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AIQ

THE CLIMATE EDITION



CLIMATE CHANGE

The journey from denial to crisis

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Putting out a fire

Historians may look back on 2019 as a major turning point in popular understanding of the threats posed by climate change. Wildfires in Australia, the Amazon rainforest and California; floods in Mozambique, the north of England and the Philippines; deadly air pollution across many cities in India and China. Extreme weather events have brought the issue firmly into the here and now, no longer something far off in the distance in terms of geography and time.

With the Climate Summit in Madrid (COP25) a massive letdown, the eyes of the world are already turning to COP26 in Glasgow later this year. The pressure to get the world back on track towards meeting the commitments of 2015's Paris Agreement could not be greater.

Sustainability scientist Kim Nicholas holds up a placard at climate rallies that sums the situation up perfectly:

1. *It's warming*
2. *It's us*
3. *We're sure*
4. *It's bad*
5. *We can fix it*

With true academic rigour, she provides footnotes to substantiate each point. Instead of reproducing those here, the articles in this climate edition of *AIQ* can be seen as our footnotes on the crisis facing the planet.

We start with a look at the science and the psychology of climate change, then assess the impact on everything from land use to the oceans and the risk of stranded assets. We then analyse potential solutions, from big data to carbon taxes.

With energy at the heart of the climate crisis, we also consider the options in shifting away from fossil fuels. Renewables are clearly part of the answer, but we also assess whether nuclear power should play a more prominent role.

Our own David Cumming and Steve Waygood offer their thoughts on how asset managers and owners, companies and policymakers can step up to be a bigger part of the solution. The magazine also comes with a special supplement featuring some of the best interviews carried out by the *AIQ* team with a range of external experts.

I hope you enjoy the issue as much as we enjoyed putting it together. If you have any feedback, please contact me at the email address below.

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Since its launch in 2016, *AIQ* has covered the big themes influencing financial markets and the global economy. We aim to give our clients in-depth analysis of the issues that affect their investments, from demographics to big data, from climate change to China's growth. We also offer insights on more specialised topics, such as portfolio construction and cashflow-driven investing.

We don't profess to have all the answers. *AIQ* actively seeks the views of independent experts as well as Aviva Investors professionals, and regularly features contributions from world-renowned policymakers, authors and academics.

Too often, the content produced by the asset management industry is bland, jargon-heavy and self-serving. Open to fresh perspectives and committed to strong editorial principles, *AIQ* stands out. After all, it's good to be different.



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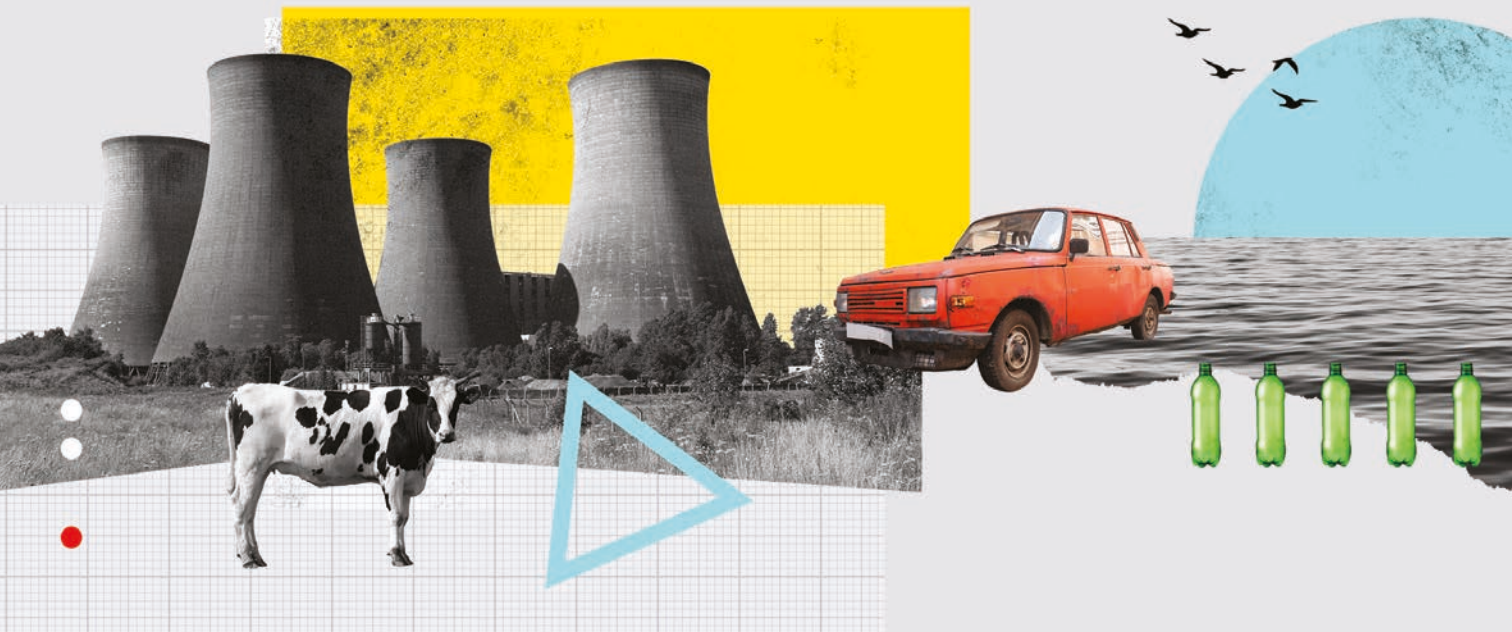
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CLIMATE CHANGE: THE JOURNEY FROM DENIAL TO CRISIS

More than 40 years since a senior NASA scientist told US Congress of concerns about human activities disrupting the climate, experts are warning of an impending climate catastrophe and the financial sector is wrestling with the implications.

“
Atmospheric CO₂ is at its
highest level for 800,000 years
—”



Think of the energy created from igniting 15,000 tonnes of TNT; that's the size of the explosion made by the atomic bomb dropped on Hiroshima in 1945. Scale up the blast 400,000 times and you have the daily global energy imbalance that is causing the world to warm and threatens environmental breakdown.¹

Grappling with this unsettled former NASA scientist Dr. James Hansen. After retirement, he joined Columbia University's Earth Institute and has become a leading climate campaigner – but his message is not one everyone wishes to hear. He claims efforts have been made to silence him as he highlights the impact of humans on the planet.² In particular, by burning coal, oil and gas to release energy, carbon locked up for millennia has been released, sending atmospheric carbon dioxide (CO₂) to its highest level for 800,000 years.³

“Adding CO₂ to the air is like throwing another blanket on the bed,” Hansen says. “It reduces Earth's heat radiation to space, so there's a temporary energy imbalance. More energy is coming in than going out, until Earth warms up enough to again radiate to space as much energy as it

absorbs from the sun. So, the key quantity is Earth's energy imbalance. Is there more energy coming in than going out?”⁴

Yes, is the short answer. The daily global energy imbalance is about six-tenths of a watt per square metre. “That may not sound like much, but when added up over the whole world, it's enormous,” says Hansen. “It's about 20 times greater than the rate of energy use by all humanity.”

With humans “throwing blankets on the bed” at some pace, the world is tending to warm⁵ and natural equilibria are being altered. Methane, an even-more powerful warming gas than carbon dioxide, has been increasing too, leaking from modern gas distribution networks, rotting food and ruminating animals. Fluorinated gases and nitrous oxide are also being emitted from various industrial processes, with a notable ability to warm.⁶

“The evidence that the climate is changing is overwhelming,” says Professor Richard Tol from the University of Sussex, a former member of the Intergovernmental Panel on Climate Change (IPCC) and joint winner of the Nobel Peace Prize for contributions to knowledge on global warming.⁷ “And the

evidence that humans are a major – if not the main cause – is also overwhelming. We see that through different lines of evidence. We see it in the paleo record and in the instrumental record. We've seen it in well-calibrated, complicated climate models, and we see it in simpler models that are essentially based on the first principles of physics. All these lines of evidence indicate that climate is changing and that humans are the main cause.”

Just like Tol, most scientists dismiss the idea human-induced climate change is a hoax, as US President Trump once famously suggested.⁸ (Nevertheless, Tol rejects the widely-publicised claim that “97 per cent of scientists agree”⁹ on climate warming. He says that is “bogus”, because of the way the net for sample data was cast.)

The consensus view is that human actions have shifted the climate into a new era – the Anthropocene¹⁰ – where humans are in the driving seat. In this phase, atmospheric CO₂ has reached “the dangerous zone”, according to Hansen, more than 15 per cent above the “long-term safe” level of 350 parts per million.¹¹

CLIMATE CHANGE: THE JOURNEY FROM DENIAL TO CRISIS

continued

The pace of change is startling. Although the earth has experienced phases of heating and cooling over millennia, atmospheric temperature is increasing around ten times faster than ever before, too fast for many plants and animals to adapt.¹² And the processes triggered have some way to run, because so much of the Earth's surface is covered in water.

"Most of the heat we have been putting in the atmosphere actually disappears into the ocean," Tol explains. "Essentially, what we are doing is heating up the ocean very, very slowly. Even if we were to stop emitting CO₂ now, the world would continue to warm for another 50 or 100 years. The same is true of the oceans. Sea level rise is essentially driven by the heating of the ocean, and the expansion of sea water. We have set something in motion that will take at least a millennium to work through."

For now, the changes in the cryosphere are most obvious in shrinking sea ice and calving glaciers. Satellite images of Greenland suggest around 278 gigatonnes of ice is melting each year, releasing enough water to fill more than 110,000 Olympic swimming pools.¹³ As the earth is exposed, it can absorb more solar energy than the ultra-reflective ice surface it has replaced.

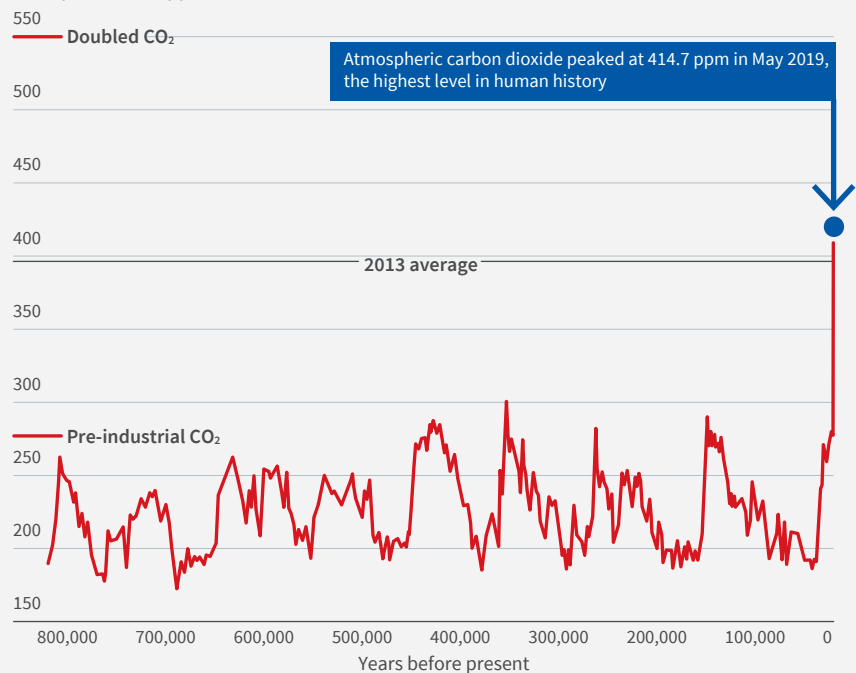
Facing a warmer, more volatile world

With more energy in the atmosphere, circulation patterns are changing, bringing hotter and drier weather in places, but more extreme rainfall and flooding in others. Extreme temperature events have become about 20 times more likely since 1950,¹⁴ with a number of new records set in the last decade.¹⁵ The idea of temperatures literally reaching "off the charts" raises the prospect that current heat indices may need to be revised.¹⁶

With higher temperatures, hurricanes intensify more quickly, rapidly swelling with water vapour.¹⁷ US academics Michael Mann and Andrew Dessler say that made Hurricane Dorian "bigger, wetter and

Figure 1: Hotting up: Levels of atmospheric carbon dioxide

Parts per million (ppm)



Source: NOAA NCDC Paleoclimatology Program, 2008, cited by Professor Chris Budd in *The Mathematics of Climate Change*, 2019. NOAA, reported in EarthSky, June 17, 2019.

more deadly", for instance, bringing a devastating storm surge and winds raging over 220 miles per hour.¹⁸

Meanwhile, population growth is changing the nature of the natural world, exacerbating the warming trend and contributing to "biological annihilation"¹⁹ (see Biological annihilation: The facts, p.9). Felling forests and clearing peatlands release CO₂ and reduce future uptake through photosynthesis, with less CO₂ absorbed and less clean oxygen released. As we clear around one football pitch of forest every second,²⁰ the Earth's potential to self regulate is being diminished.

"We need to pay as much attention to how good the natural environment is at soaking up carbon as to how much we're emitting," says Dieter Helm, professor of economics at the University of Oxford. "When it comes to that, the climate change story is much worse than people are currently projecting. Until recently, you didn't hear much discussion about the scale of destruction of rainforest, huge carbon sinks of natural sequestration. What's going on in the Amazon, the Congo, the Mekong Delta and elsewhere is very, very serious." Now the race is on to protect vast carbon stores like the Congo's Cuvette

Centrale peatlands, recently discovered to be much larger than first thought, holding the equivalent of 15 years' worth of US fossil-fuel emissions.²¹

With ecosystems degrading, extinction rates are said to running more than one hundred times faster than the "background" rate, where one to five species are lost a year. Some estimates put the figure even higher.²² Erosion and soil degradation are widespread, with topsoil being lost around ten times faster than it is being replenished.²³

So, multiple parts of the biosphere are being altered simultaneously, ringing warning bells for those watching the natural world.

Assessing the environmental fallout

Several major impacts could follow. First, large parts of the globe may become so inhospitable that human ecosystems are disrupted. Rick Stathers, responsible investment analyst and climate change specialist at Aviva Investors, says signs of this are evident already.

"Think of the recent groups of migrants leaving Syria for Europe or the Central American migrant caravans heading to

BIOLOGICAL ANNIHILATION: THE FACTS

Over 100 billion people have walked the planet, making a gigantic stamp on the Earth. Around three-quarters of the land and around two-thirds of the marine environment have been significantly altered by humans, impacting the carbon cycle and changing the prospects for many species.

