges to create the first binding treaty on plastic pollution by 2024

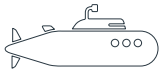
2014
Microplastics found in North Pole, within Arctic ice cores

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



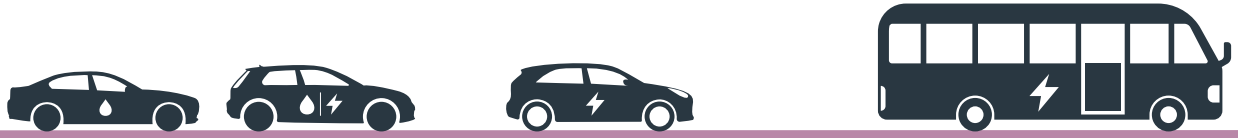
2021
In marine life near Tristan da Cunha, the world's most remote inhabited island

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

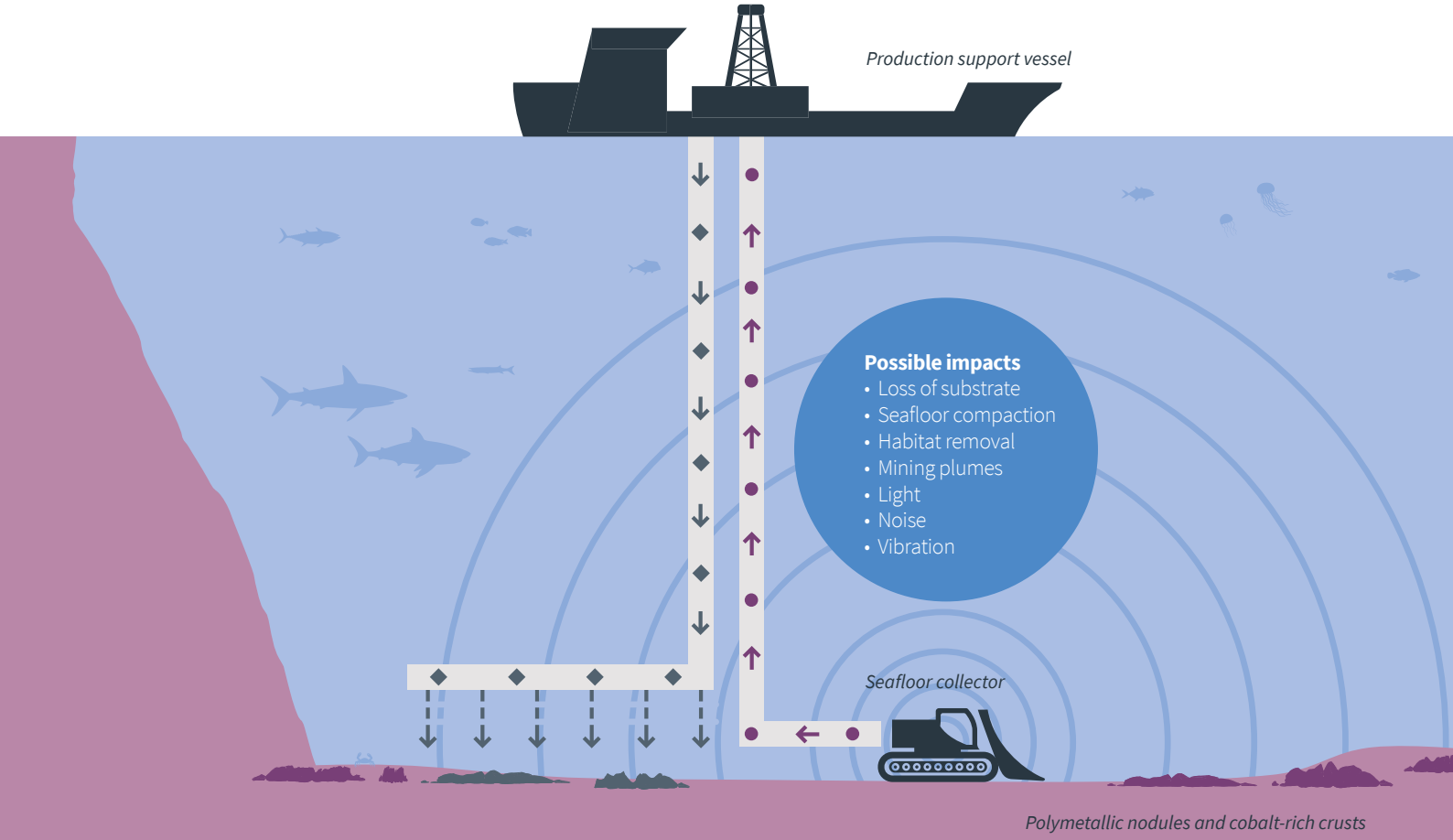
Plug-in hybrid electric vehicle
60 kg

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.

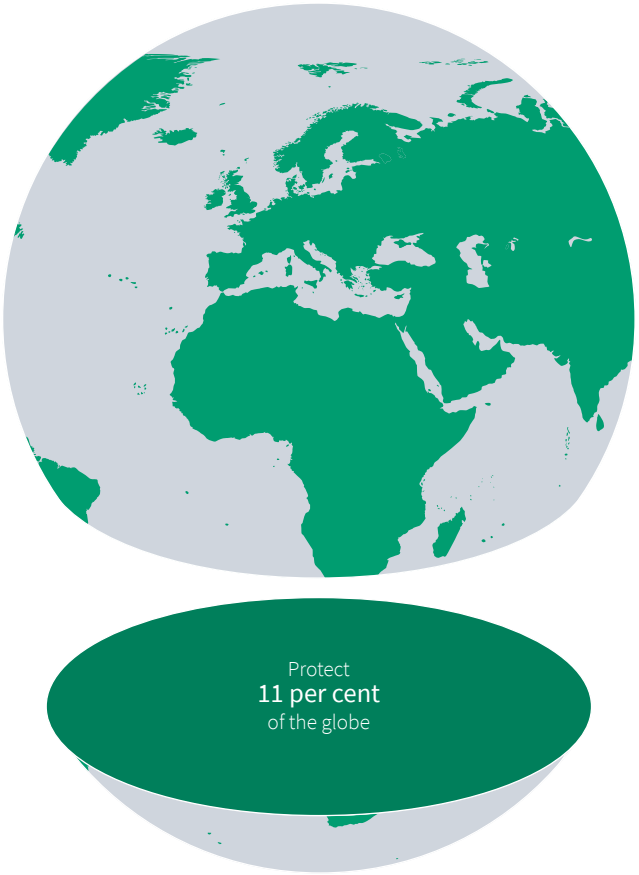


Seeking solutions

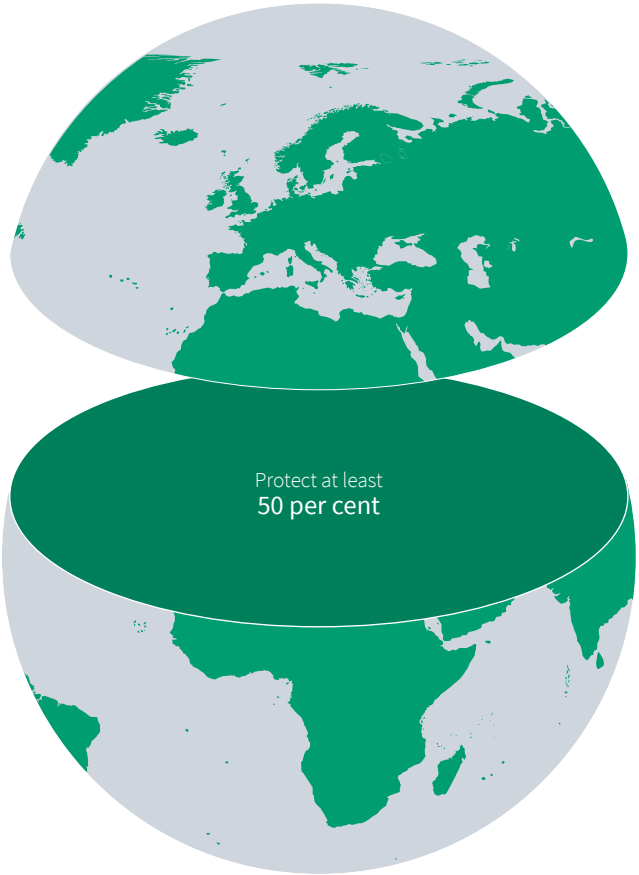
Changing goals for nature restoration and recovery

