

Tortois^o · NOTES

Getting to net zero

Notes by Barney Macintyre • Winter 2020



What's this?

Over the next two decades – three at most – the human species has to end its reliance on fossil fuels or face accelerating climate change. Failure would mean more famine, bigger deserts, fiercer storms. It would mean rising sea levels and a global migration emergency as the new status quo. It would mean we had refused collectively to heed the warnings of science and harness our capacity to act. Inertia would have won.

There's a risk that we compound the dangers by paralysing ourselves with nightmare scenarios that seem too daunting to resist. Let's not do that. As Gene Kranz urged Mission Control, let's work the problem.

We have to reverse the upward trend in carbon emissions, but thanks to satellite-based remote sensing we also have a better understanding of our planet than Kranz could have imagined. Renewable energy is cheaper and more abundant than ever. Clean energy storage in batteries and with hydrogen is being revolutionised. Capital markets are starting to price carbon with climate in mind, and the energy sector – BP included – is responding.

The generation of leaders that will convene this year's COP26 conference in Glasgow has failed to galvanise the global effort needed to safeguard the biosphere. That doesn't mean today's generation of students has to fail too. There's a great challenge all around us. We hope these notes help bring it into focus.

20' reading time
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Part one

Can we invent our way to net zero, or is it too late?

‘Listen to the science’ is good advice for a planet facing accelerating climate change, but what does it mean in practice? Can we still harness technology to drive down emissions fast enough to control global warming, or have we passed a point of no return?

What does the science say?

Carbon is cumulative

Around 60 per cent of the carbon dioxide emitted by humans ends up in the atmosphere. The earth naturally captures that CO₂ through geological processes that take thousands of years. But for as long as humans have used fossils for fuel, it has accumulated above our heads.

Ice cores show that for the past half a million years atmospheric CO₂ levels have been between 180 and 300 parts per million (ppm). They are now at 407 ppm and counting. Even if humanity kicks its carbon habit, greenhouse gas levels could stay high for decades because atmospheric emissions are cumulative – without large-scale carbon capture, they will only go up. And their rise has a direct consequence on the time-scale humans have to limit global warming.

In 2018 the IPCC said that we have 12 years to keep temperatures below 1.5°C above pre-industrial levels this century. This would require a 45 per cent carbon emissions cut by 2030. Yet even 12 years may be misleading. To stay within 1.5°C, the IPCC noted that emissions must peak this year.

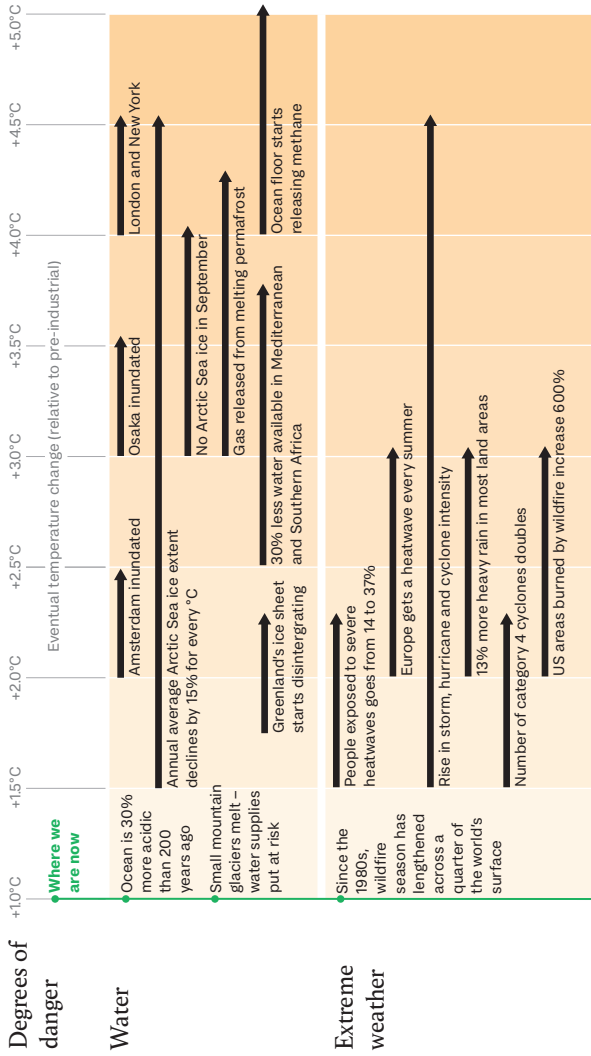
Beware the other greenhouse gases

The IPCC 1.5°C report also makes clear we need deep cuts to emissions of other greenhouse gases. Emissions of methane, which has greater warming potential but a shorter atmospheric lifetime than carbon, need to drop 35 per cent between 2010 and 2050. We’ll need to make changes in agriculture to reduce emissions of nitrous oxide – a gas that is 300 times more effective at trapping heat than CO₂.

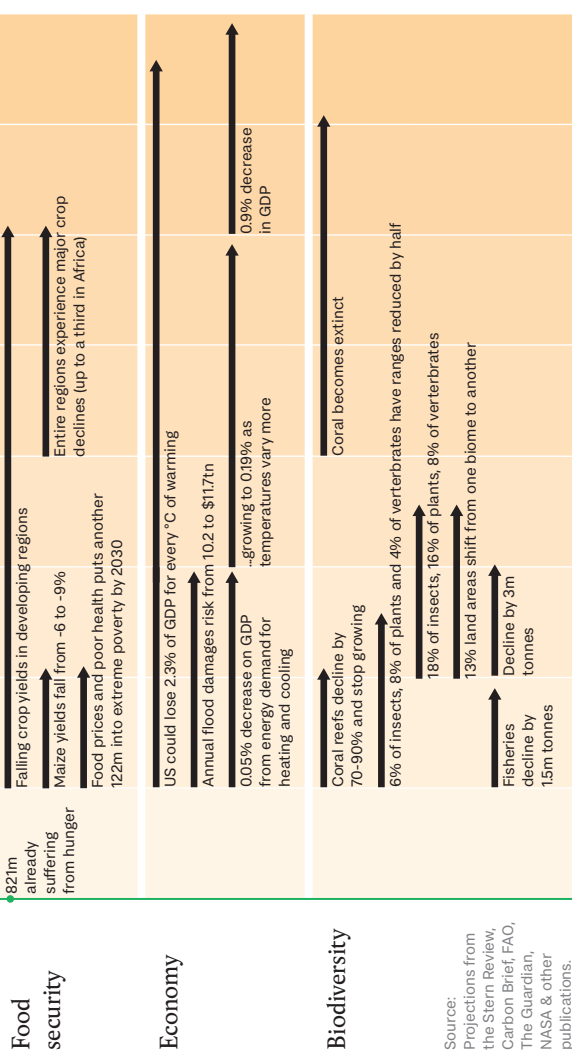
Compound	Concentrations		Atmospheric lifetime	Main human activity source	Global warming potential
	Pre-industrial (ppmv)	In 2011 (ppmv)			
Carbon dioxide (CO ₂)	280	390	50 to 200 years	Fossil fuels, cement production, land use change	1
Methane (CH ₄)	0.715	1.803	12 years	Fossil fuels, rice paddies, waste dumps, livestock	25
Nitrous oxide (N ₂ O)	0.27	0.324	114 years	Fertilisers, combustion, industrial processes	298
HFC 23 (CHF ₃)	0	0.000024	270 years	Electronics, refrigerants	14800
HFC 134a (CF ₃ CH ₂ F)	0	0.000062	14 years	Refrigerants	1430

Source: Center for Sustainable Systems, 2019

Degrees of danger



Food security



Source: Projections from the Stern Review, Carbon Brief, FAO, The Guardian, NASA & other publications.