Climate change, pollution (300-400 million tonnes of heavy metals, solvents, toxic sludge and industrial waste are dumped annually)¹ and changing land use have increased the pace at which species are dying out. A landmark report from the UN's Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services in 2019 suggests that approximately one million species of plants and animals face extinction.² Professors from Stanford University describe this as "biological annihilation".³ In contrast to past extinctions, this is a human-made crisis, with ecosystems degrading faster than ever.



As each species is closely linked to others in a complex web of life, there are likely to be cascade and multiplier effects. In the oceans, the phytoplankton at the base of the food chain have become about ten per cent less productive since the start of the industrial era.⁴ This is a potential threat to numerous forms of marine life, from the smallest shrimp to gargantuan whales.

On land, pollinators are in decline, challenging the plants that need insects to reproduce. Less diverse plant life also means possible extinctions in related organisms – in those needing specific types of vegetation to breed, for example. Ultimately, less diverse ecosystems tend to be less productive and less resilient.

Overall, we know the human population is placing growing pressure on other species, but do not fully understand the impact of homo sapiens – so our own capacity to make a difference is limited. "We cannot help every species adapt, for two reasons," explains Professor Richard Tol from the University of Sussex, a former member of the Intergovernmental Panel on Climate Change (IPCC). "Many species are still unknown, and their place in ecology is also unknown. The other is simply a question of scale."

Since the 1750s, at least 571 species of plants are thought to have become extinct in the wild.⁵ Recent losses of non-plant species include the Pinta Island tortoise of the Galapagos Islands, which died out in 2012.⁶ Lost mammals include the Pyrenean ibex, declared extinct in 2000,⁷ and the sub-Saharan Western black rhinoceros, whose last member died in 2011.⁸

1 'UN Report: Nature's dangerous decline 'unprecedented'; species extinction rates 'accelerating', United Nations, Sustainable Development Goals, 6 May 2019.

2 United Nations.

3 Paul Ceballos, Paul Ehrlich and Rodolfo Dirzo, 'Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines', PNAS 114 (30), 25 July 2017.

4 Jennifer Chu, 'Phytoplankton decline coincides with warming temperatures over the last 150 years', PHYS Org, 7 May 2019.

5 Humphreys et al., 'Global dataset shows geography and life form predict modern plant extinction and rediscovery', Nature Ecology & Evolution 3, 2019.

6 'Last Pinta giant tortoise Lonesome George dies', BBC, 24 June 2012.

7 John McKenna, 'This animal went extinct twice', World Economic Forum, 11 December 2017.

8 Jessica Phelan, 'Six endangered animals that poaching might take from us forever', AFP, 30 July 2015.

the United States that President Trump has been so vocal about. Drought is certainly not the only factor, but it has played a part," he says.

Second, floodplains and coastal areas might be threatened if extreme weather events become more common and sea levels continue to rise. Vulnerable areas include those housing some of the world's megacities – vast conurbations, each populated by more than ten million people. Low-lying areas of China, India, Japan, Indonesia, Bangladesh and the United States are all high-risk zones, with

concentrated populations living close to today's sea levels.²⁴

Conversely, well-used waterways like the Rhine, one of Europe's longest rivers, may decline and become impassable to shipping if the glaciers feeding them continue to shrink and European summer temperatures rise. (The impact has already slowed goods transport, hitting German GDP in 2018.) In fact, many areas of economic activity may need to be wholly rethought; the IPCC has called for "rapid, far-reaching and unprecedented changes in all aspects of society".²⁵

Significantly, not all climate impacts will be negative: that will depend where you are, what you are doing and what timeframe you are looking at. Professor Solomon Hsiang from the University of California, Berkeley, thinks the best way to visualise this is to imagine a U-curve, with temperature on the x-axis and impact on the y. In very cold temperatures, negative impacts tend to be elevated – for example, as people experience poor health in cold weather. Equally, very high temperatures tend to be problematic. The sweet spot is where the base of the curve falls away, in

CLIMATE CHANGE: THE JOURNEY FROM DENIAL TO CRISIS

continued

the mid-zone. Higher temperatures will shift the curve to the right; the outcome will vary in each case, depending on where the trajectory began.²⁶

This is a crisis...

One uncomfortable thought is that the poorest are most vulnerable in periods of environmental upheaval. The UK's Institute of Public Policy Research (IPPR) has declared, "This is a crisis", something mainstream political debate has utterly failed to address.²⁷ The language used by the IPPR marks a step change in the climate debate, where discussions were once carefully worded and laced with caveats. Like Extinction Rebellion, whose environmental campaigners have been gluing themselves to public transport and using drones to disrupt air transport, the IPPR believes the time for tiptoeing around the issues is over.

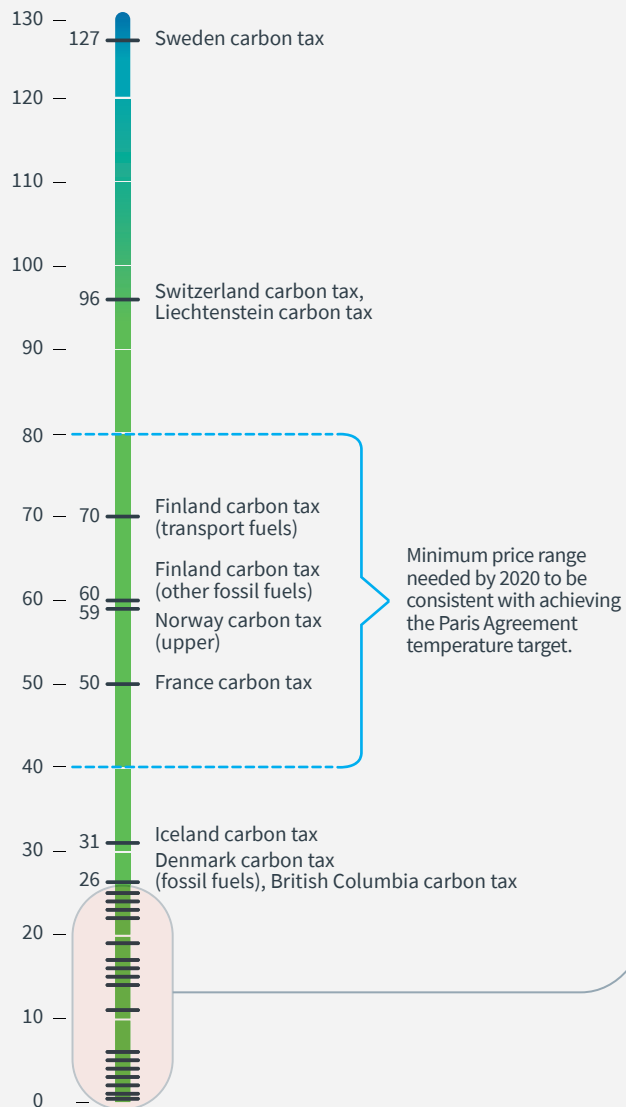
"We are not alone in using increasingly bold, but perhaps more truthful, language now," Luke Murphy, head of the IPPR's Environmental Justice Commission, says as he flags the policy vacuum. "In the past, the messages were not so strong, and there was a sense that people did not wish to scare. The idea was that we might be able to make incremental changes to address environmental issues, and that was the best way to move forward. Not anymore. People need to be aware of the fundamental risks, and we need urgent and transformational change to address them."

For some, the only solution is a less growth-driven world, where aspirations are modest and excessive consumption is frowned on. Is the way forward "bottom-up", where billions make small-scale changes, eating food produced locally to reduce unnecessary energy consumption, insulating buildings to prevent heat loss, and recycling? Or will the human tendency to focus on the present scupper change? (see Apathy, anger, action: The psychology of climate change, p.18).

The alternative response would be strongly top-down, through state-imposed price or

Figure 2: Too little, too late? Prices in implemented carbon pricing initiatives

Carbon price, US\$ per tonne of CO₂ equivalent (TCO₂e).



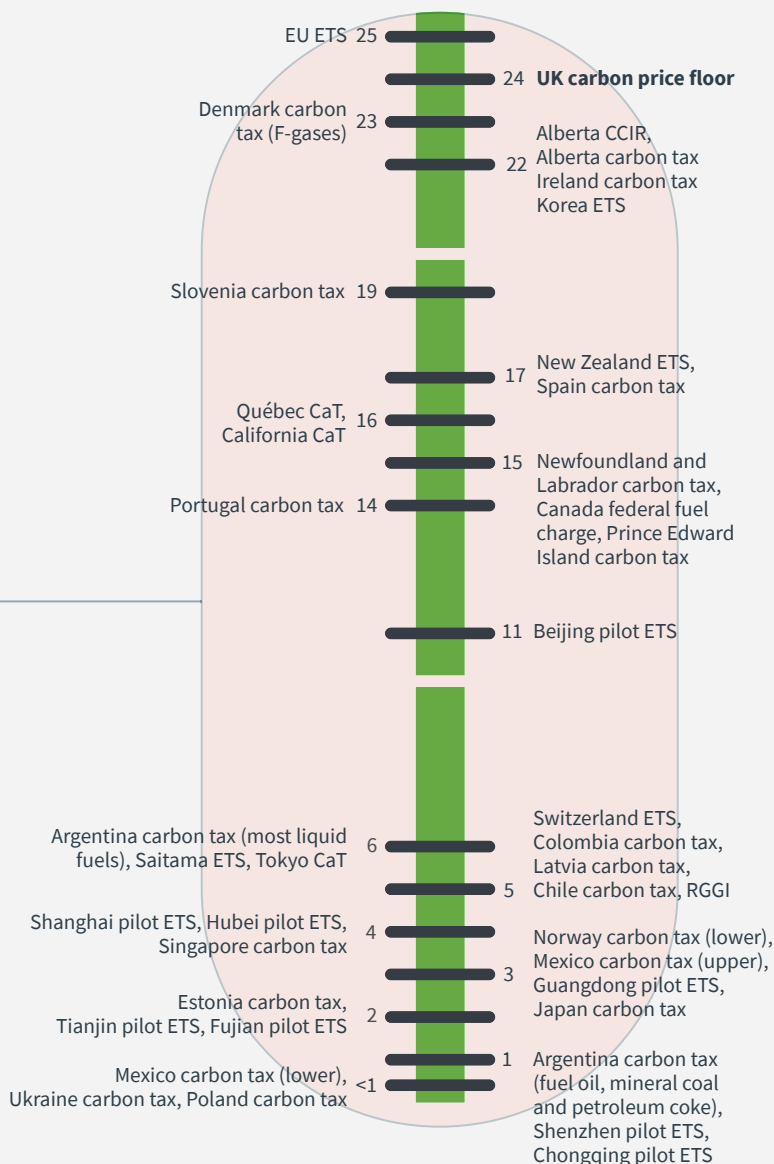
Source: World Bank State and Trends of Carbon Pricing, 2019.

quantity controls such as carbon quotas or taxes, to internalise the externalities (see 'Sticking' it to carbon: the pros and cons of taxing emissions, p.32). Past experience suggests market-based systems could trigger green innovation as well.

"The introduction of the European Emissions Trading Scheme (ETS) led to a 30 per cent rise in clean-patent filings from companies impacted by the policy," assistant associate professor Antoine Dechezleprêtre from London's Grantham Institute of Climate Change and the Environment points out. "The policy is

EU-wide, only impacting selected industry sectors. There is no uncertainty about its future; the only uncertainty is the carbon price. At the beginning it was around €30 a tonne, and that drove lots of innovation. Then it fell to €5-10 a tonne, and filings dropped because at that level companies don't feel it. But it shows economic incentives work."

Where carbon taxes have been introduced, most governments have pitched way below the "severe mitigation" scenario set out in the Paris Agreement (see Figure 2), intended to cap temperatures at below two degrees Celsius above pre-industrial levels. (The "severe



“Where carbon taxes have been introduced, most governments have pitched way below the ‘severe mitigation’ scenario set out in the Paris Agreement”

mitigation” scenario gives a 50 per cent chance of meeting that two-degree cap.)

“The Paris Agreement was made on the basis of countries making voluntary commitments,” says Steve Waygood, chief responsible investment officer at Aviva Investors. “When you add up all of those commitments, they do not get us anywhere near two degrees; they get us nearer to 3.2 degrees.” Meanwhile, policy conflicts abound: it is not unusual for an administration to negotiate a carbon tax, but have fossil-fuel subsidies running alongside.

With the outlook rather opaque, some are hoping new technologies will emerge to reverse or counter the impact of the build-up of warming gases. There are discussions around geoengineering – deliberate, large-scale interventions in natural systems to counter climate change. They range from using space reflectors to block incoming solar energy²⁸ to compressing and injecting CO₂ deep underground. (The latter has already been carried out at small scale by the Norwegian energy company Equinor,²⁹ but there are fears that scaling up might

trigger earthquakes,³⁰ ultimately allowing the gas to leak back out.)

This is the minefield policymakers must navigate. Although human-induced climate change has been described as “the greatest market failure that the world has seen”,³¹ initiatives to find solutions are far from consistent or co-ordinated. Witness the events at the 2019 United Nations Climate Change Conference (COP25), where UN climate expert Alden Meyer reported an “almost total disconnect” between the science and what negotiators delivered.³²

CLIMATE CHANGE: THE JOURNEY FROM DENIAL TO CRISIS *continued*

What happens next?

Meanwhile, academics are grappling with the processes that drive the climate to improve insights into what might happen next. In the last four decades, the models and variables being considered have developed enormously, as shown in Figure 3.

“The climate is very complex,” says Professor Chris Budd, a mathematician at the University of Bath, whose interest in using partial differential equations for problem solving has taken him deep into the operations of the Met office.³³ “It is hard to get good data, especially of the initial states. The equations for climate are hard to solve and may have multiple solutions. Chaotic behaviour is always present, and it can be hard to distinguish natural effects from human intervention.” Nevertheless, progress is being made, using supercomputers that carry out around 14,000 trillion arithmetic operations per second.