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.

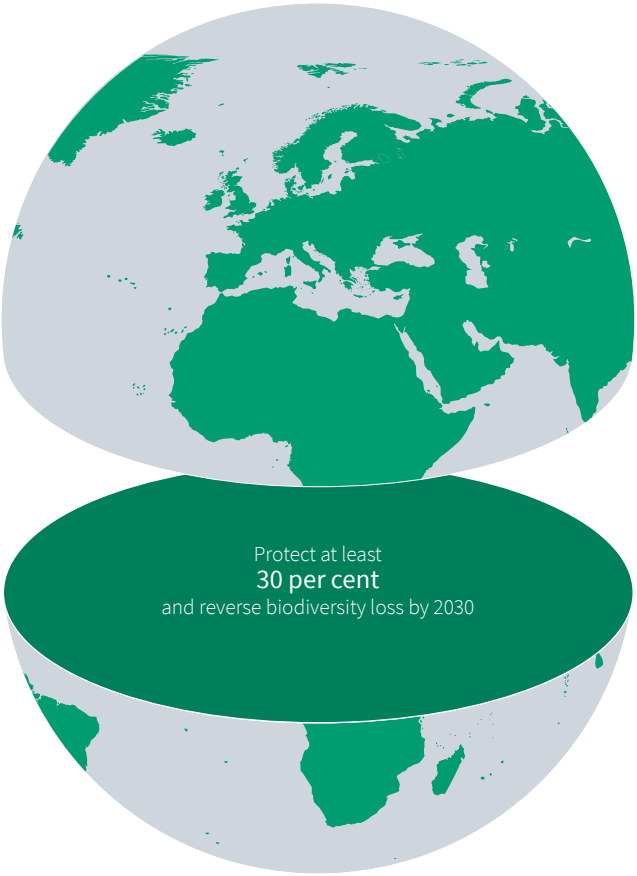
1987
Brundtland Commission '*Our Common Future*'