Five gadgets to save the planet

1. The zero-carbon home

Problem: Energy use in homes accounts for 14 per cent of UK greenhouse gas emissions. This needs to fall by a quarter by 2030 compared with 1990 levels if we want to keep warming to within 1.5°C. *CCC, 2019*

Solution: Installing a heat pump and insulation can save the average British household £85 per year in energy costs. Building 270,000 new homes with wood rather than carbon-intense concrete would triple the amount of carbon stored in UK homes each year. *CCC, 2019*

Materials

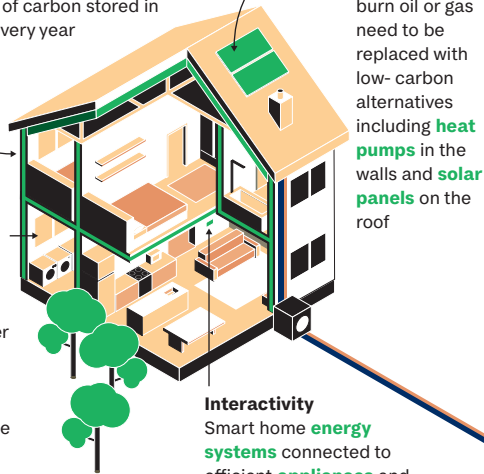
Building a quarter of a million homes with **timber** could triple the amount of carbon stored in UK homes every year

Fuel

Heating systems that burn oil or gas need to be replaced with low- carbon alternatives including **heat pumps** in the walls and **solar panels** on the roof

Efficiency

Insulation and **double glazing** can lead to lower bills, improved health and fewer people in fuel poverty



Interactivity

Smart home **energy systems** connected to efficient **appliances** and **thermostats** can help save energy and costs

Source: CCC, 2019

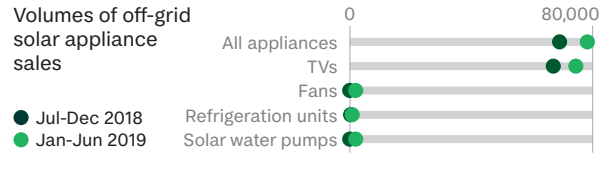
2. Personal PVs

Problem: More than a third of global CO₂ emissions come from generating electricity. *IEA, 2018*

Problem: 860 million people lack access to electricity.

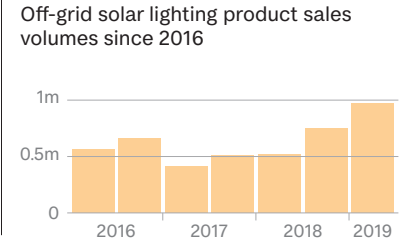
Solution: Solar panels. Enough solar energy hits the earth’s surface every hour to provide for current energy needs for an entire year. Photovoltaic (PV) solar panels act as semiconductors that convert this energy into electricity. They’re cheap, and getting cheaper – the cost of solar energy is already on par with average wholesale prices in many parts of the world and will drop another 63 per cent by 2050. Small-scale panels purchased by consumers will make up 11 per cent of the total generating capacity in 2050. *BNEF, 2019*

Off-grid solar power in Kenya



17.9m

People without electricity access

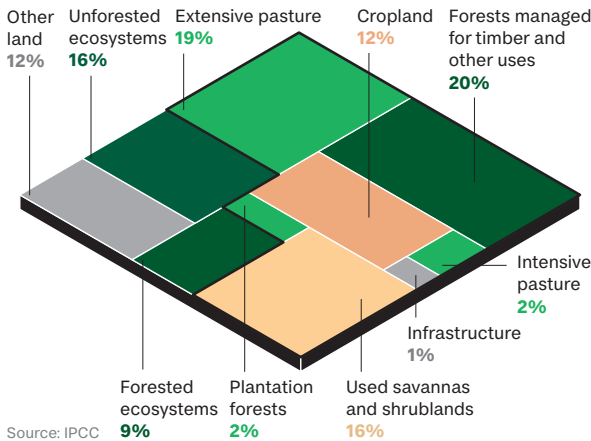


Source: Off-grid Solar Market Trends Report

3. Happy cows

Problem: With the world's population expected to reach 9.6bn by 2050, global meat consumption could rise by 70 per cent. That's especially troubling since 14.5 per cent of the emissions caused by human activity already comes from livestock. Grazing and growing the crops that feed them takes up the majority of agricultural land. *FAO*

Human land use



Solution: Shifting our diets from meat-based to plant-based and cutting food waste are the first steps we need to take. But at current rates of consumption we'll also need to change how meat is made.

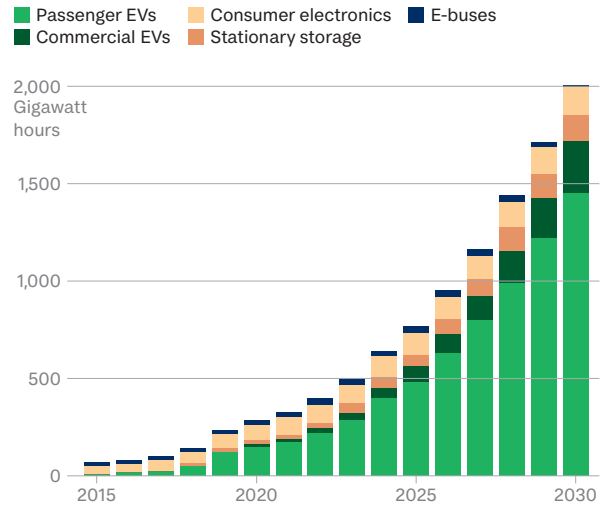
Solution: Converting 203 million acres of current pasture into silvopasture – grazing land with trees interspersed – could absorb 31 gigatonnes of CO₂ while also improving yields and animal health. It's a pernicious myth that cows and trees don't mix. *Drawdown*

4. Batteries on wheels

Problem: At times of peak energy-use the UK's power grid is forced to use energy made using fossil fuels because energy from renewable sources has run out.

Solution: By 2050 there could be 35m electric vehicles (EVs) on Britain's roads and electrified transport could lead to 30 per cent growth in electricity consumption. Smart charging of EVs (i.e. plugging them in overnight) will be essential to keeping demand balanced. It's estimated up to £90m a year could be shaved off the cost of increasing grid capacity by storing energy in the batteries of EVs to be delivered back to the grid when needed. *Edie, 2019*

Annual lithium-ion battery demand



Source: BloombergNEF, Avicenne

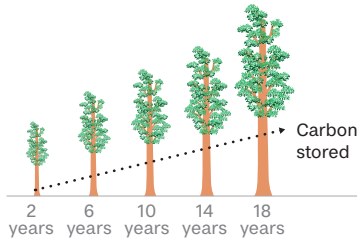
5. Carbon reduction

Problem: For those sources of emissions we can't cut, we'll need to use technologies that suck carbon out of the atmosphere.