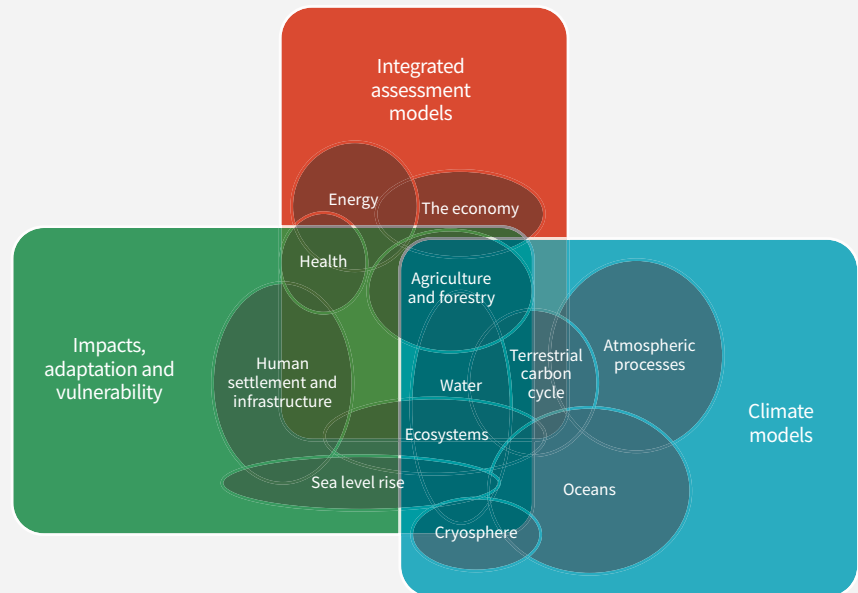
“In a typical forecast, there are about a billion discrete equations,” Budd explains. “Errors can arise in the way that the physics is represented, the algorithms used to solve that physics, the coding up of those algorithms, the data that is fed in to the calculation, and the initial conditions used to start the whole system off.”

The undertaking is riddled with uncertainty, and that includes anticipating the way in which companies and consumers might adjust their choices. So far, comparatively few in developed economies have changed their high-carbon ways, something psychologist Per Espen Stoknes blames on people’s inability to handle doom-laden visions of the future.³⁴ The problem, he believes, is “apocalypse fatigue” – we are simply exhausted by the prospect of disaster. But if large numbers perform a *volte-face*, the equations could change radically.

Combine this mega-unknown with how climate might vary anyway, and the differences in the way individual climate models function, and you can appreciate

Figure 3: Thinking connectedly: climate modelling

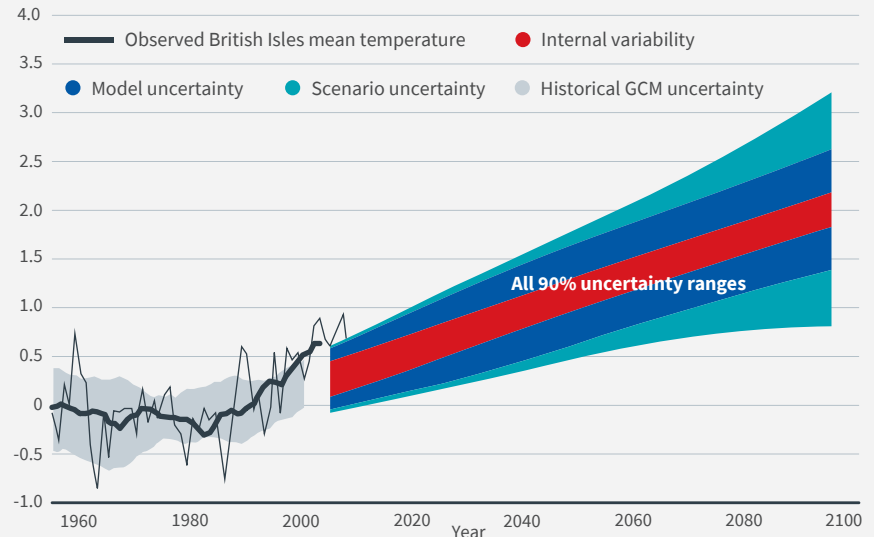
Complex, uncertain, with multiple variables in which change can occur



Source: Moss et al. 2013, cited by Budd in *The Mathematics of Climate Change*.

Figure 4: What do we know? Uncertainty in mean temperature projections

British Isles temperature change, relative to 1971–2000 (degrees Celsius).



GCM: General Circulation Model.

Source: Sources of uncertainty in CMIP5 projections, Ed Hawkins, 2013.

why the range of potential outcomes is large (see Figure 4).

Furthermore, as climate science evolves, large numbers or ensembles of simulations are being used to address the problem of climate attribution. This is a comparatively new field, designed to disentangle the drivers of natural disasters.

“A dice may be loaded to come up six,” explains Dr. Friederike Otto from the Environmental Change Institute at the University of Oxford. “But it might have come up six anyway without the loading.”³⁵

The question is: what exactly have we, as humans, done? This is a sensitive area, with major implications for companies, governments and others with a duty to plan.

“

Tracking and understanding climate attribution data is becoming increasingly important for decision makers around the world

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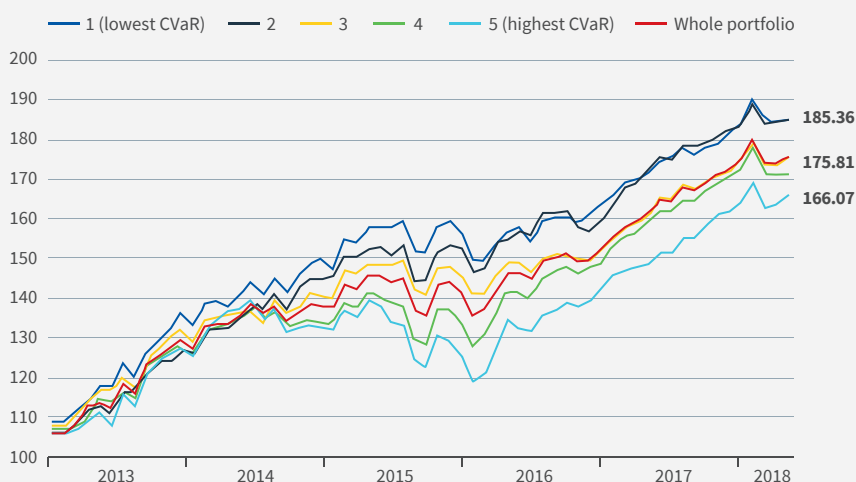
Probabilistic event attribution involves modelling how often an extreme weather event might occur in experiments representing the world as it is, then comparing it to a scenario with human impacts removed (allowing for uncertainties).

“Since I have been working on this, it’s changed from being something that people had suggested you could do theoretically to actually doing it at scale,” Otto says. “The main thing that was necessary for that to happen was that computing power has become available, so you can run large ensemble simulations of climate models; not just once or twice, but several hundred times to actually look at weather.”

Recent findings show there are certainly cases where human actions have contributed to “loading the dice”. For example, Otto’s work suggests human actions made the 2019 heatwave that saw the temperature hit 45 degrees Celsius in France near Nîmes at least five times more likely.³⁶ With European summer heatwaves, her work shows human activities have been a game changer. Conversely, there are situations where human actions seem to be making extreme events less likely; less spring-time flooding associated with snow melt, for instance.³⁷ In others, it is simply not possible to say.

Figure 5: Might a low carbon strategy pay off? Back testing 2°C CVaR

Cumulative USD return



Returns from bucket 1 (with the lowest 2°C Scenario Policy CVaR) outperformed the other four buckets and the whole portfolio, indicating an investor who would have invested in the lowest CVaR securities in 2013 (and rebalanced annually) could have generated ten per cent cumulative outperformance. Buckets are ordered by increasing levels of climate risk – i.e. bucket 1 contains the securities with the lowest levels of risk and bucket 5 contains those with the highest levels of risk.

Source: Carbon Delta, April 2019.

The blame game: Acts of God or acts of man?

Given what we know now, is it possible to allocate blame, if human actions contribute to more extreme weather and losses follow? The answer from climate modellers – where researchers have looked at both country and company-level attributions – is a qualified yes.

“When we did the study looking at different countries, you could use all the emissions since the beginning of the Industrial Revolution,” Otto explains. “Or you could say, ‘Well, you can’t say that people really knew about climate change at the time. Are they really responsible for it? Maybe we only take the emissions from 1990, when the first IPCC report was published.’ You can do that as well, and of course you will get a different number. There is a large difference between the two. Scientifically you can do both, and both make sense, but which one is the one you might want to use in court, or for any other purpose?”

Proposals are now being developed for the allocation of climate-related damages. The first of these suggested damages might be allocated by market-share theory (i.e. CO₂ contribution, multiplied by the damages caused by the climate-related event). This approach assumed CO₂ emissions and climate events have a

linear relationship. In fact, climate events may have other kinds of relationships to atmospheric CO₂ levels; they may be more extreme, so the impacts increase rapidly or exponentially, or sigmoidal in shape (like a stretched out ‘S’).³⁸

Analysis of these relationships is quite new, and the implications of integrating non-linear relationships in emissions and impact profiles are significant.³⁹ For example, if you take an S-shaped emissions profile, the impacts change markedly through time. Depending when the calculation is carried out and when emissions are released, the attributable damage liability might be lower than that calculated from a linear profile or more than three times greater.

Deep impact

Tracking and understanding these sensitivities is becoming increasingly important for decision makers around the world. The implications run deep for insurers and other asset owners: there are specific physical risks associated with the changing climate; there are litigation risks that might come from those who believe they have suffered losses; and there are transition challenges that will come from the shift to a lower-carbon economy.

CLIMATE CHANGE: THE JOURNEY FROM DENIAL TO CRISIS

continued

Transition risks might be especially acute in a rapid-change scenario – the “too late, too sudden” shift European regulators are concerned about.⁴⁰ A wholesale reassessment of prospects could destabilise markets and spark a sell off, bringing a “climate Minsky moment”, as the outgoing Governor of the Bank of England Mark Carney has warned.⁴¹ It is not unreasonable to imagine a rapid shift in attitudes could see the value of carbon-heavy investments change quite substantially (see *Stranded!* When assets become liabilities, p.25).

“If we take the Paris targets seriously, the implication of that is massive destruction of capital,” Tol points out. “Coal-fired power plants have a lifetime of 40 to 60 years; for gas-fired power plants it’s 20 to 40 years. Chemical plants – their lifetime is also measured in decades. If we are serious about getting emissions down, it means a whole lot of existing capital will have to be prematurely retired, long before the end of its technical or economic life.”

In financial markets, bond investors have already changed the frame of reference for assessing earnings prospects for oil exploration and production companies, as renewables have become more competitive.

“They used to talk about cash flows ‘at some point,’” says Tom Chinery, investment-grade credit portfolio manager at Aviva Investors. “Now they’re talking about free cash flows. There is much less focus on the future and what might happen because of the uncertainty derived from people’s thoughts on climate change and new technology. The production cost of renewables makes oil in five years’ time a little less certain. The way people look at it has changed. It doesn’t mean they’re not buying, but the confidence further out is diminished.”

In the new environment, the number of institutional investors committed to cutting fossil-fuel assets out of their portfolios has risen more than six-fold, from around 180 in 2014 to more than 1,100 in 2019.⁴²

Among the major asset owners changing course is Norway’s sovereign wealth fund, which will divest from oil and gas explorers but retain exposure to clean-energy technologies.⁴³

Adapting to the transition

These changes imply there is detailed work to be done by financial institutions around Value-at-Risk, as they seek to understand what the changing environment will mean. How might assets be impacted, and how might institutions’ actions influence others?

There are several companies, like Carbon Delta, working on granular analysis, designed to establish how climate change could affect asset values, security-by-security. “Carbon Value-at-Risk (CVaR) tends to capture Scope 1 emissions only at the moment,” says Aviva Investors’ Stathers. “That’s the emissions generated by a company directly; there is no consideration of the risks in the value chain.”

Sensitivity varies quite considerably – according to a company’s footprint, sector and business mix, based on a 15-year horizon. The data is not comprehensive, but it is a start.

Carbon Delta has back-tested notional portfolios of shares differentiated by CVaR to see whether there are performance implications from following lower-carbon strategies. It took buckets of global equities, divided by their sensitivity to a two-degree policy environment, then compared cumulative returns with a MSCI World exchange-traded fund. With regular rebalancing, the lowest-carbon strategy outperformed strongly between 2013 and 2018, by around ten per cent over five years (see Figure 5).⁴⁴

This suggests investors may already be re-evaluating the earnings potential of companies with carbon-heavy assets, but the results also conceal important underlying market trends. In Carbon Delta’s study period, oil and commodity prices were under pressure (not wholly related to the climate debate), while

technology, a sector that tends to score well on carbon metrics anyway, performed strongly.

“Some investors are already comparing the oil and gas sector to the tobacco situation,” says Frédérique Nakache, European equity portfolio manager at Aviva Investors. However, she believes that excluding these companies from investment portfolios – as some have – could be overly simplistic. “In my view, the sector will play a key role in the energy transition as it brings knowledge and resources to bear in key areas, including the transition from thermal coal to gas, and from conventional energy to renewables and to bioplastics.”

“Excluding fossil fuels will not make as much difference as you might expect,” says Jaime Ramos Martin, global equities portfolio manager at Aviva Investors. “The carbon intensity in other parts of the economy is also quite high.” Instead, he advocates an approach that does “much, much more” than exclusion, concentrating on companies providing solutions to reduce carbon emissions or helping other parts of the economy to adjust.

This means appreciating the dramatic shift in orientation being flagged by academics like Dechezleprêtre at the Grantham Institute to meet the IPCC’s target. “The change will have to be massive,” he says. “We need to reduce the carbon intensity of the global economy by at least 60 per cent by 2050. That will require a seismic shift. It’s not the direction we’ve been taking so far. There isn’t a single country where there has been that large a drop in emissions; it’s not been done anywhere yet.”

Equity market valuations of some “climate transition” players are already quite elevated, like small European independent power producers. “They are not cheap,” admits Françoise Cespedes, equities portfolio manager at Aviva Investors. “We need to bear in mind they are project companies, with a huge backlog of projects. We can’t talk about a bubble in valuations yet, given there is a backlog and

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*This is without question
the biggest issue we need to
contend with this century*

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these companies are growing very fast indeed. But part of the re-rating of these stocks has been driven by massive inflows coming from the recent development of climate equity strategies – hence some caution is needed when considering new investments.”

Finding hope

Climate change feels like the proverbial elephant in the room: something everyone is aware of but no-one has managed to tackle. Beyond the deniers, it has suffered from the tragedy of the commons and bystander problems: why act when others will hopefully act for you? But as evidence builds of how painful – or even impossible – “business as usual” might be, it cannot be ignored.