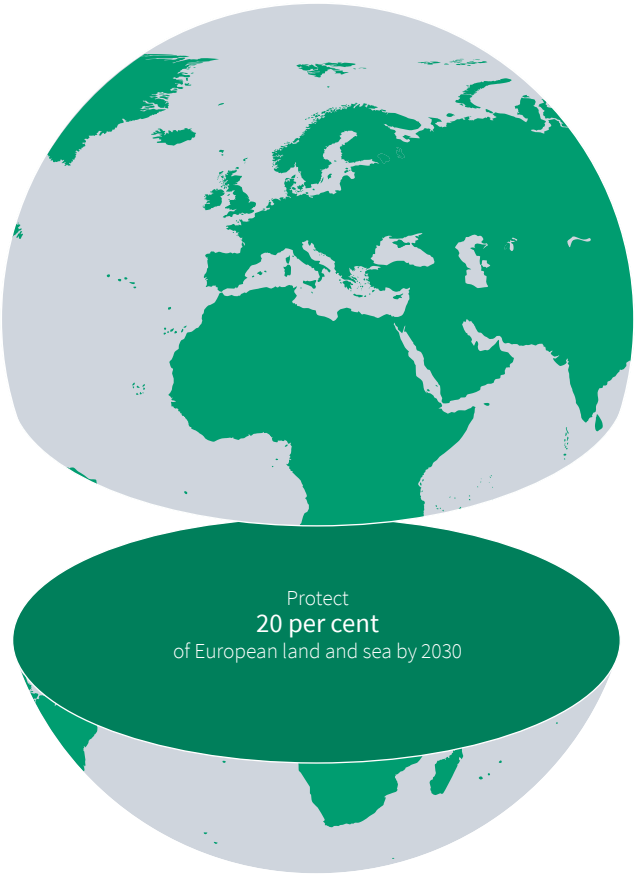
2013
Nature Needs Half



2021
G7 2030 Nature Compact

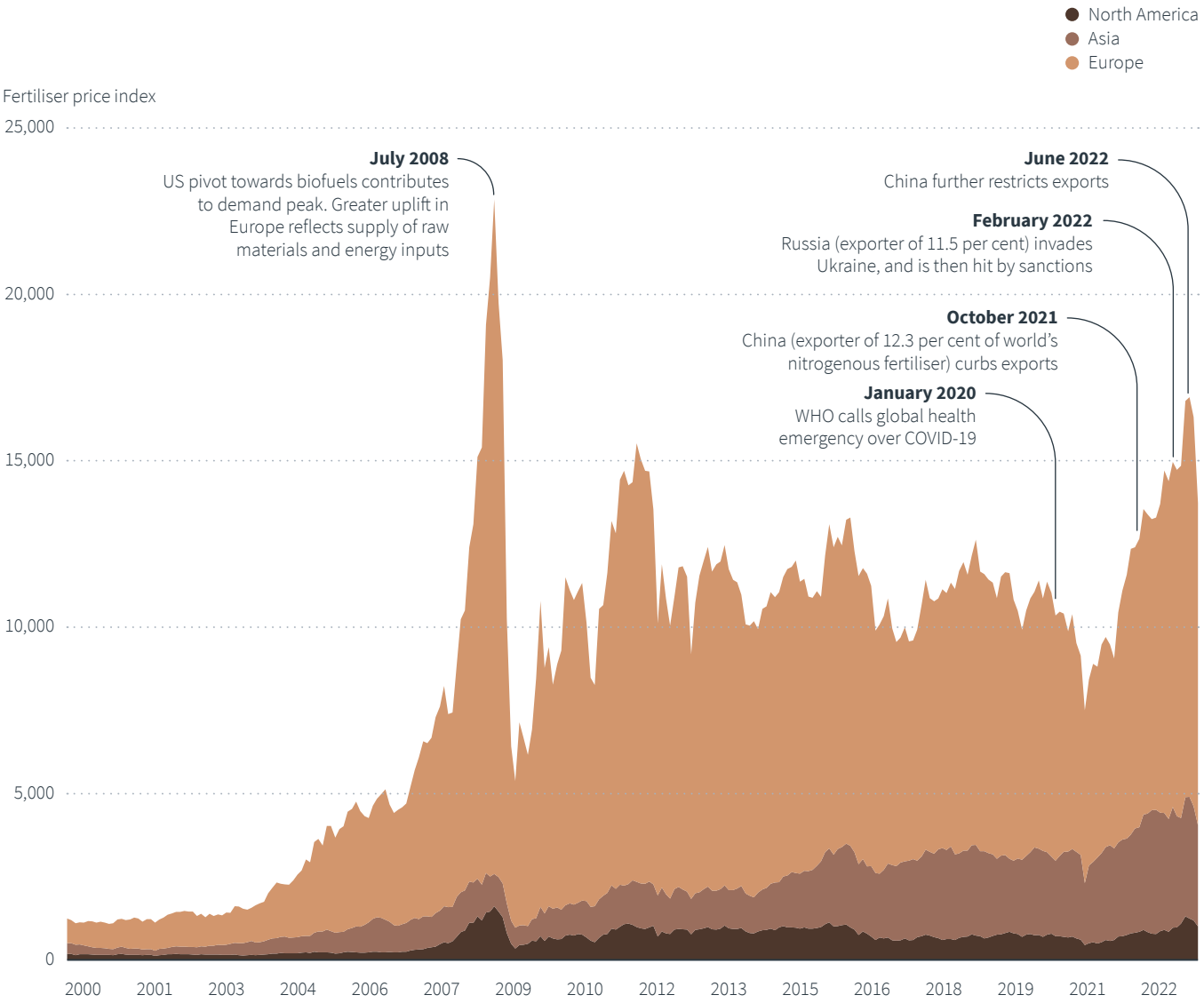


2022
Proposed EU Nature Restoration Law



Rethinking agriculture

