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.

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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

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

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

Amount of pickups
Minutes
Amount of data produced every minute
Data production and human attention
The bigger picture

Major macro and market developments
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

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
Guess who’s back?

Food and energy prices drive global inflation surge

Inflation drivers across 88 countries

<table>
<thead>
<tr>
<th>Year</th>
<th>Transport</th>
<th>Housing, water, electricity, gas and other fuels</th>
<th>Food and non-alcoholic beverages</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
“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

South Sudan

Central African Republic

Democratic Republic of the Congo

Somalia

Ethiopia

Haiti

Lesotho

Zambia

Burkina Faso

Mali

Sierra Leone

Liberia

Chad

Mozambique

Senegal

Malawi

Guinea

Burundi

United Republic of Tanzania
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

US$ billion

Debt
Equity
Digital winds blow cold
Crypto collapse highlights risk

Value of Terra

US$
1.25

$1.00
Closing price
May 1, 2022

$0.01
Closing price
May 29, 2022
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
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

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Commodities</td>
<td>-1.06</td>
<td>-9.52</td>
<td>-17.01</td>
<td>-24.66</td>
<td>11.77</td>
<td>1.70</td>
<td>-11.25</td>
<td>7.69</td>
<td>-3.12</td>
<td>27.11</td>
<td>18.44</td>
</tr>
<tr>
<td>US Treasuries</td>
<td>2.17</td>
<td>-3.35</td>
<td>6.02</td>
<td>0.83</td>
<td>1.13</td>
<td>2.43</td>
<td>0.81</td>
<td>6.99</td>
<td>8.22</td>
<td>-2.38</td>
<td>-9.19</td>
</tr>
<tr>
<td>REITS</td>
<td>28.65</td>
<td>4.39</td>
<td>15.89</td>
<td>0.06</td>
<td>4.99</td>
<td>11.42</td>
<td>-4.74</td>
<td>23.06</td>
<td>-8.18</td>
<td>27.21</td>
<td>-20.35</td>
</tr>
<tr>
<td>Cash</td>
<td>0.11</td>
<td>0.07</td>
<td>0.03</td>
<td>0.05</td>
<td>0.33</td>
<td>0.85</td>
<td>1.88</td>
<td>2.28</td>
<td>0.67</td>
<td>0.05</td>
<td>0.14</td>
</tr>
<tr>
<td>Global investment grade</td>
<td>11.21</td>
<td>0.35</td>
<td>3.15</td>
<td>-3.56</td>
<td>4.27</td>
<td>9.09</td>
<td>-3.57</td>
<td>11.51</td>
<td>10.37</td>
<td>-2.89</td>
<td>-15.52</td>
</tr>
<tr>
<td>Global high yield</td>
<td>17.99</td>
<td>8.11</td>
<td>3.24</td>
<td>-3.09</td>
<td>15.50</td>
<td>7.39</td>
<td>-2.56</td>
<td>13.83</td>
<td>5.29</td>
<td>4.84</td>
<td>-14.05</td>
</tr>
<tr>
<td>MSCI EAFE</td>
<td>17.90</td>
<td>23.29</td>
<td>-4.48</td>
<td>-0.39</td>
<td>1.51</td>
<td>25.62</td>
<td>-13.36</td>
<td>22.66</td>
<td>8.28</td>
<td>11.78</td>
<td>-19.26</td>
</tr>
<tr>
<td>MSCI EM US$</td>
<td>18.63</td>
<td>-2.27</td>
<td>-1.82</td>
<td>-14.60</td>
<td>11.60</td>
<td>37.75</td>
<td>-14.24</td>
<td>18.88</td>
<td>18.69</td>
<td>-2.22</td>
<td>-17.47</td>
</tr>
</tbody>
</table>

#### Key Points
- **US Treasuries**: Worst H1 since 1788
- **S&P 500**: Worst H1 for over five decades
Seeking shelter
Risk and reward in unlisted infrastructure

Essential characteristics of select sectors, Q1 2021

[Chart showing total returns and other metrics for various sectors, with labels for intra300, global infrastructure, contracted, merchant, global transport, airports, global projects, global wind, global core, and global core +.]
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
Real equity returns in key markets during and after World Wars

World War 1
1914-1918
Post WW1-recovery
1919-1928
Post WW2-recovery
1949-1959
World War 2
1939-1948

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

- **Poland**
  - Exit: 5,796,748
  - Return: 3,834,530

- **Belarus**
  - Exit: 16,701
  - Return: Unknown

- **Russia**
  - Exit: 2,414,075
  - Return: Unknown

- **Ukraine**
  - Total border crossings
    - Exit: 11,976,498
    - Return: 5,324,798

- **Slovakia**
  - Exit: 736,387
  - Return: 474,864

- **Hungary**
  - Exit: 1,292,632
  - Return: Unknown

- **Moldova**
  - Exit: 417,650
  - Return: 232,313

- **Romania**
  - Exit: 1,127,998
  - Return: 783,091
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.