There is now a sense of urgency, with complex models being used to explore questions of human action and causation and detailed mapping to track risks under various scenarios. Opportunities to reshape the inner workings of the economy, to create a world where growth is achieved with a lighter environmental footprint, are also vast.

A/Q has previously covered the need to think more intelligently about the role of public and private institutions when tackling big social and environmental challenges. And while we know markets can fail (climate change perhaps being the most severe example), when guided in the right direction, the creative powers of markets are nothing short of staggering. By fusing this with a deeper understanding of the psychology behind human behaviour, as well as more transparent data collection and effective insight generation, there is still cause for hope.

“Make no mistake, this is without question the biggest issue we need to contend with this century,” says Waygood. “Our whole society is at risk; it is only by harnessing the powers of capitalism that we stand a fighting chance” ●

- 1 'Why I must speak out about climate change', TED lecture by James Hansen, February 2012.
- 2 Andrew C. Revkin, 'Climate expert says NASA tried to silence him', New York Times, 29 January 2006.
- 3 Cook, et al., 'Quantifying the consensus on anthropogenic global warming in the scientific literature', IOP Publishing Ltd, 15 May 2013.
- 4 'Why I must speak out about climate change', TED lecture by James Hansen, February 2012.
- 5 Cook, et al., 'Quantifying the consensus on anthropogenic global warming in the scientific literature', IOP Publishing Ltd, 15 May 2013.
- 6 'Overview of Greenhouse Gases', United States Environmental Protection Agency.
- 7 'The Nobel Peace Prize for 2007', The Nobel Prize, 12 October 2007.
- 8 Jeff Mason, 'Trump, on climate, says he won't jeopardize U.S. wealth on 'dreams'', Reuters, 26 August 2019.
- 9 Cook, et al., 'Quantifying the consensus on anthropogenic global warming in the scientific literature', IOP Publishing Ltd, 15 May 2013.
- 10 'Results of binding vote by AWG', Working Group on the 'Anthropocene', Subcommission on Quaternary Stratigraphy, 21 May 2019.
- 11 James Hansen, 'Irreversible climate change, fee and dividend and the fossil fuel industry', Climate Science, Awareness and Solutions, Earth Institute Columbia University, 27 June 2019.
- 12 Professor Dame Julia Slingo, 'Climate change: a defining challenge for the 21st Century', Gresham College, 14 June 2018.
- 13 Kelly Levin and Eliza Northrop, '4 things to know about the IPCC Special Report on the ocean and cryosphere', World Resources Institute, 25 September 2019.
- 14 Laurie Laybourn-Langton, Lesley Rankin and Darren Baxter, 'This is a crisis. Facing up to the age of environmental breakdown', IPPR, 12 February 2019.
- 15 Jeff Masters, 'October 2019: Earth's second warmest October on record', Scientific American, 18 November 2019.
- 16 Stephen Leahy, 'Off-the-charts' heat to affect millions in U.S. in coming decades', National Geographic, 16 July 2019.
- 17 Michael Mann and Andrew E Dessler, 'Global heating made Hurricane Dorian bigger, wetter – and more deadly', The Guardian, 4 September 2019.
- 18 Gabriella Bortor, 'Monster' Hurricane Dorian pummels Bahamas, forecast to threaten Florida', Reuters, 1 September 2019.
- 19 Paul Ceballos, Paul R. Ehrlich and Rodolfo Dirzo, 'Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines', Proceedings of the National Academy of Sciences, July 2017.
- 20 Damian Carrington, Niko Kommenda, Pablo Gutiérrez and Cath Levett, 'One football pitch of forest lost every second in 2017, data reveals', The Guardian, 27 June 2018.
- 21 'Vow to protect massive African peatland a huge win for planet', UN environment programme, 19 March 2019.
- 22 Laurie Laybourn-Langton, Lesley Rankin and Darren Baxter, 'This is a crisis. Facing up to the age of environmental breakdown', IPPR, 12 February 2019.
- 23 Laurie Laybourn-Langton, Lesley Rankin and Darren Baxter, 'This is a crisis. Facing up to the age of environmental breakdown', IPPR, 12 February 2019.
- 24 'Cities and Climate Change: An urgent agenda', The World Bank, December 2010, Vol. 10.
- 25 Christophe McGlade and Paul Ekins, 'The geographical distribution of fossil fuels unused when limiting global warming to 2 °C', Nature 517, 187–190, 2015.
- 26 'Climate winners and losers', climate one, 29 May 2018.
- 27 Laurie Laybourn-Langton, Lesley Rankin and Darren Baxter, 'This is a crisis. Facing up to the age of environmental breakdown', IPPR, 12 February 2019.
- 28 'What is geoengineering?', Oxford Geoengineering Programme.
- 29 Nathalie Thomas, 'Carbon capture schemes urged to be more ambitious', Financial Times, 1 July 2019.
- 30 Jeff Hecht, 'Earthquake risk for carbon capture and storage schemes', 20 June 2012.
- 31 Alison Benjamin, 'Stern: Climate change a 'market failure'', The Guardian, 29 November 2007.
- 32 Alden Meyer and Rachel Cleetus, 'World's nations take immoral stance at COP25, side with Trump, Bolsonaro rather than youth across the globe', Union of Concerned Scientists, 15 December 2019.
- 33 Professor Chris Budd OBE, 'The mathematics of climate change', Gresham College, 13 November 2018.
- 34 Per Espen Stokes, 'How to transform apocalypse fatigue into action on global warming', TED, September 2017.
- 35 Friederike Otto, Rachel James and Myles Allen, 'The science of attributing extreme weather events, and its potential contribution to assessing loss and damage associated with climate change impacts', Environmental Change Institute, School of Geography and the Environment, University of Oxford.
- 36 Damian Carrington, 'Climate change made European heatwave at least five times likelier', The Guardian, 2 July 2019.
- 37 Friederike Otto, Rachel James and Myles Allen, 'The science of attributing extreme weather events, and its potential contribution to assessing loss and damage associated with climate change impacts', Environmental Change Institute, School of Geography and the Environment, University of Oxford.
- 38 Luke J Harrington and Friederike E.L. Otto, 'Attributable damage liability in a non-linear climate', Climatic Change 153, 15-20, 2019.
- 39 Luke J Harrington and Friederike E.L. Otto, 'Attributable damage liability in a non-linear climate', Climatic Change 153, 15-20, 2019.
- 40 'Too late, too sudden: Transition to a low-carbon economy and systemic risk', ESRB Advisory Scientific Committee, Reports of the Advisory Scientific Committee, No 6, February 2016.
- 41 Mark Carney et al., 'Open letter on climate-related financial risks', Bank of England, 17 April 2019.
- 42 Billy Nauman, 'Sharp rise in number of investors dumping fossil fuel stocks', Financial Times, 9 September 2019.
- 43 Adam Vaughan, 'Norway to sell off fossil fuel stocks worth more than \$8 billion', New Scientist, 12 June 2019.
- 44 'Backtesting climate value-at-risk yields 10% outperformance against developed markets equity index', The Emission, Issue 5, 2 April 2019.

WHY ASSET MANAGERS CANNOT BE PASSIVE ON CLIMATE CHANGE

As active investors step up their engagement efforts on the climate crisis, discussions need to be at the CEO rather than board level, argues David Cumming.



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The lack of urgency threatens the most catastrophic failure in the history of free-market capitalism
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The United Nations warns we are approaching the “point of no return on climate change”; scientists describe it as an “existential threat to humanity”. And yet, the lack of urgency by governments and many parts of the private sector – including some of the largest financial institutions belatedly talking up their own credentials – threatens the most catastrophic failure in the history of free-market capitalism.

Climate change is causing the most significant shift in the investment universe I have seen in 35 years in the industry. But if asset managers are to play a critical role in the response to the crisis, they will have to adopt a more radical and active approach.

Our customers, particularly the next generation coming into money, and those that will replace my generation in running money, increasingly regard climate change as the biggest global threat. We need to respond in a manner that is substantive, authentic, informed and impactful. This means focusing on actions, not excuses; outcomes, not intentions. Failing to do so will hurt firms’ reputations, their businesses and their ability to attract talent.

To create impactful outcomes, we need to understand the problem and agree objectives. The threat of rising temperatures is well understood; mass extinctions, mass migration, flooding and environmental destruction. Given the consequences, investors cannot wait for governments to respond. We have to start redeploying capital now to find solutions and address the risks.

The obvious template for solutions is the 2015 Paris Agreement, which seeks to limit the increase in global temperature this century to well below two degrees Celsius above pre-industrial levels, and to pursue efforts to limit the increase even further to 1.5 degrees Celsius. Investors should recognise we are nowhere near these levels currently: the FTSE 100, for example, is on course to burn the planet at 3.9 degrees Celsius.

Our focus is to put pressure on companies and governments to enact policies that will deliver these objectives. We need to be direct and visible in representing our views and communicate our position to customers.

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*We cannot be passive in
the face of climate change.
We have to be active*
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In our equity business, combining the climate expertise of our responsible investment team with the financial, sector and company knowledge of our portfolio managers will be critical in driving a positive corporate response. But while we were one of the first managers to integrate sustainability factors, including climate change, into our voting policy in 2001, our engagement needs to change. This will now be led by our equity team, fully supported by our responsible investment colleagues.

Rather than engaging mainly with boards in an effort to get climate change on a company's agenda, we will prioritise discussions with chief executives, chief financial officers and their executive teams. If we want companies we invest in to take the necessary actions on capital expenditure, innovation and repositioning assets, we must communicate with their senior management and hold them directly accountable.

To that end, we will make climate a key agenda item in around 1,000 company engagements this year. We will include a climate ask in every discussion, built around the need for companies to adopt science-based targets. While many companies are setting emissions reduction targets and other environmental measures, we are long past being satisfied with symbolic gestures.

We want to know whether a company's ambitions and targets are sufficiently progressive to create the necessary outcomes to tackle the climate emergency. The use of science-based targets is an independently verifiable approach that specifies by how much and how quickly companies need to reduce carbon emissions to align with the Paris targets.

There will be consequences for those that do not meet our expectations. We will vote against directors of companies in high- and medium-impact sectors that are climate laggards and against directors of companies in the Climate Action 100+ that have not committed to science-based targets.¹ How companies react this year will determine our actions in 2021: While our approach has always been driven by engagement over divestment, we will consider shifting capital away from non-responsive companies.

Clearly, as an active asset manager, we see this issue through a certain lens. We believe an engagement approach like ours only works if you have the climate expertise, the resources and proven influence with company decision makers. Passive managers cannot deliver on these preconditions. They track indices that are algorithms of the past, supporting existing business models and ignoring the massive future business impact of climate change.

Passive managers often have tens of thousands of holdings but limited research coverage; their engagement therefore takes place at a superficial level. They lack connectivity with the core reality of a business and are not equipped to evaluate the credibility of corporate responses. Passive investors' poor record on voting on climate-related shareholder proposals supports this view. As a result, there is limited incentive for companies to engage with passive managers on this issue.

Climate change has changed everything. Investment objectives now have to include responsible values and actions, in addition to financial returns. We have to respond by engaging in a different way and by taking decisive action when the companies we invest in don't. We cannot be passive in the face of climate change.

We have to be active ●

¹ Climate Action 100+ is an investor initiative to pressure the world's largest greenhouse-gas emitters to take action on climate change.

APATHY, ANGER, ACTION:

THE PSYCHOLOGY OF CLIMATE CHANGE

Psychological barriers can prevent people from acting to avert the climate threat, even when they recognise the problem. So how can we best engage individuals, companies and communities in the quest for solutions?

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By paying attention to psychology, we can come to a better understanding of why we find it so hard to face up to climate change

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Three golfers stand together on a putting green, planning their shots. Such is their focus on the game, they seem not to have noticed the danger looming in the distance. A massive fire surges through the forested hillside above the course, leaving a swathe of charred tree trunks in its wake.

Captured by US-based photographer Kristi McCluer, the image went viral on social media in the summer of 2017. It was hailed as symbolic of our shared failure to acknowledge the reality of climate change. David Simon, creator of television series *The Wire*, commented it was a “visual metaphor for America today”.¹ And the photo has taken on a new relevance in early 2020, as footage of the Australian wildfires blazes across smartphones and television screens.

McCluer seems to capture a psychological truth: Like the golfers who continued to swing their clubs as the flames raced towards them, people have become adept at compartmentalising. Even if we see the evidence that climate change is happening, we turn our attention to other, more trivial things. We all have lives to live, work to do, games to play. In psychological parlance, this failure to face up to the facts is known as *The Ostrich Effect*, after the apocryphal story of the bird that sticks its head in the sand.

Doubt and denial

Our reluctance to take the climate crisis more seriously presents a puzzle. After all, the underlying science – the evidence that carbon emitted as a by-product of industrial activity gets trapped in the atmosphere, forcing global temperatures upwards – was long ago established in the public consciousness.

As early as 1958, an episode of Frank Capra’s prime-time US documentary series *The Bell Science Hour* informed viewers that human-driven carbon emissions could eventually lead to catastrophe. “A few degrees’ rise in the Earth’s temperature

would melt the polar ice caps,” intoned the narrator. “Tourists in glass-bottomed boats would be viewing the drowned towers of Miami through 150 feet of tropical water.”²

As documented by the journalist Nathaniel Rich, most governments and fossil-fuel companies accepted the scientific consensus by the late 1970s. Over the following decade, the world came agonisingly close to averting disaster, as carbon taxes and binding international emissions targets were proposed.

In 1992, 165 countries came together to sign the United Nations Framework Convention on Climate Change, pledging to stabilise emissions. But these promises were non-binding and the opportunity to take decisive action was missed. As the author David Wallace-Wells has observed, more than half of the total carbon emissions in human history have occurred over the 30 years since the framework was established, which means “we have engineered as much ruin knowingly as we ever managed in ignorance”.³

During this time, energy giants led by Exxon Mobil stepped in with a disinformation campaign that cast doubt on the scientific evidence and drained momentum from initiatives to tackle climate change.⁴ Outright climate denial is now less of a problem, partly because the weight of scientific evidence has become impossible to ignore. Surveys show the majority of citizens in Western nations accept the planet is heating up (see Figures 1 and 2, overleaf). Nevertheless, many people remain wary of attributing climate change to human activity and are unwilling to countenance lifestyle changes that would reduce emissions. This is the case even in communities that have already experienced the direct effects of extreme weather.⁵

To explain this, we need to look to the deeper drivers of human thought and behaviour. By paying attention to the underlying psychology, we can come to a better understanding of why we find it so hard to face up to climate change – and begin to develop solutions.