Solution: Trees. Planting a trillion of them on the billion hectares of land available for forest restoration could remove the equivalent of a third of all CO₂ emissions humans have added to the atmosphere since the start of the industrial age. *Bastin et al., 2019*

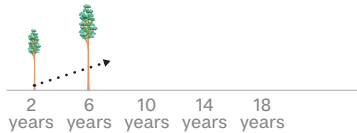
Left to grow

Indian Rosewoods can sequester more than 2 tonnes of carbon each by the time they reach maturity. That stays locked up if the trees are left to grow or used for housing or furniture



Harvested young

Often harvested after just six years, trees like plantation eucalyptus usually release carbon quickly back into the atmosphere via pulp mills, incinerators and landfill



Solution: Man-made machines that capture waste carbon at its source or direct from the air may also be required for certain sectors. Carbon capture and storage (CCS) has yet to be applied at scale but is nevertheless included in most net-zero scenarios.

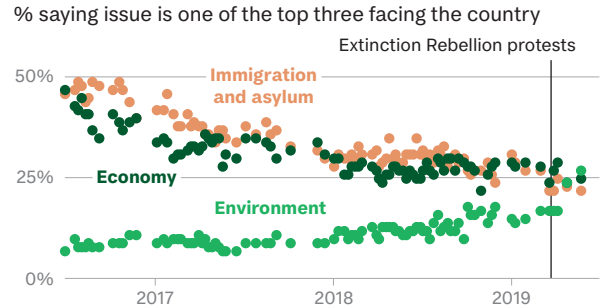
Part two

Whose job is it to fight climate change – activists, voters or the people they elect?

Last year saw an upsurge of climate activism that focused minds from the UN to Westminster and Wall Street. But the next step – turning activism into action – looks more complicated. Who's going to take it?

The Greta effect

In the UK, concern about the environment is at the highest level on record...



Source: YouGov

...but how to turn rising anxiety into meaningful action? The sheer number of reports, figures, and campaigns can be overwhelming. And who's to say that our own efforts to be sustainable won't be undone by a more selfish person somewhere else? Is Greta Thunberg right when she says that "no one is too small to make a difference"?

“Our house is still on fire. Your inaction is fuelling the flames by the hour. We are still telling you to panic, and to act as if you loved your children above all else.”

Greta Thunberg’s speech at the Davos World Economic Forum Annual Meeting, 2020

What you can do to save the planet

Individual behaviours, when applied at a global scale, have the potential to remove up to a third of cumulative greenhouse gas emissions released into the atmosphere between 2020 and 2050. *RARE, Drawdown, 2019*

Potential for emissions to be cut by 2050

Cuts that require changes in behavior

Solution	Gt CO2 equivalent
Reduced Food Waste	71
Plant-Rich Diet	66
Silvopasture	31
Rooftop Solar	25
Regenerative Agriculture	22
Tropical Staple Trees	20
Conservation Agriculture	17
Tree Intercropping	17
Clean Cookstoves	16
Managed Grazing	16
Farmland Restoration	14
Electric Vehicles	11
Improved Rice Cultivation	11

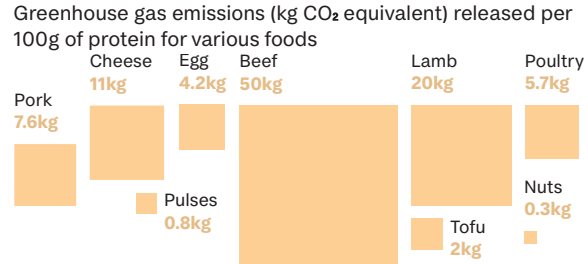
Source: RARE, Drawdown, 2019

Other solutions

Solution	Gt CO2 equivalent
Refrigerant Management	90
Wind Turbines (Onshore)	85
Tropical Forests	61
Educating Girls	51
Family Planning	51
Solar Farms	37
Peatlands	22
Temperate Forests	22
Afforestation	18
Geothermal	17
Nuclear	16
Wind Turbines (Offshore)	14

Eat well

If the world’s population moved to a plant-based diet, emissions would fall by up to 8bn tonnes (25 per cent) a year and human health would improve. *IPPC*



Source: Science Mag

Travel well

Global emissions from aviation could increase 180 per cent by 2030. A return flight from London to Rome emits 234kg of CO₂ per person, which is more than the average person in 17 of the lowest-emitting countries produces in a whole year. *Bloomberg, 2019*

Dress well

The global fashion industry has an annual carbon footprint of 3.3bn tonnes of CO₂ equivalent. That’s close to the combined carbon footprint of all 28 current members of the EU (3.5bn tonnes). *The Guardian, 2015*

“If you don’t think you’ll wear a garment at least 30 times, then don’t buy it.”

Livia Firth, Founder of Eco Age

Protest

In the 20th century political parties and NGOs like Greenpeace championed environmentalism. Now it's international grassroots movements like Extinction Rebellion and Fridays for Future that are taking action.

Who are XR?

Extinction Rebellion (XR) was founded in 2018 by Roger Hallam, an organic farmer from Wales, and Gail Bradbrook, a director of strategy in non-profit work.

Among the movement's demands are (1) a government declaration of a climate and ecological emergency, (2) net zero greenhouse gas emissions by 2025, and (3) handing government decision-making on climate policy to a citizens' assembly.

Two of those demands have been met (sort of): the UK declared a climate emergency in May last year and the first citizens' assembly took place in January 2020. While XR activists welcomed it, they said they "cannot pretend that this is a legitimate assembly with real or legislative power".

72 Countries with an XR branch

643,000 Instagram followers

3,000 Number of arrests in the UK during two protests in April and October of last year

>1m Total income in £'s last October

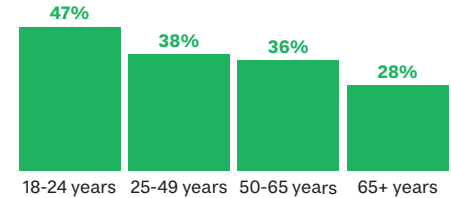
59 Per cent of XR's income that was crowdfunded in last quarter of 2019

Extinction Rebellion

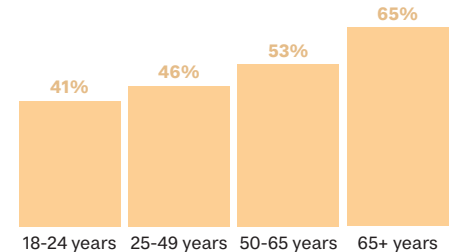
Extinction Rebellion gets the most support from younger adults

Do you support or oppose disruptive climate protests?