<table>
<thead>
<tr>
<th>Total ground force personnel</th>
<th>Tanks</th>
<th>Artillery pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,040,000</td>
<td>6,300</td>
<td>7,000</td>
</tr>
<tr>
<td>88,000</td>
<td>800</td>
<td>1,100</td>
</tr>
</tbody>
</table>

1 = 5,000 soldiers
1 = 100 tanks
1 = 100 artillery pieces
### Aircraft carriers

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

### Destroyers

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td></td>
<td>21</td>
</tr>
</tbody>
</table>

1 = 2 destroyers

### Frigates

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td></td>
<td>41</td>
</tr>
</tbody>
</table>

1 = 2 frigates

### Submarines

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

1 = 3 submarines

### Fighter planes

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,600</td>
<td></td>
<td>400</td>
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</table>

1 = 50 fighter planes

### Bombers

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

1 = 20 bombers
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$_2$e)
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.

Global defence spending

<table>
<thead>
<tr>
<th>Year</th>
<th>Group 1 (20 countries)</th>
<th>Group 2 (77 countries)</th>
<th>Group 3 (41 countries)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td></td>
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</tr>
</tbody>
</table>

Developing economies
Advanced economies
World
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

Europe
109
Largest Russian fossil-fuel takers, February 24 to October 5, 2022

<table>
<thead>
<tr>
<th>Country</th>
<th>US$ billions</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>41</td>
</tr>
<tr>
<td>UK</td>
<td>1</td>
</tr>
<tr>
<td>US</td>
<td>2</td>
</tr>
<tr>
<td>South Korea</td>
<td>3</td>
</tr>
<tr>
<td>Turkey</td>
<td>16</td>
</tr>
<tr>
<td>India</td>
<td>10</td>
</tr>
<tr>
<td>Others</td>
<td>21</td>
</tr>
</tbody>
</table>
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
Number of sanctions on Russia by country, 2022

**22 February | Europe**
Ban on trading Russian sovereign debt

**02 March | Europe**
Russian banks banned from SWIFT international payments system

**11 March | UK**
UK sanctions over 300 members of Russian parliament

**15 March | UK**
UK targets oligarchs, including Defence Minister Sergei Shoigu

**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
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)
- Rise of middle class in the emerging world
- Squeezed lower and middle-income groups in rich countries
- The bottom 50 per cent captured two per cent of global wealth growth
- The top one per cent captured 38 per cent of global wealth growth
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.
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

Based on past data
Baseline projection
Pessimistic scenario
Includes COVID-19 impacts, rising inflation and equally distributed Ukraine impacts

Greater impacts of rising food costs on poorest 40 per cent

Sub-Saharan Africa

Based on pre-COVID-19 forecasts

405
411.5
417.8
419.8
419.8
424.3
429.3
434.5
437.1
460.4
463.6

405
411.5
417.8
419.8
419.8
424.3
429.3
434.5
437.1
460.4
463.6

7.5
7
6.5
6.5
5.2
5.2
4.7
4.7
3.9
5

7.5
7
6.5
6.5
5.2
5.2
4.7
4.7
3.9
5


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
The baby bust?
A junction for life on earth

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

Millions

190

- Observed
- 60 sample trajectories
- 90 per cent predication interval
- 80 per cent predication interval
- Median
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

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

20

18

16

14

12

10

8

6

4

2

0

0.01 0.05 0.06 0.08 0.08 0.11 0.13 0.17 0.20.21 0.24 0.24 0.25 0.36 0.42 0.64

Natural disasters Conflict Poisonings Hepatitis Fire Drug use disorders Alcohol use disorders Maternal disorders Meningitis Protein-energy malnutrition Drowning Nutritional deficiencies Parkinson’s disease Homicide Malaria

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.
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

<table>
<thead>
<tr>
<th>Category</th>
<th>2019 Millions of dollars</th>
<th>2022 Millions of dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartwatch</td>
<td>18,501</td>
<td>31,337</td>
</tr>
<tr>
<td>Ear-worn</td>
<td>14,583</td>
<td>44,160</td>
</tr>
<tr>
<td>Wristband</td>
<td>5,101</td>
<td>4,477</td>
</tr>
<tr>
<td>Smart patches</td>
<td>3,900</td>
<td>7,150</td>
</tr>
<tr>
<td>Head-mounted display</td>
<td>2,777</td>
<td>4,573</td>
</tr>
<tr>
<td>Smart clothing</td>
<td>1,333</td>
<td>2,160</td>
</tr>
</tbody>
</table>
Fair’s fair
Could better treatment in the workplace be a win-win?