Kristi McCluer's viral photograph.

APATHY, ANGER, ACTION: THE PSYCHOLOGY OF CLIMATE CHANGE

continued

PAIN points

Professor Cass Sunstein, founder and director of the Program on Behavioral Economics and Public Policy at Harvard Law School, is one of the world's leading experts on the deep psychological roots of human decision making. He argues our difficulties in grappling with climate change may derive from homo sapiens' experiences in prehistory.

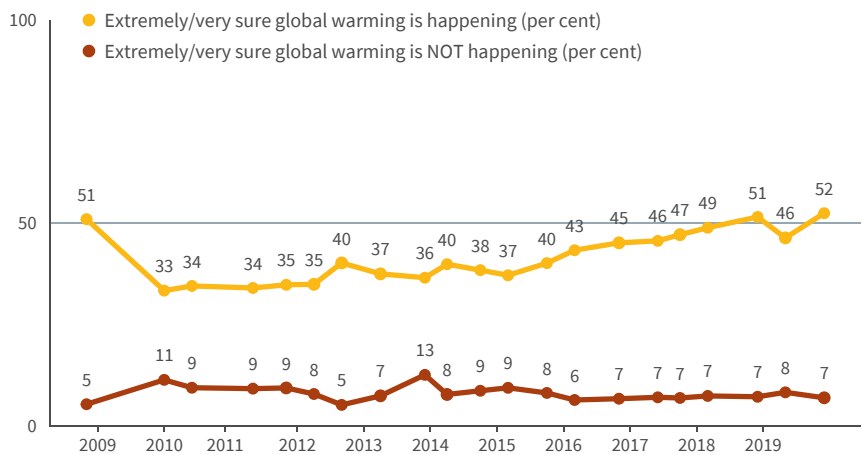
"We are the products of evolution and our evolutionary heritage is well-suited to certain kinds of dangers – lions and tigers for example – but it is not suited to the climate change problem," Sunstein tells *AIQ*. "The human mind just isn't wired to think that burning fossil fuels is going to lead to carbon in the air, which is going to lead to a warmer planet. It's a very complicated mental operation."

Think about what life was like out on the savannah, two million years ago. Our hunter-gatherer ancestors were surrounded by mortal threats, from rival tribes to sabre-tooth cats. In this environment, we were primed to avoid dangers we could see, hear and touch.

These primeval impulses continue to govern human behaviour in the modern world. The psychologist Daniel Gilbert coined the acronym PAIN to describe the kinds of stimuli that trigger our ancient synaptic pathways and rouse us into action. These catalysts tend to be *Personal* (affecting us or our loved ones directly); *Abrupt* (relating to sudden changes in our environment); *Immoral* (things we deem unethical or repulsive); and present right *Now* (as opposed to occurring in the future).⁶

For many, climate change is too slow-moving and abstract to press these psychological buttons. Even if extreme weather impacts us directly, we find it difficult to connect the felt reality of fires and flooding to the bigger climate issue, due to that "complicated mental operation" Sunstein describes.

Figure 1: The majority of Americans believe climate change is real...



Source: Climate Change in the American Mind, George Mason University/Yale University, November 2019.

Adding to the problem, many of the proposed solutions to the climate crisis run counter to our evolutionary instincts. In the early days of humanity, when life was nasty, brutish and short, we learned to pursue near-term gains and avoid near-term losses. This means we are disinclined to accept the immediate costs and reductions in living standards that would be needed to curb climate emissions.

"The science shows we prioritise immediate wants and needs and avoid planning for the future, whether that involves saving for our retirement or taking steps to tackle climate change," says Marte Borhaug, global head of ESG investment solutions at Aviva Investors. "These psychological factors can be a real impediment to action, even when we know what's best and also want to change. It's like exercise – you know it will feel better afterwards, but when Netflix and the sofa is right there in front of you, it's hard to put the gym kit on and start running."

Bias and social influence

For these reasons, some noted psychologists are pessimistic that societies will be able to muster an adequate response. Daniel Kahneman, who was awarded the Nobel Prize in economics for his research into human behaviour and its applications in finance, is among them.⁷

Kahneman's research points to further reasons why climate change seems so

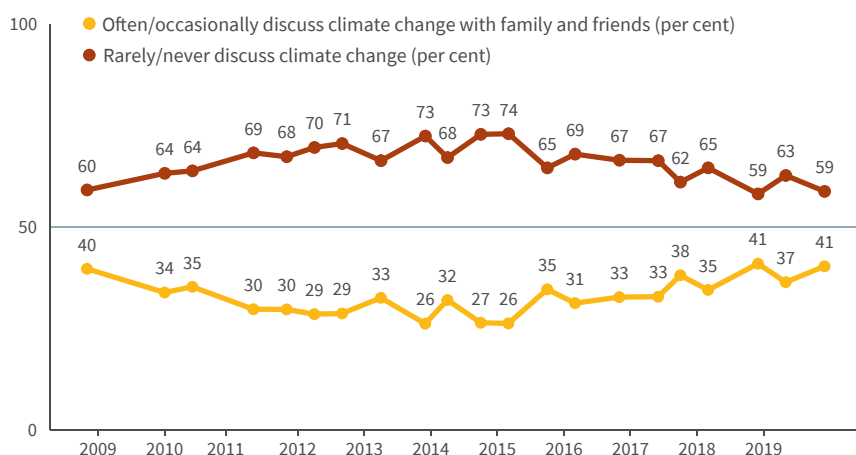
intractable. He is best known for his theory that people think according to two different systems: "fast" (or "system one") thought is automatic, unconscious and swayed by physical or emotional reactions; "slow" (or "system two") thought is said to be more calculating and rational.⁸ System two might hold sway while we are reading a textbook or solving a maths problem, but most of the time we act according to system one, leaving us vulnerable to various cognitive biases – a kind of mental shortcut.

These biases are particularly unhelpful when it comes to the climate crisis. *Availability bias*, for example, leads us to rely on the evidence closest to hand – this is why people may cite the presence of snow on their own driveways to reject the idea that the world is heating up. *Status quo bias*, an aversion to change, is part of the reason we reject lifestyle adjustments that would reduce our carbon footprints.

One implication of Kahneman's research is that although we may possess all the facts, we still act irrationally. In the same way we continue eating chocolate biscuits even though we are fully aware they are bad for our teeth, we persist with our high-carbon lifestyles in the knowledge we are destroying the planet.

Kahneman also shows behaviour is governed by a subtle interplay between psychological and social cues. One of the most powerful cognitive biases is *groupthink*, which disposes individuals to mimic the beliefs and behaviours of

Figure 2: ...but they don't want to talk about it



Source: Climate Change in the American Mind, George Mason University/Yale University, November 2019.

“*In the same way we continue eating chocolate even though we are fully aware it is bad for our teeth, we persist with our high-carbon lifestyles in the knowledge we are destroying the planet*”

those around them. This amplifies the effects of other biases among collectives. Like individuals, large organisations often take the path of least resistance, deferring difficult decisions and following the herd. Such institutional lethargy helps account for the wider failure to incorporate climate risk into business plans and investment portfolios.

At a societal level, meanwhile, groupthink means people's views on climate change tend to correlate strongly with those of others who share their political or religious leanings. In the US, studies show Democrats are far more inclined than Republicans to worry about the problem.⁹ In the UK, Brexit voters are twice as likely as Remainers to believe humans are not responsible for climate change.¹⁰

As a result of this partisanship, climate change has become tangled up with a variety of other hot-button social and political issues, making it tricky to build a consensus across different cohorts. “Everyone, experts and non-experts alike, converts climate change into stories that embody their own values and prejudices,” as the environmental activist George Marshall puts it.¹¹

Carrot and stick

Human psychology, then, presents some daunting barriers to action on climate change. But governments, businesses and non-profit organisations have a

variety of tools available to tackle these ingrained habits and social influences. And behavioural science offers guidance about which approaches are likely to be effective.

Start with policy. Carbon taxes, which place a charge on CO₂ emissions to incentivise greener behaviours, are a common recourse for climate-conscious governments, but they can be unpopular.

“Even governments like the one in which I worked, the Obama administration, were very cautious about a carbon tax,” says Sunstein, who ran the White House Office of Information and Regulatory Affairs under Barack Obama from 2009-2012. “The immediate cost of a carbon tax is tangible, while the benefit of a carbon tax isn't something you can feel: people have to trust it will *eventually* be felt.”

Some carbon taxes have worked well. In 2008, the Canadian province of British Columbia introduced a tax on emissions that applied to both companies and households, with the amount rising in increments from ten Canadian dollars to C\$30 by 2012. The policy won wide support and helped the province cut emissions by around as much as 15 per cent over the period, with no apparent economic costs (in fact, British Columbia's average GDP grew faster than most of its neighbours).¹²

Other attempts to compel green behaviour with carbon taxes have foundered, however. Introduced in 2014, France's carbon tax was sharply hiked in 2018 to bring it in line with

rising fuel prices. This sparked the *Gilets Jaunes* (Yellow Vests) movement, a series of mass protests that brought parts of the country to a standstill and prompted a government climbdown.

One lesson to draw from these contrasting examples is that carbon taxes are more likely to work if the punitive measures are offset with economic sweeteners that appeal to our preference for short-term rewards. The British Columbia carbon tax came bundled with other measures that lowered income tax and health insurance premiums and kept citizens onside. Companies also benefited from corporation tax cuts.

No such incentives were offered in France. Neither was the money raised by the tax allocated wholly to projects that might bring tangible green benefits (a measure that tends to make the public more amenable¹³); much of it was simply added to the federal coffers.

France's policy also offended people's sense of fairness. Because many companies were exempt, the carbon tax was deemed to be regressive.¹⁴ As so often with climate change, the issue became tangled up with wider political and social dynamics such as inequality, and fomented an “us versus them” mentality, with Emmanuel Macron's administration cast as the enemy. In fact, the French carbon tax activated all of the “PAIN” points identified earlier: It was seen to be *Personal, Abrupt, Immoral* and happening *right Now*. No wonder it backfired.

APATHY, ANGER, ACTION: THE PSYCHOLOGY OF CLIMATE CHANGE

continued

British Columbia's careful policy mix of carrot and stick is a more useful template, although a carbon tax is likely to be only one part of the solution. Darryl Murphy, managing director of infrastructure at Aviva Investors, argues governments need to be attentive to context and the nature of the particular problems they hope to address when designing green laws.

"The 'stick' can be effective when the outcomes are specific – the threat of taxes can bring about faster progress on insulating buildings and cutting energy usage, for example. But you also need to provide the right incentives to invest, especially for large-scale and long-term public-interest projects. In those cases, you might need to offer some form of risk sharing to attract private capital," says Murphy.

Whichever path governments choose, consistency is important. Sudden policy reversals can undermine confidence and deter investment. Take the UK coalition government's unexpected decision to retroactively reduce feed-in-tariffs for solar energy in 2015 – an incentive for small-scale suppliers – which led to a significant drop in renewable energy investment over the following two years.¹⁵

More helpful is the UK's recent pledge to make the country's energy mix carbon neutral by 2050. Murphy argues this is the kind of clear policy framework that provides useful guidance on the direction of travel, focusing minds among investors and the public alike.

Nudge, nudge

In recent years, a policy approach has been devised that seeks to be more sensitive to people's psychological tendencies and biases in order to change their behaviour.

In his bestselling book *Nudge*, co-authored with the Nobel Prize-winning economist Richard Thaler, Sunstein showed how policymakers can improve outcomes in various walks of life by tweaking the "choice architecture" within which people make decisions.¹⁶ The idea works on the basis

people are more likely to do the right thing if it is easy – or at least easier than doing the wrong thing.

The technique has proven particularly effective in influencing financial decisions. Under auto-enrolment, for example, individuals are signed up to pension schemes automatically, with the freedom to opt out if they wish; due to inertia and status-quo bias, most people stick with the default option. In the US, auto-enrolment has boosted annual savings rates by \$7.4 billion.¹⁷

Using the same principle in the area of climate action, "green defaults" have been shown to bring about climate-friendly outcomes when implemented by governments or private organisations. To take an early example, Rutgers University modified the default setting on its printers from "print on a single page" to "print on front and back" in an effort to save paper. The results were dramatic. Within three years of the start of the initiative in 2010, the university estimated it had saved 55 million sheets, a reduction of more than 40 per cent. This is equivalent to 4,000 trees, or more than 100 tonnes of sequestered carbon.¹⁸

The principle of green nudging is also behind the use of energy-saving lighting that switches off when no-one is around, and the hotel industry's now-widespread policy of cutting back on laundry unless guests specifically ask for clean towels and bed linen.

On a larger scale, nudging has been shown to increase the take-up of green energy by households. German supplier Energiedienst GmbH led the way here, making a green tariff its default offering in 1999. Two other options were made available: one was less climate friendly, but cheaper; one was greener but more expensive. Around 94 per cent of customers stayed on the green tariff – a striking result, given that green energy usage in Germany was just one per cent at the time of the study, even though many consumers said they would be willing to pay a premium for it.¹⁹

"Automatic enrolment onto green-energy tariffs can create very significant movement when it comes to reliance on green-energy sources," Sunstein says. "People have the opportunity to opt out and go for coal-powered energy, but the data shows they don't, even if the green option is a little more expensive. If that can happen in Germany, it can happen all over the world."

Powers of persuasion

While nudging may be part of the solution, it is no panacea. Nudges have been criticised as drily technocratic – even paternalistic – and sometimes provoke a backlash similar to the opposition that led to the demise of the French carbon tax. One US-based attempt at green nudging led to increased energy consumption among conservatives who were irritated at what they saw as a high-minded environmentalist conspiracy to control their behaviour.²⁰

To bring about sustained change at the kind of scale needed to address the climate crisis, experts agree more people need to be *persuaded* of the threat, as well as incentivised and nudged to adopt carbon-light lifestyles. This will require effective communication that considers our emotional, system-one brains, as well as group identities and core values.