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



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

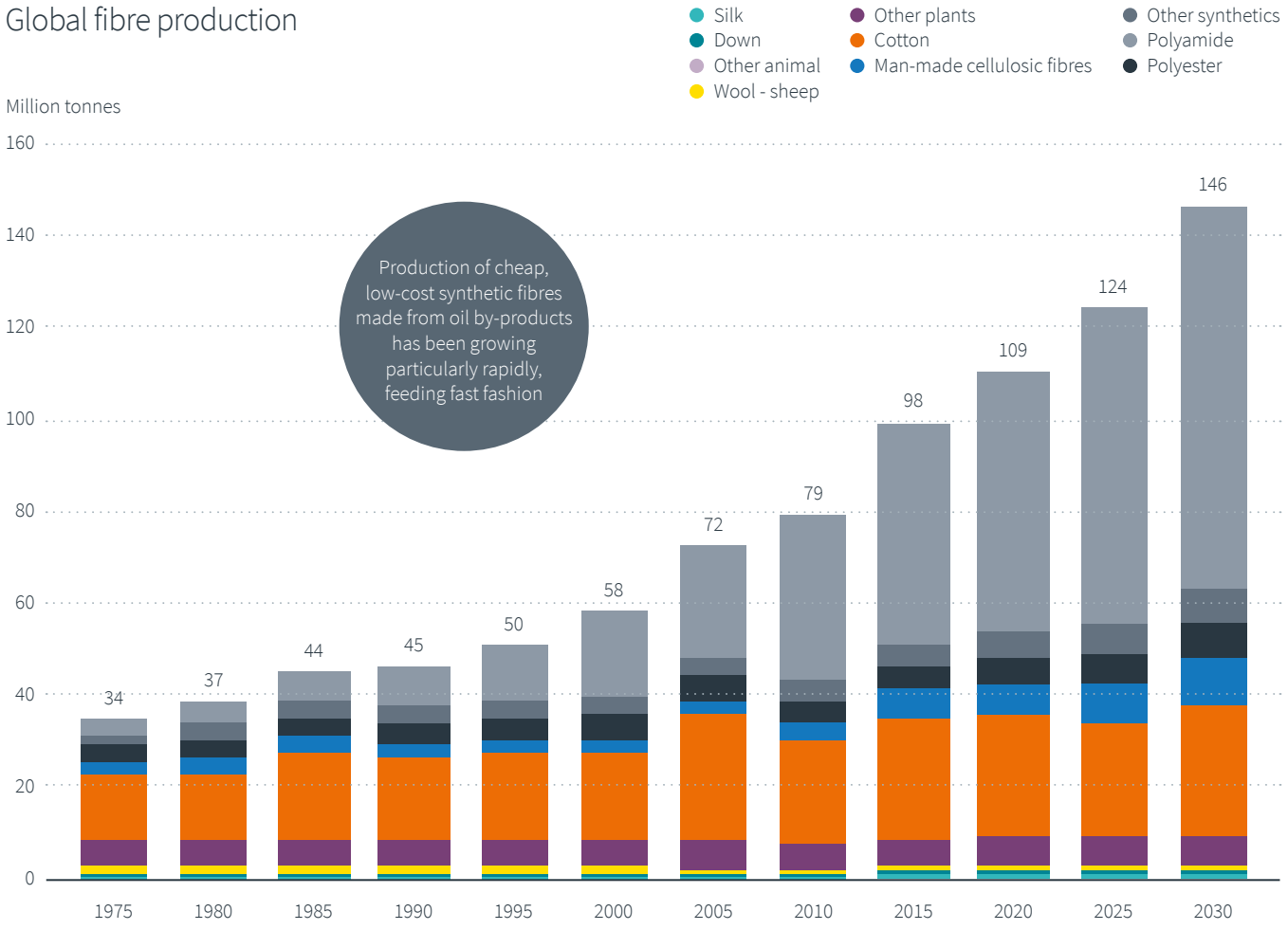
Allen Kampschnieder
Consultant, Nutrient Advisors

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.