Employee satisfaction and stock market returns, 1984-2020

Portfolio balance, US$
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.
Climate

As temperatures and natural disasters surge, make no mistake: this is an emergency.
Mercury rising
Record high temperatures in Europe

Country | Year | Temperature (°C)
--- | --- | ---
Italy | 2021 | 48.8
France | 2019 | 46
UK | 2022 | 40.3

Countries included: Albania, Austria, Belgium, Bulgaria, Croatia, Denmark, Estonia, Finland, France, Greece, Germany, Iceland, Ireland, Italy, Latvia, Lithuania, Macedonia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom.
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

Heat dome

Jet stream diverted north

42°C
Whistler: 29 June

42°C
Agassiz: 28 June

49.6°C
Lytton: 30 June

44°C
Castlegar: 30 June

44°C
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

Humans exposed to extreme heat

1.5°C: 14%
2°C: 37%

Tropical maize harvest

1.5°C: 3%
2°C: 7%

Coral reef decline

1.5°C: 70-90%
2°C: 99%
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.
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

- China
- US
- India
- Russia
- Iran
- Germany
- Indonesia
- Brazil
- Mexico
- Turkey
- Thailand
- Egypt
- Nigeria
- Philippines
- Bangladesh
- Ethiopia
- Congo
- Japan
- Vietnam
- Ethiopia
- Congo
Each line represents one year with the length highlighting CO₂ emissions per capita in tonnes.

Country
Emissions in 2000
2019
2005
2010
2019

Emissions in 2000 were lower than in 2019
Per capita emissions in 2000 were higher than in 2019
Peak of CO₂ emissions within range

Area represents total annual CO₂ emissions in tonnes in 2019.

China
2.60 - 7.10
US
21.29 - 16.06
India
0.93 - 1.91
Russia
10.05 - 11.51
Iran
5.63 - 9.40
Germany
11.05 - 8.40
Indonesia
1.26 - 2.28
Brazil
1.85 - 2.21
Mexico
4.00 - 3.44
Turkey
3.63 - 4.86
Thailand
2.71 - 4.14
Egypt
2.04 - 2.46
Pakistan
0.74 - 1.15
Vietnam
0.65 - 2.57
Nigeria
0.64 - 0.70
Philippines
0.93 - 1.33
Bangladesh
0.21 - 0.63
Ethiopia
0.05 - 0.15
Congo
0.18 - 0.64
Japan
9.92 - 8.72

Population in thousands:

127,575 144,373 163,046 200,963 211,049 216,565 270,625 328,239 1,366,417 1,397,715
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
<table>
<thead>
<tr>
<th>Event</th>
<th>Number</th>
<th>Total Damages</th>
<th>US$ Billions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Droughts</td>
<td>119</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floods</td>
<td>610</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildfires</td>
<td>94.3</td>
<td>51.3</td>
<td></td>
</tr>
<tr>
<td>Heat waves</td>
<td>13.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold waves</td>
<td>31.3</td>
<td>4.63</td>
<td></td>
</tr>
</tbody>
</table>

Total damages: 134.3 US$ billions
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.
Bio-based and CO$_2$-infused construction materials

- Glulam
- Bamboo
- Cross-laminated timber
- Concrete

Carbon pool formation
Carbon pool depletion
Carbon pool replenishment

Mineral-based construction materials
- Masonry
- Concrete
- Steel
- Composite

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

- Baseline case: no energy-efficiency improvements and old gas boiler
- Energy-efficient home with gas boiler, EV, solar panels and battery
- Energy-efficient home with electric boiler, heat pump, EV, solar panels and smart battery

- Annual costs (£)
- CO₂ emissions (tonnes)

- Household energy costs (£/yr)
- Net energy costs (incl. vehicle fuel costs)
- Residual CO₂ emissions (lifetime TCO₂)
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.
**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

1950
2m Mt

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

2017
438m Mt

2019
10,972 metres deep in the South Pacific Ocean

2022
In human blood
2000: 213m Mt

2007: 438m Mt

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

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

2022: In human blood

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

Earth 95
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?
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

Protect
11 per cent
of the globe

Protect at least
50 per cent
Protect at least 30 per cent and reverse biodiversity loss by 2030

2021
G7 2030 Nature Compact

Protect 20 per cent of European land and sea by 2030

2022
Proposed EU Nature Restoration Law
Rethinking agriculture
Fertiliser: Surging costs trigger demand for manure and treated human waste

Fertiliser price index

- **July 2008**: US pivot towards biofuels contributes to demand peak. Greater uplift in Europe reflects supply of raw materials and energy inputs.
- **February 2022**: Russia (exporter of 11.5 per cent) invades Ukraine, and is then hit by sanctions.
- **October 2021**: China (exporter of 12.3 per cent of world's nitrogenous fertiliser) curbs exports.
- **June 2022**: China further restricts exports.
“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

Production of cheap, low-cost synthetic fibres made from oil by-products has been growing particularly rapidly, feeding fast fashion.
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
Sources and notes


10-11 Multiple systemic shocks Aviva Investors, September 2022.