"To mobilise people [on climate change], this has to become an emotional issue," as Kahneman has put it. "It has to have immediacy and salience."²¹

There is a growing awareness that in focusing on making the scientific case through patiently showcasing the data, climate communicators have thus far failed to engage people at this deeper level. So how can this be addressed?

The psychological theory suggests both language and imagery are important. The phrases "climate crisis" and "climate breakdown" are useful in conveying urgency and more likely to trigger our inbuilt sense of threat than "global warming", which sounds gradual and unthreatening (and maybe even desirable to those living in chilly northern climes). Similarly, pictures

“

You have to emphasise the positives of what a sustainable lifestyle could look like: the health benefits, the community benefits

”

of dewy-eyed polar bears stranded on dwindling ice floes play into a sense that the issue is remote from everyday life; images of people affected by climate change are more striking.

“I recently came across a report on climate change with a little leaf on the cover – I deleted it straight away,” says Ed Dixon, head of ESG, real assets, at Aviva Investors. “We need to think about the way we present the crisis we’re in, and one way we can do that is by demonstrating this is a *human* crisis. The impact is very human and very real and the imagery used should reflect that.”

Telling stories

One key benefit of using more powerful language and imagery is that this will enable better *stories* to be told about climate change. Humans have swapped stories since they first emerged blinking from the primordial cave, and narrative techniques can persuade individuals and shift social norms.

Climate deniers and sceptics were quick to grasp the role of stories in shaping the debate. The bestselling book about climate change was not written by Al Gore or Greta Thunberg, but the late novelist Michael Crichton, whose techno-thriller *State of Fear* (2004) depicts the issue as a conspiracy invented by green extremists. The novel told an exciting story, with clearly delineated heroes and villains, and skilfully tapped into a conservative readership’s mistrust of statist intervention and the environmentalist movement. The book was enthusiastically promoted by political opponents of climate action – then President George W. Bush invited Crichton (a climate sceptic) to the White House to explain the thinking behind his work of fiction.

Marshall, who founded the non-profit organisation Climate Outreach, argues that those hoping to persuade people of the climate threat should take a leaf out of Crichton’s book and pay close attention to the values and beliefs of their audiences.

When addressing conservative communities who have typically been resistant to talk on climate, for example, it is best to avoid the “eco stuff” and find common ground. One way to do this is to emphasise that by working to counteract climate change, they can protect the things they value most: family, property, and the local environment.²²

Borhaug keeps this principle in mind when working with companies to encourage them to be more sustainable and manage their climate risks. “You do need the ultimate threat of divestment, but as active shareholders, we usually find it is more effective to compel firms to do better through engagement. By stressing the interests we have in common, the need to create long-term value while also doing good for the planet, we can persuade people to act. Threats and criticism sometimes provoke a negative reaction, creating an ‘us and them’ mentality. But to tackle climate change, we need the whole economy to change.”

Practical solutions

Bringing emotion into climate communication brings its own risks, as visceral responses to the threat such as despair or anger can be just as unhelpful as apathy or denial.²³ There is a fine line between emphasising the urgency of the problem and scaring people into paralysis.

Switching the narrative from a negative to a positive one can be helpful. In 2009, *USA Today* published a cartoon by Joel Pett that did this beautifully. Pett depicts a climate summit at which a speaker extols the virtues of energy independence, rainforest preservation, green jobs, liveable cities and renewables. A member of the audience interrupts him to ask: “What if it’s a big hoax and we create a better world for nothing?” Humour has a way of cutting through the absurd and the complex, allowing us to see things as they really are. But climate messaging is often bleak in tone.

“The climate change discourse at the moment is really about doom and gloom. Thunberg is extraordinary in getting people to talk about climate change, but the message has been so negative – ‘*Our house is on fire*’ – without really addressing in a practical and thoughtful way what they can do about it,” says Geoffrey Beattie, professor of psychology at Edge Hill University and author of *The Psychology of Climate Change*.

“You have to emphasise the positives of what a sustainable lifestyle could look like: the health benefits, the community benefits, and connect people in a communal way. You need to put much more focus on what people can actually do,” Beattie adds.

When countries focus on specific solutions that governments, campaigners, private companies and individuals can get behind, they can make substantial progress. Take Norway’s efforts to increase the take-up of electric vehicles (EVs) to reduce gas emissions. Launched in the late 1990s, the multi-pronged initiative has been a remarkable success. Norway now leads the world in EV ownership per capita, and electric and battery-powered cars account for just under 50 per cent of all vehicles on Norwegian roads – a far higher proportion than in any other country. Out of every 100 EVs sold in Europe, 35 end up in Norway.²⁴

Overarching policy targets, green incentives, behavioural nudges and cultural factors all played a role in the process. The government started by offering incentives such as tax breaks on EV purchases, along with other sweeteners like free parking and permission to drive in the bus lane during rush hour, and made clear it would not allow the sale of fossil-fuel cars after 2025.²⁵ In addition, companies and local governments have been incentivised to build charging infrastructure. Much of this charging network runs on clean hydroelectric power and incorporates behavioural nudges into its design.

“When you drive into a car park or service station in Norway, you have to look extra hard for the non-electric parking bays and petrol pumps, because EV charging stations

APATHY, ANGER, ACTION: THE PSYCHOLOGY OF CLIMATE CHANGE

continued

are now the default, even in remote locations up in the mountains,” says Borhaug. “This makes owning an electric vehicle seem like the normal thing to do for Norwegians – people don’t feel like they are standing out by owning one.”

EV usage has also been boosted by an inspiring narrative: the story of Norway’s collective push to overcome its historic reliance on fossil fuels and become a leader in green living. The government uses the widespread availability of charging stations to promote the country as a destination for eco-friendly travel.²⁶

Harnessing social conformity

Norway’s success on EVs indicates the power of social norms in propelling change. Part of the reason action on the climate crisis has been frustratingly slow is that individuals tend to require proof others are doing something before they follow suit. But once people begin to think and act differently, the power of social conformity can begin to operate in the other direction, thanks to a process known as a “cascade”. This amplifies the effect of individual consumer choices and creates momentum.²⁷

There is proof this can make a difference in tackling serious global threats. Sunstein points to a social cascade that worked to expedite international efforts to protect stratospheric ozone three decades ago.

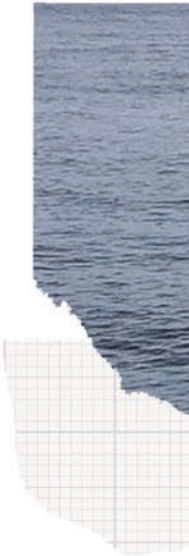
Like climate change, the “hole in the ozone layer” was once seen as a near-impossible challenge to overcome. But public opinion shifted extremely quickly during the mid-1980s and policymakers secured a binding international agreement, the Montreal Protocol (1987), to phase out ozone-damaging chemicals. The process involved a combination of shrewd policy design, which ensured economic costs were fairly distributed and eased corporate buy-in, and a clever messaging campaign to raise awareness. The concept of a “hole” in the earth’s “shield”, though scientifically dubious, was clear and emotive.²⁸

Sunstein is hopeful a similar mechanism could accelerate action on climate change. As more people become convinced of the need to do their bit, they will influence others in turn and potentially set off a green cascade across whole societies. *Flygskam*, the “flight-shaming” movement born in Sweden, provides an example. It resulted in a four per cent drop in passengers flying via the country’s airports in 2018, according to airport operator Swedavia.

“So much of the carbon emission problem is the product of individual consumers’ behaviour, aggregated across large populations. If we can get each person to cut their carbon footprint by a non-trivial amount, then we’re getting very large progress across the planet towards less destruction,” says Sunstein.

As any behavioural scientist will tell you: where there’s a will, there’s a way ●

- 1 Twitter post, September 2017.
- 2 Nathaniel Rich, ‘Losing Earth: The decade we almost stopped climate change,’ The New York Times, August 2018.
- 3 David Wallace-Wells, ‘The Uninhabitable Earth’ (Penguin, 2018).
- 4 Rich, ‘Losing Earth’.
- 5 George Marshall, ‘Don’t Even Think About It: Why our brains are wired to ignore climate change,’ (Bloomsbury, 2014), Chapter two.
- 6 Marshall, Don’t Even Think About It.
- 7 Marshall, Don’t Even Think About It.
- 8 Daniel Kahneman, ‘Thinking, Fast and Slow,’ (Penguin, 2012).
- 9 Pew Research Center, ‘The politics of climate change,’ October 2016.
- 10 Adam Vaughan, ‘Brexit voters almost twice as likely to disbelieve in manmade climate change,’ The Guardian, 16 June 2016.
- 11 Marshall, Don’t Even Think About It.
- 12 Josh Burke, Rebecca Byrnes and Sam Fankhauser, ‘Policy brief: Global lessons for the UK in carbon taxes,’ London School of Economics, August 2019.
- 13 David Klenert, Cameron Hepburn, ‘Making carbon pricing work for citizens,’ Voxeu.org, July 2018.
- 14 Cécile Barbière, ‘France reopens carbon tax debate that fuelled ‘yellow vest’ protests,’ Euractiv, January 2019.
- 15 Alex White, Nick Molho, ‘Increasing investment in the UK’s green infrastructure,’ Aldersgate Group, March 2018.
- 16 Richard Thaler, Cass Sunstein, Nudge: Improving decisions about health, wealth and happiness (Yale University Press, 2008).
- 17 Richard Thaler, ‘Behavioural economics: Past, present and future,’ American Economic Review, May 2016.
- 18 Cass R. Sunstein, Lucia A Reisch, ‘Green by default,’ Kyklos International Review for the Social Sciences, August 2013.
- 19 Sunstein, Reisch, ‘Green by default.’
- 20 Utpal M. Dholakia, ‘Why nudging your customers can backfire,’ Harvard Business Review, 15 April 2016.
- 21 Marshall, Don’t Even Think About It.
- 22 Marshall, Don’t Even Think About It.
- 23 Adam Corner, ‘Emotions and climate communication,’ The Climate Communication Project.
- 24 ‘Electric cars grab almost half of sales in oil-producing Norway,’ Reuters, July 2019.
- 25 ‘Norway invites you to explore its electric vehicle paradise,’ Wired, June 2019.
- 26 See the official website of Norway’s tourist board:
- 27 Cass R. Sunstein, ‘Conformity: The power of social influences,’ (New York University Press, 2019), chapter two.
- 28 Jonathan Watts, ‘How to stop the climate crisis: six lessons from the campaign that saved the ozone,’ The Guardian, 20 January 2019.





STRANDED!

WHEN ASSETS BECOME LIABILITIES

Until recently, many investors made light of dire warnings of the risks posed by assets becoming “stranded” by climate change. However, as the threat becomes reality, fears are mounting that whole industries could be wiped out.



STRANDED! WHEN ASSETS BECOME LIABILITIES

continued

In the past couple of years, the concept of “stranded assets” has become synonymous with the existential threat climate change poses to the fossil-fuel industry. Nowadays, energy analysts cannot ignore these threats, and any credible discounted cash-flow projection must factor them in.

Industry disruption is nothing new. When electricity started replacing oil lamps for illuminating homes in the first half of the 20th century, the incumbent lighting and whaling industries’ assets became stranded almost overnight. Austrian economist Joseph Schumpeter saw this as a natural feature of any market economy, coining the phrase “creative destruction” to describe the phenomenon.

Recent history provides us with a litany of other examples. The emergence of streaming companies like Netflix led to the demise of home-movie rental firms such as Blockbuster, while the rise of digital photography saw Eastman Kodak, the world’s biggest photographic film corporation, filing for bankruptcy protection in 2012.

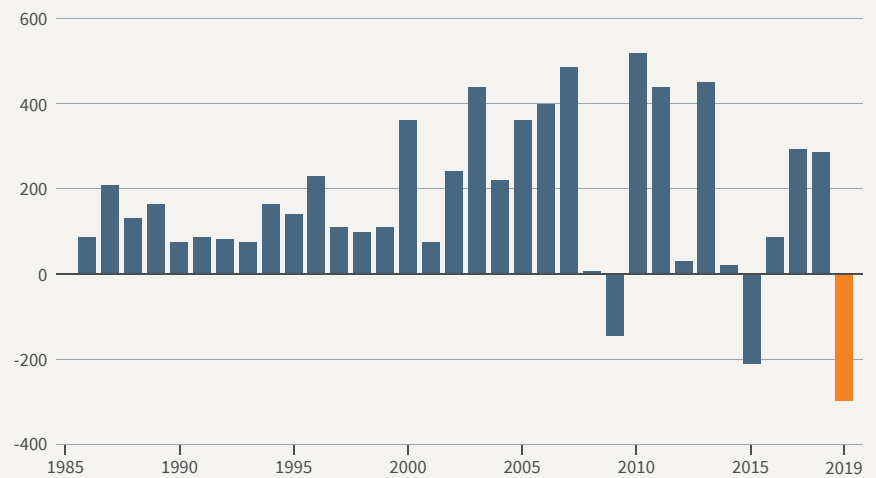
However, much as the failures of Blockbuster and Kodak were costly for investors in these firms, the losses pale in comparison with those that fossil-fuel companies and others face as the world attempts to combat global warming.

The Intergovernmental Panel on Climate Change (IPCC) in October 2018 said the atmosphere can absorb, calculated from the end of 2017, no more than 420 gigatonnes (Gt) of carbon dioxide (CO₂) if the global temperature rise this century is to be kept below 1.5 degrees Celsius above pre-industrial levels. However, since around 42 Gt of CO₂ is emitted globally every year, this budget is expected to be exhausted by the end of 2027.

The budget for staying below the Paris Agreement’s two degrees Celsius threshold – signed in 2016 by nearly 200 countries – affords precious little wiggle room either, at approximately 1170 Gts.¹ A 2015 study in *Nature* concluded that on the basis of those

Figure 1: Electricity production from coal

Terawatt hours



Source: Carbon Brief website, 2019.

estimates of the two degrees Celsius carbon budget, a third of oil reserves, half of gas reserves and more than 80 per cent of known coal reserves should remain buried if temperature targets set under the Paris Agreement are to be met.²

Shift from coal gathering steam

Since coal is the dirtiest of the three main types of fossil fuel – coal-fired power stations emit around double the CO₂ per unit of electricity that natural gas plants do – governments in Europe and elsewhere are phasing out use of the fuel. UK-based website Carbon Brief reckons global electricity production from coal is on track to fall by around three per cent in 2019, the largest drop on record, thanks to big falls in developed countries that are not being matched by increases elsewhere.³

The European Union has been steadily shifting away from coal generation. According to European energy research firm EnAppSys, coal and lignite power plants produced 95.8 terawatt-hours in the three months to the end of September 2019, almost 30 per cent less than gas-fired stations. By contrast, coal plants produced 31 per cent more than gas in the third quarter of 2018 and 37 per cent more in the same period of 2017.⁴

“This move away from coal has already led, and will continue to lead, to the stranding and closure of many coal

assets across Europe,” says Pedro Faria, strategic advisor to CDP, a not-for-profit organisation that helps investors, companies and cities measure and understand their environmental impact.