Support



Oppose



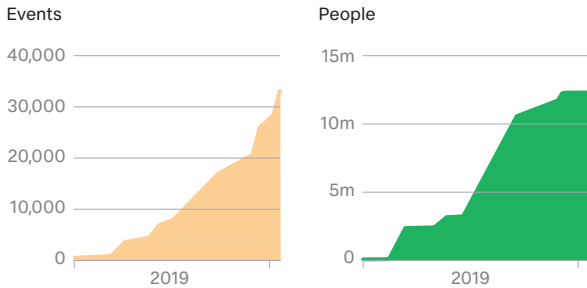
Source: BBC/YouGov, April 2018=9

Fridays4Future

In April 2019 1.6m students in more than 300 cities protested for climate action, eight months after the first school strike by 16 year-old climate activist Greta Thunberg in Stockholm. *The Guardian*

In early September, the number of people walking out of schools or classrooms to protest lack of engagement in the climate emergency had swelled to 6m. *350.org, The Guardian*

Cumulative number of Fridays for Future events and participants



Source: Fridays for Future

A Friday in jail

Arshak Makichyan is a 25 year-old violinist from Armenia. Inspired by Greta Thunberg, Makichyan joined the Fridays4Future movement and spent 40 weeks solo-striking in front of his school in Moscow. Last December, Russian authorities detained him for a week for demonstrating.

Despite the fact that Russia is warming 2.5 times faster than the planet as a whole, President Vladimir Putin has repeatedly denied that climate change is the result of human activity. *PRI, 2015*

What is government promising to do about the climate crisis?

The UK government has set itself the challenge of reaching net-zero greenhouse gas emissions by 2050. How ambitious, and achievable, is that target?

Promises of net-zero

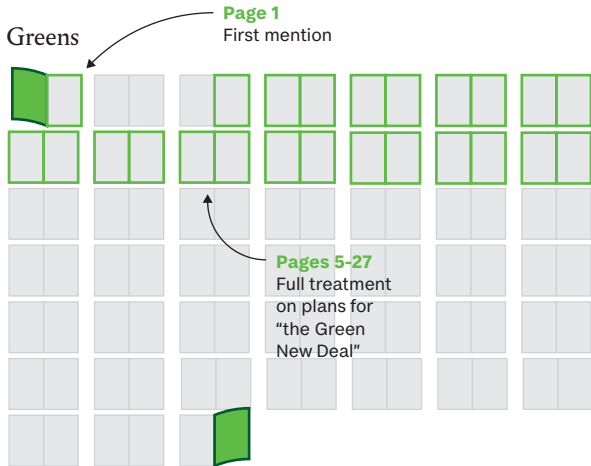
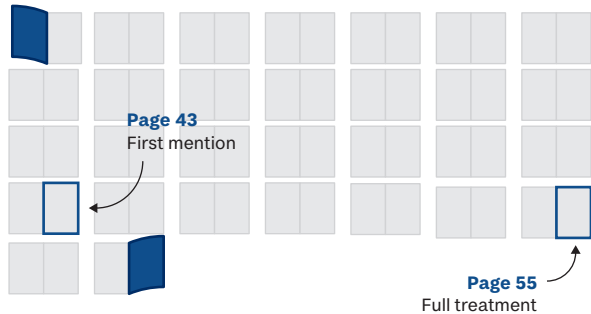
Status	Country	Proposed date	Includes international aviation and shipping?
In law	Sweden	2045	No
	UK	2050	Yes
	France	2050	No
	New Zealand	2050	No
Proposed legislation	Chile	2050	Unclear
	Fiji	2050	No
In policy document	Norway	2030	No
	Uruguay	2030	No
	Finland	2035	No
	Iceland	2040	No
	Switzerland	2050	Unclear
	Denmark	2050	No
	Portugal	2050	No
	Costa Rica	2050	No
Target under discussion	EU	2050	No
	Germany	2050	No
	Italy	2050	Unclear
	Canada	2050	Unclear
	Spain	2050	No
	Mexico	2050	Unclear

Source: ECIU, 2020

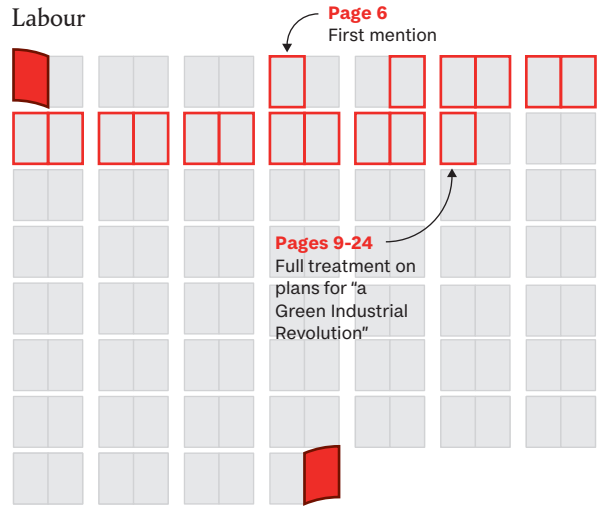
During the last UK general election Tortoise asked whether mounting public awareness of the climate emergency was reflected in the manifestos of the four main political parties. Here's what we found:

Climate as pagination

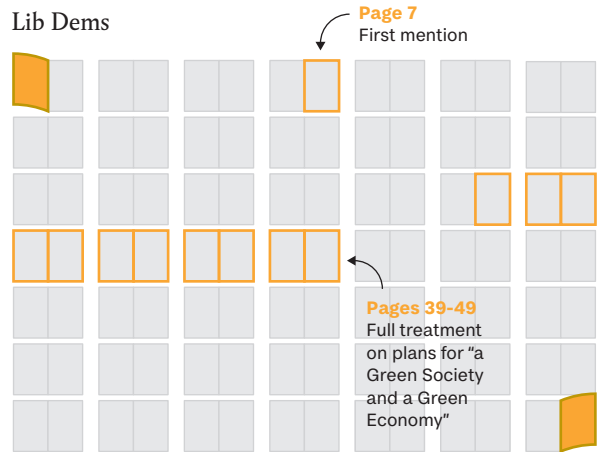
Conservatives



Labour



Lib Dems

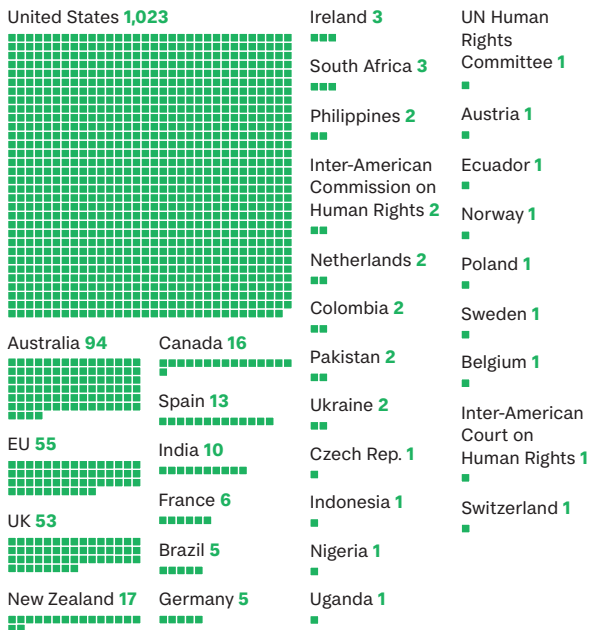


Accountability

“Young people standing up in court for their right to a viable future may be our best chance to ensure that we rise to the challenge and fight hard to avoid the worst impacts of climate change.”