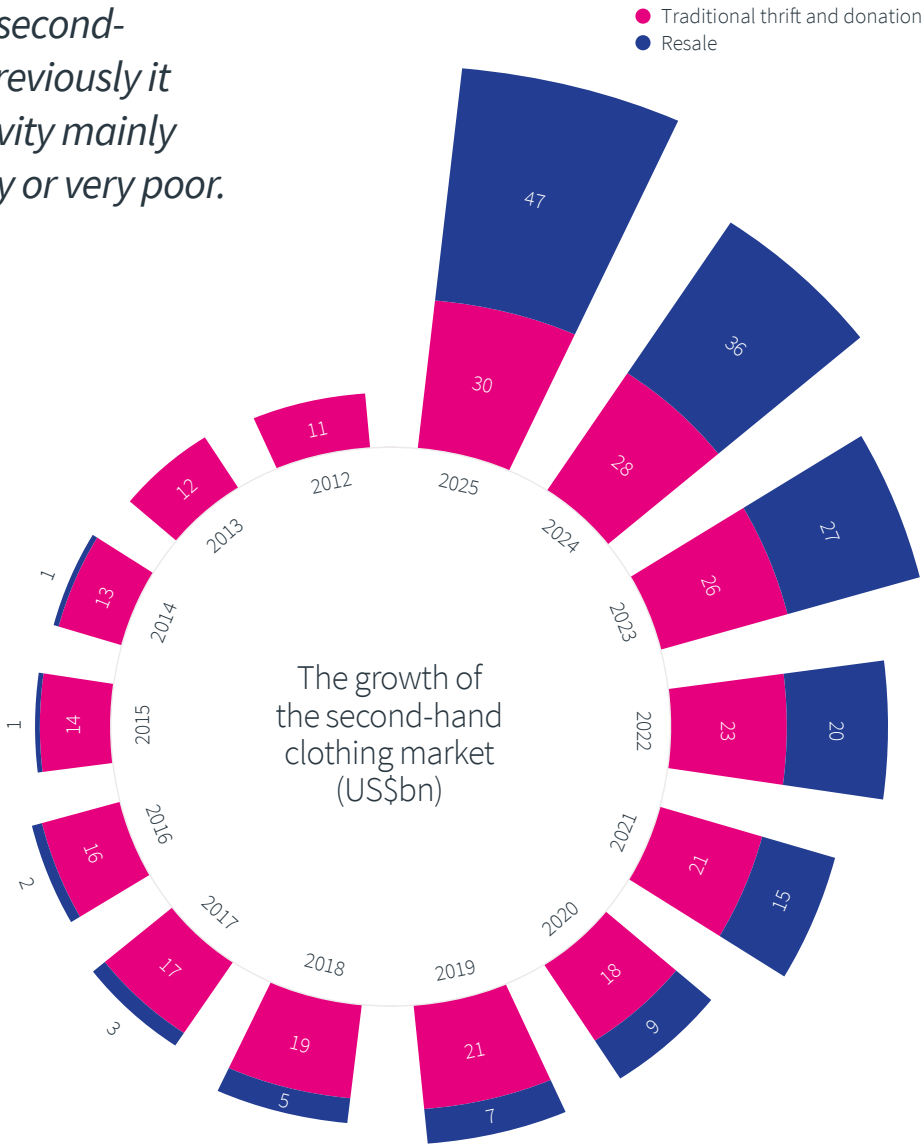
Global fibre production



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



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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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