Take the case of German utility RWE. With Berlin looking to phase out coal-fired electricity generation by 2038, RWE is trying to reinvent itself as a renewable energy company – it is now the world’s second-biggest producer of offshore wind power and Europe’s third-biggest provider of renewable energy.

However, unlike Danish group Orsted, which in 2017 took big steps towards transforming itself into a pure renewables business when it sold off its upstream oil and gas assets, RWE retains sizeable coal operations.

Although the German government recently agreed to pay it to close them down, Aviva Investors’ European equity portfolio manager Ed Kevis argues there is very little, if any, value ascribed to those assets. “This helps explain why the shares trade on a multiple of just 10 times forecast 2021 EBIT (underlying earnings) when Orsted shares trade on a multiple of 27,” he says.

In the UK, the government is looking to phase out coal-fired generation by 2025, with the inevitable result of power generation assets becoming stranded. Shares in Drax Group have lost more than two thirds of their value over the past six years as profits plunged after the electricity



Solar and onshore wind are now the cheapest way of generating electricity across more than two thirds of the world



producer shifted away from coal to biomass.⁵ Rival SSE is to abandon the last of its remaining coal-fired plants by March 2020 after it racked up annual losses of £40 million.

“As national and international policies focus on promoting lower-carbon forms of power generation in a bid to tackle climate change, the economics of coal-fired stations have become increasingly challenged,” SSE said in June 2019.⁶

Aligning incentives

Even where governments are reluctant to close coal-fired power stations, the decision is being taken out of their hands by economic forces. Recent advances in technology have helped drive rapid falls in the cost of both generating electricity from renewables, such as solar and wind, and storing it. According to an October 2019 report by Bloomberg New Energy Finance (BNEF), solar and onshore wind are now the cheapest way of generating electricity across more than two thirds of the world, with solar costs having plunged 85 per cent and wind 49 per cent since 2010.⁷

The plummeting price of renewable energy, combined with bountiful supplies of fracked gas, has been driving coal-fired power plants out of business across the US. In November, two of the country’s biggest, which in combination emitted 258 million tonnes of carbon between 2010 and 2017, shuttered operations.⁸ That is, in turn, stranding a growing number of mines, scuppering President Trump’s efforts to rescue the US coal industry by easing environmental regulations.

On October 8, Blackhawk Mining LLC said it would idle three mines and two processing plants in West Virginia.⁹ A week later, Peabody Energy said it will close a southern Illinois mine and a nearby coal-processing plant.¹⁰ A fortnight after that, Murray Energy became the eighth coal company in a year to file for bankruptcy protection.¹¹ The US Energy Information Administration expects coal output to drop eight per cent in 2019 and 13 per cent this year.¹²

Although BNEF reckons renewables are set to undercut commissioned coal plants almost everywhere by 2030, the amount of electricity generated globally from coal is not set to peak until 2026 as new power plants open in China, India and elsewhere. As a result, and despite the threat of stranded assets, new coal mines continue to open in other parts of the world, at least for now. For instance, the government of the state of Queensland, Australia, in June gave the go ahead for construction of the Carmichael coal mine. It promises to be one of the world’s biggest. Indian company Adani, which owns the site, plans to produce 2.3 billion tonnes over 60 years.¹³

The project is likely to open up the Galilee Basin, one of the world’s largest untapped reserves of thermal coal – the type used in power plants. The controversial project has run into trouble. Under pressure from environmental activists and concerned over the threat of being left with a stranded asset on their books, over 30 of the world’s financial institutions have refused to lend to Adani. As a result, the Indian group is having to fund the first A\$2 billion phase itself.¹⁴

Pressure on Australia’s coal industry, the country’s biggest export earner, is also coming from other quarters. In February, a judge in New South Wales banned a bid by Gloucester Resources to mine 21 million tonnes of coal over 16 years because it would have contributed to climate change.¹⁵ The same month, Glencore, Australia’s biggest coal miner, announced it would cap production at current levels. Though the Swiss-based company is not abandoning coal, it is steering investment towards commodities such as cobalt, copper and nickel, which underpin a lot of the transition to renewable energy. Pressure from Climate Action 100+, a group whose affiliates include several Australian pension funds that want to support cleaner energy, undoubtedly played a part.¹⁶

Casey Merriman of Energy Intelligence, a leading provider of analysis and data on the global energy industry, says although

demand from China, India and other Asian nations may be growing for now, the global market for coal will remain under “extreme pressure”.

“Maybe demand from these countries can slow the death a little bit, but even miners with the lowest production costs need to factor in falling prices and a struggle to find a market for their product beyond the next decade,” she says.

Faria agrees, arguing that even though China and India may be continuing to build new coal-fired power stations, that policy is at risk of being rapidly reversed given worsening pollution in both nations has led to social unrest.

“Even in the absence of pressure from governments and other regulatory bodies, it makes sense for long-term investors to encourage miners to keep coal underground. While it might seem like a strange thing to do, it is increasingly apparent climate change is having a devastating impact on other parts of the portfolio and this threatens to get even worse,” he says.

Will oil and gas go the same way as coal?

Trevor Green, UK equity portfolio manager at Aviva Investors, says the problems facing coal look to be a foretaste of what is in store for oil and gas explorers. With more and more investors calling into question the long-term investment case, Green believes there is already clear evidence oil and gas companies’ cost of capital has begun to rise.

“Investors are demanding greater compensation for taking on the risk of investing in these assets. If you perform a discounted cash-flow analysis of the fossil fuel sector, it suggests the market is pricing in flat earnings up to around 2030, beyond which point companies will be worthless,” he says.

Green says it is damning that the combined US energy sector is worth less than Apple after losing more than 40 per

STRANDED! WHEN ASSETS BECOME LIABILITIES

continued

cent of its value since the middle of 2014. “While much of that is explained by a 40 per cent drop in oil prices, it is telling that oil majors’ dividend yields have risen,” Green says.

According to Martijn Rats, head of European oil and gas equity research at Morgan Stanley, while it may be too pessimistic to suggest oil majors will be worthless in a decade, it is true the market is either already, or very close to, pricing in no dividend growth for European oil majors into perpetuity. He describes this as “a remarkable change” for companies that have been growing their dividends for decades.

Pressure on oil companies to transform their businesses in line with climate goals is coming not just from environmental groups but large institutional investors too. With many countries indicating they intend to electrify their transport networks at an accelerating pace as climate change rises to the top of the political agenda, oil companies are being stung into action.

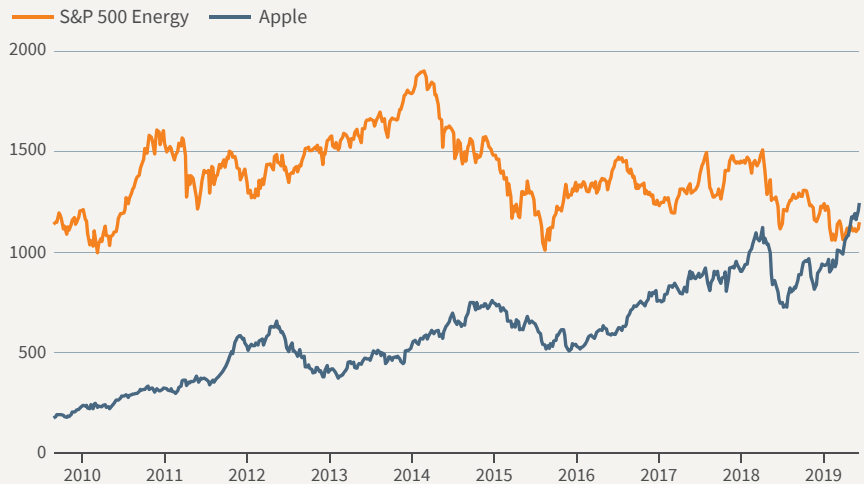
On December 2, 2019, Repsol embarked on the most ambitious attempt yet by an oil major to wean itself off fossil fuels. The Spanish oil group, which took a €4.8 billion charge as it wrote down the value of oil and gas assets, said it will eliminate all greenhouse-gas emissions from its own operations and customers who use its products by 2050.¹⁷

Interestingly, Repsol’s shares as of January 17 were largely unchanged in the wake of the announcement. Rats says while that is partly because it was no more than an “extension” of previous guidance, it also reflects the difficulty the market is having in gauging what such statements actually mean.

“The industry at the moment is in a position where doing nothing is not an option because simply betting on oil and gas for the next 20-30 years looks increasingly risky. But the alternatives, such as expanding into renewable energy, are also fraught with uncertainty.

Figure 2: Apple’s value surpasses US energy sector

Market Cap (\$ tn)



Source: Refinitiv Datastream, December 2019.

The returns on capital from doing that may not be very good at all,” he explains.

Rats adds rising uncertainty is making it increasingly difficult to value shares, meaning investors are building in larger and larger margins of safety, resulting in share prices performing poorly.

Similar trends are starting to emerge in bond markets. Tom Chinery, investment grade credit portfolio manager at Aviva Investors, argues investors’ nervousness can be seen in a shortening of debt maturities for oil and gas companies.

“The market is changing dramatically. While ExxonMobil has 30-year debt, there’s nothing issued by BP with a maturity over 15 years. Investors are still buying these companies’ bonds, but visibility and confidence in their long-term prospects is diminishing,” he says.

Although Chinery concedes it is hard to detect any appreciable widening of credit spreads on debt issued by oil majors, in 2017 Moody’s warned the oil and gas industry faced significant credit risks from the carbon transition. The credit ratings agency said the potential for oversupply as demand falls is likely to put pressure on margins and cash flows, which could lead to assets being stranded.¹⁸

Projects most at risk include those with high operating costs or a high carbon intensity of production; large upfront capital commitments and long investment lead times; and a higher carbon content.

These include oil sands, shale and extra-heavy oil, as well as reserves of higher-grade oil and gas in deep waters and other hard-to-access sites like the Arctic. On December 15, 2019, US investment bank Goldman Sachs ruled out financing oil drilling or exploration in the Arctic in future, adding it would not invest in new thermal coal mines anywhere in the world.¹⁹

Since most companies’ proven reserves are likely to be extracted within the next ten years, Merriman believes there is little risk of them getting stranded. But new projects that are likely to take longer to come to fruition are looking increasingly risky, helping explain what she terms “widespread capital austerity”.

“There is enormous pressure to prioritise free cash flow and turn that into dividends and returns. Companies are being much more selective about where their capital expenditure goes. They’re doing everything they can to prioritise projects with short pay-off periods to bring cash flow forward and I don’t see this changing,” she says.

A fragile bridge? Natural gas’s methane problem

While no company has gone as far as Repsol, its competitors such as Royal Dutch Shell, Total and BP have set their own targets to reduce emissions and are investing in renewable energy, electric-car charging and battery technology. But in all three cases, as with many other oil majors,

\$1.3 trillion

The amount being invested in LNG terminals that risk becoming stranded

an even more significant strand of their strategy is to shift the production mix away from oil towards natural gas.

Shell, which acquired BG Group in 2016 to become the world's top trader of liquefied natural gas (LNG), currently produces around 3.7 million barrels of oil equivalent per day, of which roughly half is natural gas. Chief executive Ben van Beurden said in March 2018 natural gas production could be triple that of oil by 2050 as Shell looks to meet a self-imposed goal to halve the net carbon intensity of the energy products it sells.²⁰

As power plants running on gas emit about 40 per cent less CO₂ than those running on coal, gas has until recently been seen as a bridge from coal to renewables. However, according to Merriman, this view is being challenged.

"The green credentials of gas have started to come under significant scrutiny due to the amount of methane being released into the atmosphere, in addition to its still-sizeable carbon footprint," she says. A US government study published in November 2019 corroborated this as it reported atmospheric methane had risen unexpectedly sharply to 1,859 parts per billion (ppb) in 2019, from 1,775 ppb in 2006.²¹

Compared to carbon dioxide, methane is a relatively short-lived but potent global warming gas. According to the IPCC, over a 20-year period methane's global warming impact is 86 times that of CO₂. The IPCC is calling for natural-gas production cuts of 15 per cent by 2030 and 43 per cent by 2040, relative to 2020 levels.²²

A June 2019 report by *Global Energy Monitor* said the fact natural gas appears to contribute more to global warming than previously realised means various gas assets are in danger of becoming stranded too, not least if the price of renewables continues to fall. The US fracking industry, which has been eating up cash, looks especially vulnerable.²³ Fracking is estimated to release 50 per cent more methane into the atmosphere than drilling

for gas in conventional ways. A 2018 study by Alvarez et al, published in *Science*, concluded 2.3 per cent of US gas production was leaking into the atmosphere, 60 per cent more than the US government had assumed.²⁴

Global Energy Monitor warned much of the US\$1.3 trillion being invested in developing over 200 LNG terminal projects is also at risk of being stranded. The report's authors said LNG tends to lead to higher fugitive emissions, as well as requiring significant amounts of energy to ship, liquefy and turn back into gas.

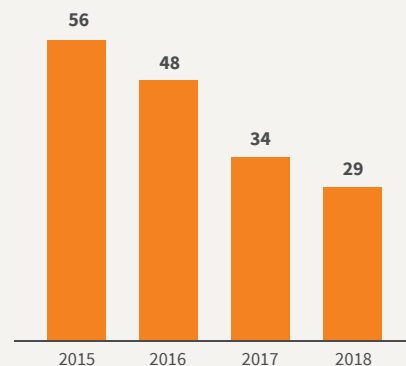
While evidence gas-fired power stations are becoming stranded is inconclusive, they could be at risk further ahead. Worryingly for the US owners of such assets, according to a 2018 report by Dyson et al, clean energy portfolios can often be procured at significant net cost savings, with lower risk, compared to building a new gas plant.²⁵ With about half of the existing thermal generator fleet likely to retire by 2030, US power companies have big decisions to make as they prepare to commit their customers and investors to as much as US\$1 trillion in investment and fuel costs over the coming decade.