Paul Rink, Yale School of Forestry and Environmental Studies

Number of climate change cases filed by jurisdiction



Source: Grantham Institute, 2019

Over 75 per cent of national constitutions contain some reference to environmental rights or responsibilities. The UN Special Rapporteur on Human Rights and the Environment stated that “climate change clearly and adversely impacts the right to life”. *Rink et al., 2019*

In recent years, climate advocates, many of them children, have begun to invoke these rights in court in order to hold governments to account:

UK Secretary of State for Environment vs Client Earth

Client Earth, the environmental law firm, has won three cases against the UK government over illegal air pollution. Last year the High Court ruled that there was a failure to require action from 45 local authorities with unlawful pollution levels.

State of the Netherlands vs The Urgenda Foundation

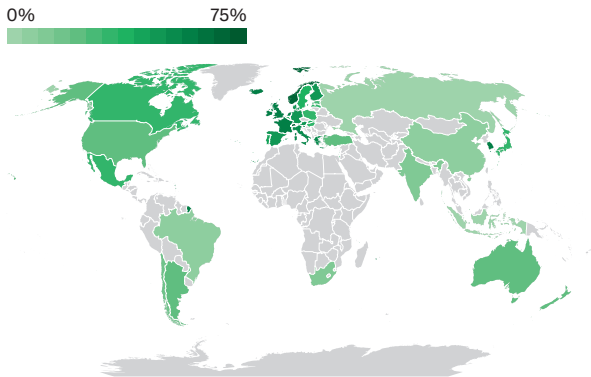
In 2015, the NGO Urgenda, together with 900 citizens, won a case against the Dutch government, forcing it to take more action on climate change. The High Court ruled that the Netherlands must reduce national greenhouse gas emissions by a quarter by 2020 (relative to 1990 levels).

What else should governments do?

Price carbon

46 governments around the world have implemented a form of carbon pricing, either through direct taxation on fossil fuel producers or cap-and-trade programmes. 13 per cent of annual global emissions are within a CO₂ pricing framework. *IMF*

Share of emissions from energy-use priced above €30 per tonne of CO₂ (the OECD's lower estimate for the price needed to achieve the objectives of the Paris agreement)



Source: OECD, 2019

\$2 a ton: global average carbon price

\$50 a ton: price which, if implemented in all G20 countries, could prevent 600,000 premature deaths from air-pollution by 2030

\$75 a ton: carbon price consistent with 2°C warming target

IMF Fiscal Monitor

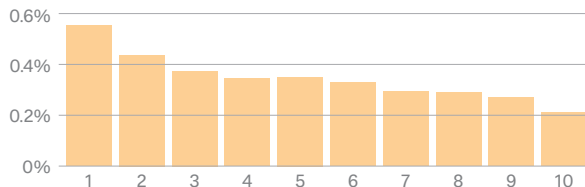
Tricky transitions

Carbon pricing can be an effective way of reducing emissions. But flat fuel taxes also have the potential to disproportionately affect the most vulnerable in society.

The Gilets Jaunes

In 2018, proposed energy tax reforms by the French government threatened the poorest tenth of the population with an effective tax burden that was nearly three times higher than for households in the top decile.

Tax burden increase from proposed French energy tax, per income decile



Source: OECD, 2019

The Gilets Jaunes movement was a response. At its height 285,000 people across France wore the signature high-vis bibs. Emmanuel Macron's government scrapped the tax increase on 5 December following violent clashes in Paris that led to eleven deaths.

A global approach

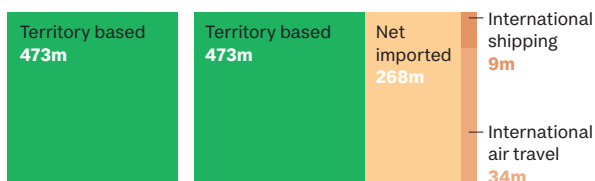
Cutting domestic emissions is only part of the battle. Around 22 per cent of global CO₂ emissions come from goods produced in countries where they are not, ultimately, consumed. *Carbon Brief, 2017*

Imports to the UK from countries outside the EU constitute 45 per cent of our total imports but are responsible for 79 per cent of imported emissions. This is largely due to imports of agricultural and manufactured goods from countries like China where energy is carbon intensive. *CCC, 2019*

International and imported emissions accounted for UK carbon footprint increases totalling 613 million tonnes of CO2 equivalent in 2016

473m tonnes

784m tonnes



Source: ONS

One way to price these international emissions could be to establish a “carbon border tax”. This would force consumers in the West to pay for the carbon used to make products abroad. Some businesses say this would present an obstacle to free trade.

“The bottom line is that carbon consumption, not production, is what counts. Any serious global climate policy would have those who cause the emissions paying for them. And the obvious answer is to price carbon whatever its source.”

Professor Dieter Helm, *Financial Times*, 2010

Part three Business and net zero

Business leaders like to talk about tackling climate change...

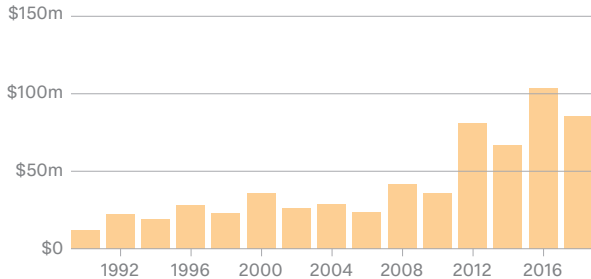
“Climate change has become a defining factor in companies’ long-term prospects... Awareness is rapidly changing, and I believe we are on the edge of a fundamental reshaping of finance.”

Larry Fink, Chairman and CEO of BlackRock, 2020 Letter to Shareholders

...but are they walking the walk?