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24-25 Taming the beast Refinitiv Datastream, Aviva Investors, data as of September 12, 2022.


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.

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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.

43 What happened to the peace dividend? Benedict Clements, et al., ‘Military spending in the post-pandemic era’, International Monetary Fund, Summer 2021. Note: Group 1 = In 20 countries experiencing a high degree of conflict, defence spending is substantially above the global trend. Members include Armenia, Azerbaijan, the Democratic Republic of the Congo, Oman, and Saudi Arabia. Group 2 = In 77 countries accounting for 90 percent of global military spending, outlays have plateaued at about 2–2.5 percent of GDP. Members include China, India, Russia, UK and US. Group 3 = The majority of the lowest spenders are developing nations, where spending is averages just under one per cent of GDP.

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Extreme poverty for others Daniel Gerszon, 'Pandemic, prices, and poverty', World Bank Blogs, April 13, 2022. Note: Extreme poverty is measured as the number of people living on less than $1.90 per day. 2018 is the last year with official global poverty estimates. 'No pandemic projection' utilises Global Economic Prospects growth forecasts from before the COVID-19 pandemic. Baseline and pessimistic projections utilise growth forecasts from April 2022 Macro and Poverty Outlooks. Baseline scenario distributes the impacts of the COVID-19 pandemic, rising inflation, and the conflict in Ukraine equally to all households. Pessimistic scenario includes the disproportionate impact of rising food prices on the bottom 40 per cent compared to the top 60 per cent over the baseline scenario. Official poverty estimates are available for Europe and Central Asia, Latin America and Caribbean, and Rest of World for up to 2019. Regions are categorized using PIP definition.

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**Making positive changes to decarbonise** ‘Better homes, cooler planet: How low-carbon technologies can reduce bills and increase house value’, WWF-UK and ScottishPower, July 20, 2022. Note: The cases in this chart involve different combinations of five low-carbon technologies (LCTs) – heat pumps, electric vehicle chargers, solar panels, battery storage, and energy efficiency upgrades. Case 1 represents a house with an old gas boiler and no LCTs, while Case 17 contains all five technologies, with policy costs moved from electricity bills. The running cost figures are derived from modelling which assessed the impact that low carbon technologies have on annual home energy bills, by combining datasets that calculate the energy demands of different house types with information about the characteristics of different technologies. Bill levels used to calculate running cost savings assume that the householder is on a Standard Variable Tariff set at the level of the Default Tariff Cap for the period beginning April 2022, and which was in place at the time of publication. Updates to the price cap level may impact the estimates. The detail on the technology specific assumptions is available in the full report.

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Heat and hot water fuel</th>
<th>LCTs installed and energy efficiency standard</th>
<th>Upfront cost (£)</th>
<th>Energy costs (exc. vehicle fuel costs) (£/yr)</th>
<th>Energy costs saved (£/yr)</th>
<th>Energy costs (inc. vehicle fuel costs) (£/yr)</th>
<th>Residual CO₂ emissions (lifetime TCO₂)</th>
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<tbody>
<tr>
<td>Case 1</td>
<td>Gas</td>
<td>Baseline case (no EE improvement) + old gas boiler</td>
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<td>2,118</td>
<td>N/a</td>
<td>2,816</td>
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<tr>
<td>Case 2</td>
<td>Gas</td>
<td>Baseline case (no EE improvement) + modern gas boiler</td>
<td>0</td>
<td>1,874</td>
<td>245</td>
<td>2,572</td>
<td>73</td>
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<td>Case 3</td>
<td>Gas</td>
<td>Energy efficiency upgrade (EE4) + modern gas boiler</td>
<td>4,285</td>
<td>1,749</td>
<td>370</td>
<td>2,447</td>
<td>62</td>
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<td>Case 4</td>
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<td>5,285</td>
<td>2,048</td>
<td>71</td>
<td>2,048</td>
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<td>Case 5</td>
<td>Gas</td>
<td>EE4 + solar panels</td>
<td>10,615</td>
<td>978</td>
<td>1,141</td>
<td>1,676</td>
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<tr>
<td>Case 6</td>
<td>Gas</td>
<td>EE4 + solar panels + battery</td>
<td>16,497</td>
<td>374</td>
<td>1,744</td>
<td>1,072</td>
<td>45</td>
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<tr>
<td>Case 7</td>
<td>Gas</td>
<td>EE4 + electric vehicle + solar panels</td>
<td>11,615</td>
<td>1,277</td>
<td>842</td>
<td>1,277</td>
<td>48</td>
</tr>
</tbody>
</table>


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