- Despite voicing concern for climate-related risk, asset managers BlackRock and Vanguard blocked 16 climate-critical shareholder resolutions at S&P 500 companies last year. *The Guardian, 2018*
- 100 companies were responsible for 71 per cent of estimated global emissions between 1988 and 2015. *Full Fact, 2018*
- Since 2010, the world’s five biggest publicly traded oil and gas companies – Chevron, BP, Exxon Mobil, Shell and Total – have spent more than a quarter of a billion euros lobbying the EU. During the 2018 US midterm elections, oil majors spent a collective \$2m on targeted Facebook ads that promoted the benefits of increased fossil fuel production. *InfluenceMap, 2019*

Total lobbying spend of the US oil and gas industry, 1990–2018

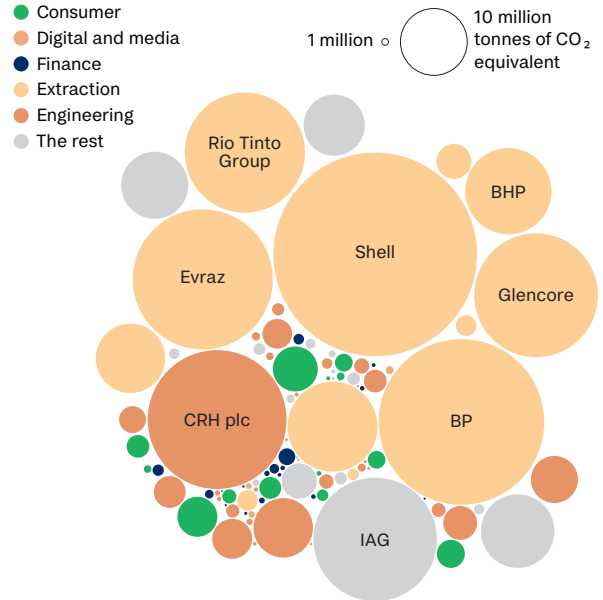


Source: Open Secrets

Tortoise’s Responsibility100 Index ranks companies in the FTSE 100 on their “talk” (how many promises they made to improve sustainability) and “walk” (their actions).

Company	Talk	Walk	Gap	Sector	Total rank
Glencore	8	82	-74	Mining	68
Mondi	2	75	-73	Packaging	55
Royal Dutch Shell	16	86	-70	Energy	74
Smurfit Kappa	26	91	-65	Packaging	85
Carnival Corporation & plc	35	90	-55	Travel	86
M&G	33	83	-50	Financial Services	78
Prudential plc	33	83	-50	Insurance	78
CRH plc	37	85	-48	Construction	83
DS Smith	45	93	-48	Packaging	91
Polymetal International PLC	43	89	-46	Mining	87

Source: Tortoise Responsibility100 Index



Source: Tortoise Responsibility100 Index

BP's pledge

In February 2020 BP said it planned to cut carbon emissions from its operations and the oil and gas it sells to net zero by 2050. That would be a reduction of 415 million tonnes of CO₂ a year, more than other oil companies have pledged.

Standard Life Aberdeen, a shareholder, called the announcement "significant". Greenpeace UK said the 2050 deadline was too far off. A spokesman asked: "What are they going to do this decade, when the battle to protect our climate will be won or lost?"

How can business help us get to net zero?

“Carbon emissions have to decline by 45 per cent from 2010 levels over the next decade in order to reach net zero by 2050. This requires a massive reallocation of capital. If some companies and industries fail to adjust to this new world, they will fail to exist.”

Mark Carney, Governor of the Bank of England

1. Measure

More than 8,300 companies have disclosed information on their environmental performance to the Carbon Disclosure Project.

Under regulations added to the UK Companies Act in 2013, quoted companies are required to list emissions in their directors’ report. Accurate carbon footprint reporting could help cut four million tonnes of CO₂ emissions by 2021. *Defra*

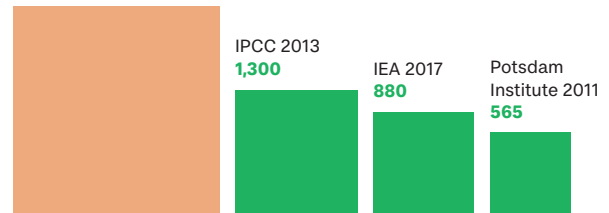
285 companies around the world have approved a science-based target specifying exactly how they plan to limit emissions in alignment with the Paris goal of below 2°C. *Science Based Targets, 2019*

2. Divest

UCL’s Institute for Sustainable Resources estimates that a third of all oil reserves, half of gas reserves and 80 per cent of coal reserves as of 2015 need to stay in the ground until 2050 if we are going to stick to 2°C.

Known reserves and varying estimates of how much CO₂ can be released under the terms of the Paris Agreement

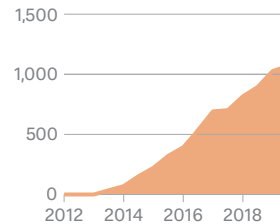
Emissions from all known oil and gas reserves
3,683 gigatonnes



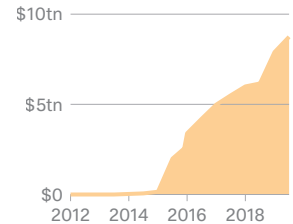
Source: Carbon Tracker

Growth of fossil-fuel divestment

Cumulative number of committed institutions



Cumulative represented assets

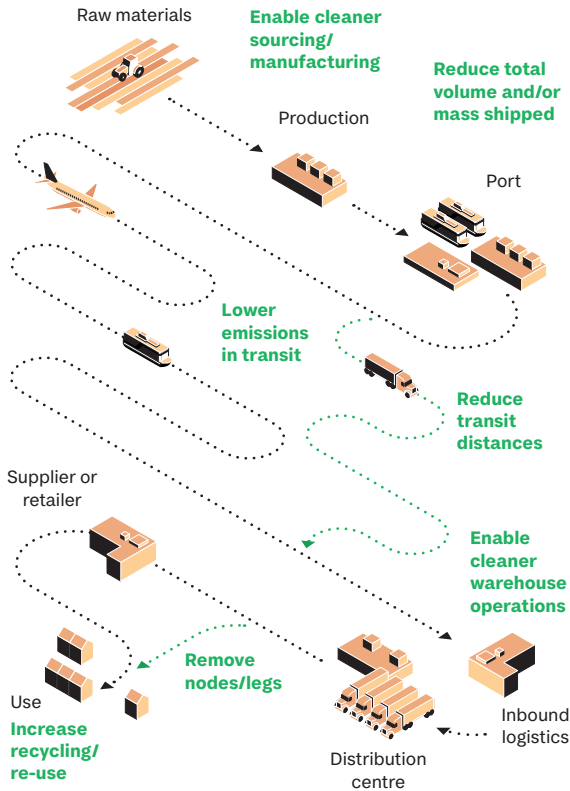


Source: Gofossilfree.org

In response to this problem, the number of institutional investors dumping fossil fuel stocks has risen from 180 in 2014 to more than 1,100 today. Total assets under management in divesting institutions have passed the \$11tn mark – a rise of 22,000 per cent from 2014. *350.org*

3. Decarbonise

Emissions from a company's entire supply chain including its products (known as scope 3 emissions) are on average 5.5 times higher than emissions by the company itself. *CDP, 2019*



Source: WEF

The sustainable supply chain

There's growing awareness that governments alone can't get us to net zero. We increasingly look to companies to lead on sustainability issues, to work with governments and NGOs and to be transparent about their operations. Some have already made positive changes:

- Unilever has been active in supporting local government in Sabah, Malaysia, to stick to its commitment to sourcing palm oil that is certified by the Roundtable on Sustainable Palm Oil.
- In 2007, Coca-Cola committed to replenish an amount of water equivalent to their sales volume, and worked with thousands of franchises and communities to achieve that goal.
- Walmart is working with 500 of its biggest suppliers to analyze supply chains in an effort to mitigate one gigatonne of CO₂ emissions.

4. Incentivise

One in four European companies reward their senior management for meeting climate targets. *CDP*

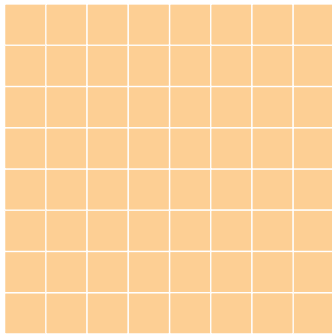
But only 62 per cent of CEOs say they would agree to link their pay to sustainability outcomes.

Accenture, UN Global Compact, 2019

Most pension funds don't hold executives accountable on climate issues:

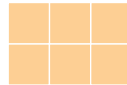
No accountability or information

64%



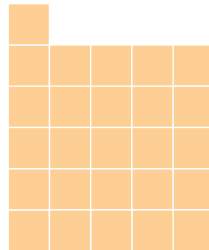
Dedicated team or position below the executive

6



Executive accountable

26



Other

4



Source: Share Action

Case study: Doing a Dong

In 2012 Dong, Denmark's largest oil and gas company, was in the red. Natural gas prices were dropping fast and its S&P credit rating was downgraded to negative. A new CEO was installed and the company changed its name – and focus.

Dong is now called Orsted and is the world's biggest offshore wind developer, controlling a third of the market outside China. The company has committed to reducing greenhouse gas (GHG) emission intensity from its energy production by 96 per cent by 2023.

This might not hurt that much...

"The business case to invest in a transition to a low-carbon economy is becoming extremely compelling."

David Blood, Managing partner, Generation Investment Management

Total assets under management, selected regions

\$92tn

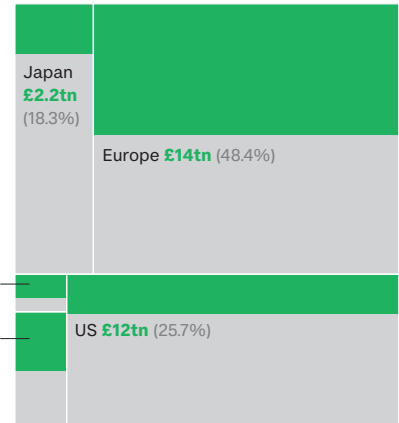
Of which sustainable

\$30.6tn

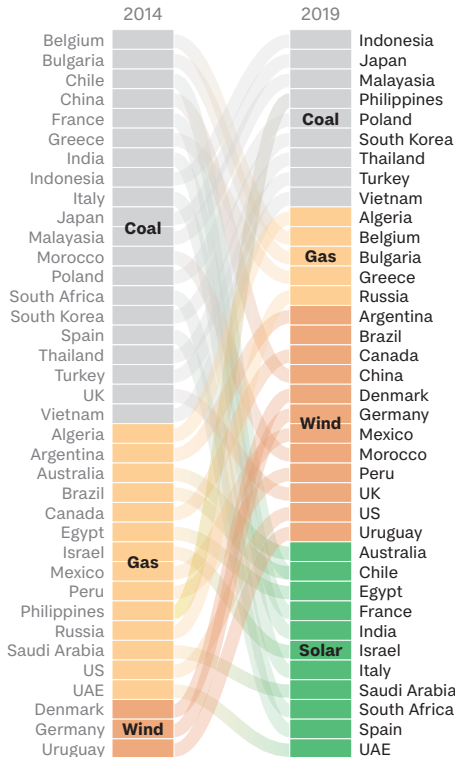
Australia/N Zealand
£0.7tn (63.2%)

Canada
£1.7tn (50.6%)

Source: BloombergNEF



Cheapest energy generation technology, by country



Source:
BloombergNEF
New Energy
Outlook

Global trade in low-carbon goods and services could grow from £150bn in 2015 to between £2.8–£5.1 trillion in 2050. *Grantham Institute, 2015*

In the UK, low-carbon industries could grow from around 2 per cent of total output in 2015 to 8 per cent of GDP by 2030 and 13 per cent by 2050. *Grantham Institute, 2015*

Part four Living with net zero

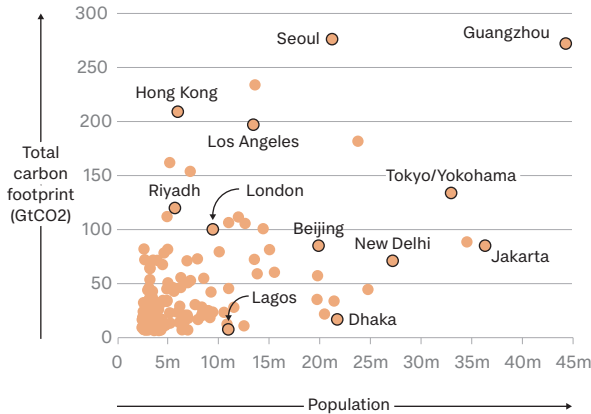
“Don't it always seem to go,
That you don't know what
you've got til it's gone,
They paved paradise,
And put up a parking lot.”

Big Yellow Taxi by Joni Mitchell

Combating climate change has to start in cities. Urban areas are responsible for around 70 per cent of energy-related carbon emissions. They produce more than half of global waste and consume three quarters of natural resources. By 2050, 66 per cent of the world's population will live in them. *UN, 2018*

Cities are polluting, and they are vulnerable. Over 90 per cent of urban areas are coastal, putting them at risk from increased flooding. By 2050, eight times as many city dwellers as now could be exposed to extreme temperatures. 650m people could face a decline in freshwater availability. For cities, preparing for the physical damage caused by climate change is almost as urgent as stopping it. *C40 Cities, 2019*

Carbon footprint of world cities in gigatonnes of CO₂



Source: Global Gridded Model of Carbon Footprints

The positive news is that these two issues – mitigating and adapting to climate change – can be dealt with simultaneously in many cities. Reforestation, urban planning and land and water management offer strategies for protecting cities from risk as well as cutting their carbon footprint.

Homes in large towns also tend to emit less CO₂ per person than those in the countryside, on account of being smaller, more tightly packed and easier to heat. *CCC, 2019*

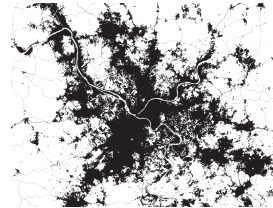
A tale of two cities

Levels of particulate pollution in Pittsburgh rose last year. The former steel town has the worst air quality in the US outside California, and higher than average rates of asthma and cancer.

In Stockholm, 95 per cent of the population lives within 300 metres of a green space, 99 per cent of locally-produced waste is recycled and 80 per cent of the city's energy comes from renewables. *Renewable Energy Atlas*

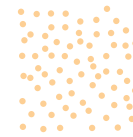
Pittsburgh, Pennsylvania
United States

Urban extent



Population density

740
residents
per km²



GDP per capita (\$)

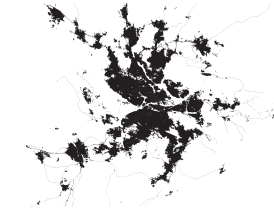
54,192

CO₂ emissions per capita

17.72

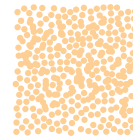
Stockholm
Sweden

Urban extent



Population density

3,660
residents
per km²



GDP per capita (\$)

80,234

CO₂ emissions per capita

3.15

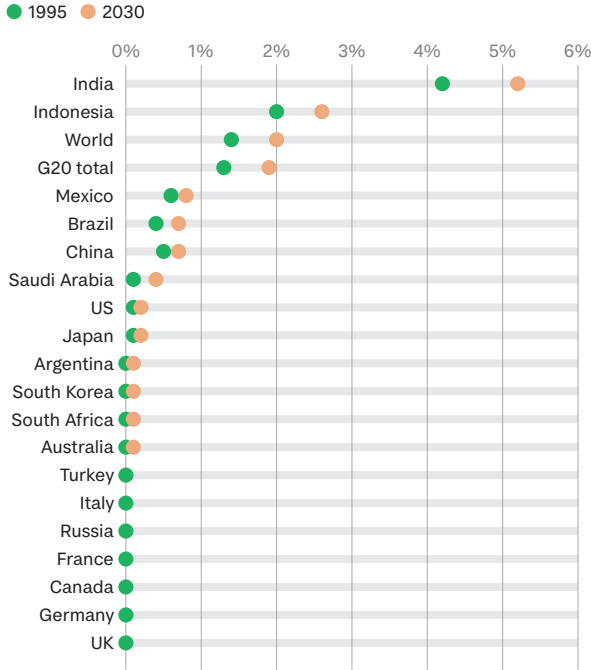
Source: Coalition for Urban Transitions, Sedac, Nasa

Work and net zero

As the frequency and intensity of extreme weather events increase, the productivity of the world's labour force will be impacted. Heat stress caused by higher temperatures could reduce the total number of work-hours in G20 countries by 1.9 per cent by 2030. *ILO, 2019*

Percentage of work-hours lost owing to heat stress under a 1.5°C scenario

Selected G20 countries, 1995–2030



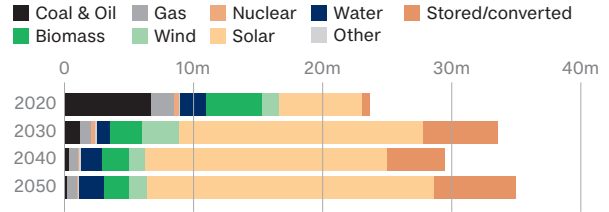
Source: ILO, 2019

But adapting to a zero-carbon economy can also create jobs. In Europe, around 500,000 new jobs could be created in adaptation-related sectors such as construction, water management, forestry and skills development. *ILO, 2019*

A transition to net zero by 2050 would also boost employment in the energy sector:

Energy transition creates more jobs

In millions per energy type worldwide



Source: LUT, Energy Watch Group

A “just” transition

Changes in climate policy are expected to impact 0.5 per cent of total employment – that’s relatively small compared with the overall job “churn” that occurs in market economies. *UNPRI, 2019*

But there will be workers in some sectors and regions who need extra help dealing with the transition. Historical experience of deindustrialisation shows it’s important not to leave workers or communities stranded without access to the benefits of a low-carbon economy.

- The UK car industry could receive a significant boost from the move to electric vehicles. In the UK this could lead to 7,000 to 19,000 additional jobs.
- Greater focus on recycling, repairing and renting could create more than 200,000 jobs in the UK.
- Employment in the UK oil and gas sector fell by a third between 2014 and 2017.
- There are now fewer than 700 people who work in the UK’s coal industry. *ECIU, 2018*

Part five

Redefining progress

For most of the last century, human development has been measured almost exclusively in economic terms. But indicators like GDP per capita or the HDI (human development index) fail to account for the causes and impacts of climate change. Countries that appear at the top of the list of “most developed” are frequently the biggest emitters.

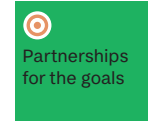
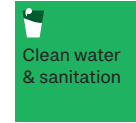
In response, several models have been proposed that measure progress differently.

The Sustainable Development Goals Index

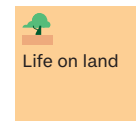
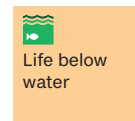
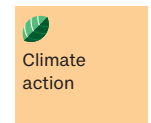
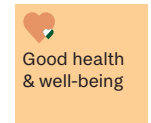
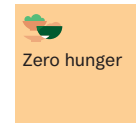
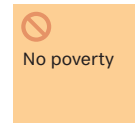
The SDG Index is a worldwide study that tracks where each UN member state stands in relation to 17 sustainable development goals.

Here’s how the UK fared in 2019:

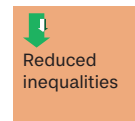
On track or maintaining SDG achievement



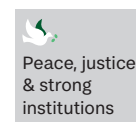
Moderately improving



Stagnating



Information unavailable



Source: UN

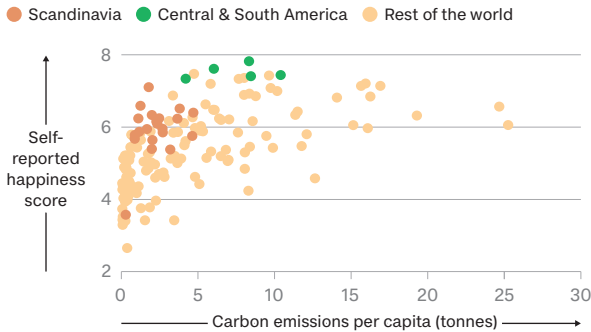
Wellbeing

Some have argued that happiness or wellbeing are better metrics for progress than GDP, HDI or the SDGs.

“Money does not equate with happiness. Population surveys have produced this striking finding, demonstrating that significant increases in average income in many countries have not translated into a corresponding rise in average levels of happiness and subjective wellbeing.”
Professor Richard Layard, LSE

Likewise, increased carbon consumption doesn't necessarily make citizens happier. In certain areas of the world per capita emissions are relatively low while self-reported wellbeing is high.

CO₂ emissions per capita and self reported happiness score of selected countries



Note: Wellbeing is an individually and culturally subjective measure.
Source: World Bank and World Happiness Report

Others say it is not so much how progress is measured that's the problem but the economic system that has underpinned progress so far.

“We have not done the things that are necessary to lower emissions because those things fundamentally conflict with deregulated capitalism, the reigning ideology for the entire period we have been struggling to find a way out of this crisis.”

Naomi Klein, *This Changes Everything: Capitalism and the Climate*, 2014

Tortoise is a different kind of newsroom, for a slower, wiser news. Tortoise became the biggest journalism project ever on Kickstarter in late 2018 and was launched to the public in April 2019. Tortoise is built with and for its members, of whom it has almost 30,000 at February 2020, of which over 8,000 are funded memberships through the Tortoise Network. The Tortoise Network is an inclusive membership model which ensures Tortoise journalism is open to the people who are hardest for news platforms to reach but whose voices we most need to hear.

Tortoise was co-founded by James Harding, former Director of BBC News, Katie Vanneck-Smith, former President of Dow Jones and the Wall Street Journal, and Matthew Barzun, former US Ambassador to the UK.

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