Knock-on implications

The risks of asset stranding as the world transitions to a low-carbon economy extend far beyond fossil-fuel companies and energy producers. For a start, suppliers to these industries will be affected. A prime example is General Electric, which in 2018 took a US\$23 billion charge after writing down the value of power-generation assets acquired from Alstom just three years earlier. That followed a collapse in global gas turbine orders.²⁶

According to Steve Waygood, chief responsible investment officer at Aviva Investors, any company with its own carbon footprint, or whose products create one, must wake up to the threat of

Figure 3: Sharp fall in gas turbine orders
Gigawatts



Source: GE 2018 Annual Report. Includes turbines 30 megawatts and larger.

the rapid deployment of new technologies, and the speed and scale at which regulations could come into force to deliver the goals of the Paris Agreement.

Auto manufacturing, for example, is undergoing a period of especially profound change as companies make their fleets more efficient in response to the changing regulatory environment around the world. The EU's fleet-wide emissions target for new cars will be set at 95 grams of CO₂ per kilometre by 2021 and big fines await companies that don't comply.

Carmakers around the world are rushing out new electric models to meet the new rules, as well as to tap in to growing consumer demand for such vehicles. British-based luxury carmaker Jaguar Land Rover will offer customers electrified options for all new models from 2020, while German rival BMW plans to bring 25 electric vehicles to market by 2025.

Chinery says the electrification of the car industry is likely to produce clear winners within the next decade, with other companies being at serious risk. Since developing new electric vehicles requires significant investment, companies with strong balance sheets should have a major competitive advantage.

STRANDED! WHEN ASSETS BECOME LIABILITIES

continued

“Volkswagen has a massive balance sheet that is allowing it to spend €20 billion building five electric car plants. It can create economies of scale by doing tie ups with weaker companies such as Ford that don’t have the same investment capacity. It should make Volkswagen one of the winners, so long as it gets it right,” he says.

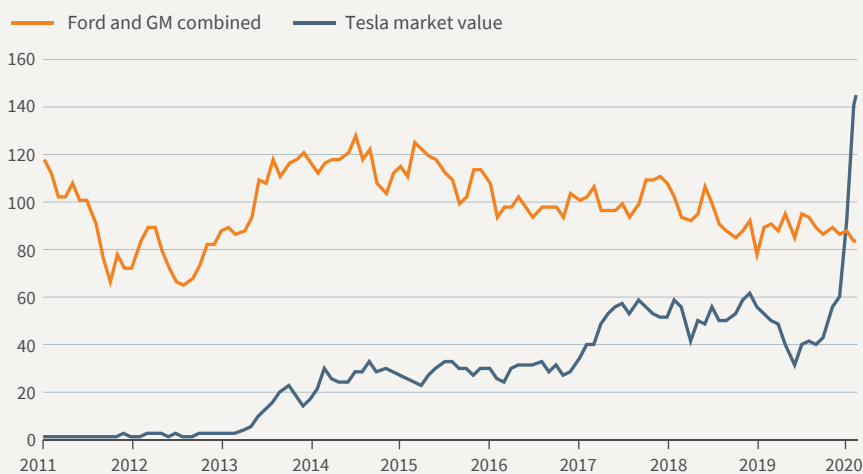
For some, the answer has been consolidation. Fiat Chrysler and France’s PSA, the owner of Peugeot, in December agreed a deal to create the world’s fourth-largest carmaker. The companies hope the merged entity will have the financial firepower to invest in new technologies, notably electric vehicles.²⁷

The extent to which electrification is shaking up the car industry can be seen by comparing the fortunes of Tesla with traditional US auto rivals Ford and GM. As Figure 4 shows, between the start of 2011 – six months after the company floated – and February 13, Tesla’s market value surged 5,740 per cent to US\$145 billion. That makes it worth considerably more than Ford and GM, whose combined value sank 29 per cent to US\$83 billion in that period.

Elsewhere in the transport sector, airlines and aircraft makers are under increasing pressure to curb emissions. Since there is little prospect of the aviation industry electrifying in the foreseeable future, airlines will struggle to grow, and could even begin to see assets becoming stranded if regulators demand sizeable cuts in emissions. As for aircraft makers, Airbus in February 2019 took a €463 million charge after pulling the plug on the A380, in which it had invested around €25 billion. Sales of the superjumbo were undercut by other more fuel-efficient offerings like its own A350 and Boeing’s 787.

Meanwhile, heavy industry is responsible for around 22 percent of global CO₂ emissions. Roughly 42 per cent of that – just over nine per cent of global emissions – is the consequence of fossil-fuel combustion to produce heat to make products such as cement, steel and petrochemicals. To put

Figure 4: Tesla worth more than GM and Ford combined
(\$bn)



Source: Refinitiv Datastream, February 13, 2020.

that in perspective, industry’s requirement for heat leads to more emissions than all the world’s cars (six per cent) and planes (two per cent) combined.²⁸

Since low-carbon production techniques for steel and cement are scarce and expensive, and outright alternatives few and far between, there may be a relatively low risk of assets becoming stranded in the near term. However, given the scale of emissions generated, it seems quite possible companies will come under intensifying pressure to develop and adopt new technologies. That could offer advantages to first movers. In November, German steelmaker ThyssenKrupp launched the world’s first tests into the use of hydrogen in a blast furnace. The gas will be injected to partially replace pulverized coal at a large scale during steel production.

An existential threat

In April 2019, the Bank of England warned up to US\$20 trillion of assets were at risk of being stranded globally if the climate emergency is not addressed effectively.²⁹ In terms of fossil fuels specifically, a 2018 study in *Nature* said, regardless of the decisions policymakers take, at least US\$1 trillion of assets will be stranded in the near future as the “overwhelming” momentum behind technological change in the global power and transportation sectors leads to a dramatic decline in demand for fossil fuels. Should more stringent climate policies be enacted by governments, the value of stranded

assets could swell to US\$4 trillion.³⁰

Waygood believes the need to transition to a low-carbon economy will present an existential threat to fossil-fuel companies that resist pressure to transform their businesses. “Projected capital expenditure over the next ten years is about US\$4.7 trillion. I think much of it is going to be wasted,” he says.

David Cumming, Aviva Investors’ chief investment officer for equities, says it is imperative oil companies set out a clear strategy in view of the long-term trend towards low-carbon energy and renewables.

“While this does not necessarily mean they should stop investing in developing new fossil-fuel reserves altogether, we’re encouraging companies to scale back investment. The risk of assets being stranded means they need to apply a much higher cost of capital,” says Cumming.

While Morgan Stanley’s Rats agrees oil companies need to apply stricter criteria when deciding where to explore for oil, he does not believe exploration will dry up overnight, as without it supplies would fall too fast.

“Even the most hardened clean-energy proponents would agree we need to develop more fields under almost any scenario.”

Rats explains there are two reasons to do more exploration. “We are still finding new oil that is cheaper than the oil we

The Bank of England has warned up to \$20 trillion of assets are at risk of being stranded globally

already have,” he says. “So, if you look at what Exxon has done offshore in Guyana for example, those are really very good discoveries and they make economic sense at much lower oil prices than fields other companies might have developed if they had not been found.”

New oil supplies are also needed as insurance against the risk the world takes longer than expected to decarbonise. “If it takes 50 to 100 years rather than the 20 to 30 years we want it to take, we’ll have to use more oil and gas. We need an inventory of reserves,” Rats says.

Nonetheless, Cumming believes over the long term fossil-fuel companies need to adopt one of two approaches. They could choose a “managed decline”, focusing on maximising returns from their existing portfolio while refraining from sanctioning new projects that fail to fit into a given carbon budget. As a result, upstream production would gradually diminish, with excess cash being returned to investors. A second option would be to use free cash flow to diversify into other sectors, such as the provision of renewable energy, or developing carbon-capture technologies.

“Either way, companies need to outline a credible strategy. Those that don’t are starting to get punished. It’s hard to believe this trend won’t accelerate,” Cumming argues.

Every cloud...

While the transition to a low-carbon economy threatens the existence of many companies and whole sectors, Tesla has shown that for others the potential rewards on offer are huge.

Kevis says Orsted is a company that has shown how tackling climate change head on can create value for investors. “The transition to renewables has done wonders for its shares. Investors will be on the lookout for other utility companies contemplating similar moves.”

The Danish company’s share price has soared 132 per cent since it sold its oil and gas assets in May 2017.

As for Green, he says engaging with a whole range of companies is helping create shareholder value at the same time as aiding the process of decarbonisation. “If you take the packaging sector, it’s a big energy user. In the past five years, we’ve seen companies such as DS Smith making big strides to becoming more efficient by using less energy and recycling more to keep investors like ourselves happy. It makes the business more efficient so it’s a win-win,” he says.

Waygood believes the investment industry has never had a more important role to play. For so long in an unenviable position of trying to maximise returns for investors while safeguarding the livelihoods of future generations, suddenly the two objectives are beginning to align.

“Asset stranding isn’t a new concept. It is the fact that it is fossil fuels that makes it unique. There is no denying governments need to get their acts together and take a lead. But the fact financial markets are suddenly waking up to this threat gives me hope we as an industry can play our part in averting a disaster, the consequences of which are hard to overestimate,” he says ●

- 1 Intergovernmental Panel on Climate Change (IPCC) website.
- 2 McGlade, C., Ekins, P., ‘The geographical distribution of fossil fuels unused when limiting global warming to 2 °C’, Nature 517, 187–190, 2015.
- 3 Lauri Myllyvirta, Dave Jones and Tim Buckley, ‘Analysis: Global coal power set for record fall in 2019’, Carbon Brief, 25 November 2019.
- 4 ‘EU electricity market summary shows shift from coal to gas’, EnAppSys Energy Insight, 15 October 2019.
- 5 Bloomberg.
- 6 ‘SSE announces proposed closure of fiddler’s ferry coal-fired power station’, SSE, 13 June 2019.
- 7 ‘New Energy Outlook 2019’, BloombergNEF.
- 8 Benjamin Storrow, ‘And now the really big coal plants begin to close’, Scientific American, 16 August 2019.
- 9 Jake Flatley, ‘Blackhawk Mining announces closure of facilities in southern West Virginia’, MetroNews, 8 October 2019.
- 10 ‘Peabody energy to close illinois coal mine, processing plant’, Associated Press, 15 October 2019.
- 11 Clifford Krauss, ‘Murray Energy is 8th coal company in a year to seek bankruptcy’, The New York Times, 29 October 2019.
- 12 ‘Short-term energy outlook – Coal’, US Energy Information Administration website.
- 13 ‘Adani wins final approval to begin work on controversial Carmichael coal mine project in Australia’, Financial Express, 13 June 2019.
- 14 Samantha Hepburn, ‘Why Adani’s scaled-down coal mine in Australia is still a bad idea’, Quartz India, 4 December 2018.
- 15 Ben Potter, ‘Landmark decision blocks Gloucester Resources coal mine in NSW’, Australian Financial Review, 8 February 2019.
- 16 ‘Furthering our commitment to the transition to a low-carbon economy’, Glencore, 20 February 2019.
- 17 ‘Climate change: Official Notice’, Repsol, 2 December 2019.
- 18 ‘Moody’s: Significant credit risks arise for oil and gas industry from carbon transition’, Moody’s Investors Service, 26 April 2017.
- 19 Stephanie Kirchgaessner, ‘Goldman Sachs to stop financing new drilling for oil in the Arctic’, The Guardian, 16 December 2019.
- 20 ‘Changing in a time of change’, Shell, 7 March 2018.
- 21 ‘Global CH4 Monthly Means’, US Department of Commerce, National Oceanic and Atmospheric Administration.
- 22 IPCC website.
- 23 Ted Nace, Lydia Plante & James Browning, ‘The new gas boom: tracking global LNG infrastructure’, Global Energy Monitor report, June 2019.
- 24 Ramón A. Alvarez et al, ‘Assessment of methane emissions from the US oil and gas supply chain’, Science vol 361, issue 6398, pp 186–188 (2018).
- 25 Mark Dyson, Alex Engel & Jamil Farbes, ‘The economics of clean energy portfolios’, Rocky Mountain Institute, 2018.
- 26 ‘2018 Annual Report’, GE.
- 27 ‘Fiat Chrysler and Peugeot agree to merge in giant auto deal’, Financial Times, 18 December 2019.
- 28 Dr. Julio Friedmann, Zhiyuan Fan & Ke Tang, ‘Low-carbon heat solutions for heavy industry: sources, options, and costs today’, Columbia SIPA Center on Global Energy Policy, October 2019.
- 29 ‘Avoiding the storm: Climate change and the financial system’, Speech by Sarah Breedon, Bank of England Executive Director, International Banks Supervision, 15 April 2019.
- 30 Mercure, J., Pollitt, H., Viñuales, J.E. et al, ‘Macroeconomic impact of stranded fossil fuel assets’, Nature Clim Change 8, 588–593, 2018.

‘STICKING’ IT TO CARBON: THE PROS AND CONS OF TAXING EMISSIONS

With governments urged to do more to tackle climate change, carbon taxes are being touted as a politically expedient solution.



\$40 per tonne

The carbon tax advocated by leading US economists

In his 1984 book *Managing the Global Commons: the economics of climate change*, Yale economist William Nordhaus said the burning of fossil fuels and release of carbon dioxide and other greenhouse gases created significant externalities. Moreover, he believed markets would be unable to correct them on their own.

In the intervening years, Nordhaus's pioneering work – which began in the mid-1970s and led to him being awarded the Nobel Prize in Economics in 2018 – has become widely accepted. There now seems little doubt the world economy is facing significant risks from unabated climate change. Furthermore, while households and businesses have an important role to play, it seems almost certain greenhouse-gas emissions will hit perilous levels if economies are left to operate freely.

Consequently, many economists believe governments must step up their efforts to address the situation. Although subsidies to encourage the development of clean technologies are one option, their cost can be prohibitive. As a result, policymakers have primarily focused less on the carrot, and more on the stick.

Polluter pays

To date, countries that have attempted to apply the polluter-pays principle and put a price on the emission of carbon dioxide and other greenhouse gases have done so via a carbon tax (known as a price instrument); a cap-and-trade scheme (a so-called quantity instrument); or a combination of the two.

A carbon tax imposes a tax on each unit of greenhouse-gas emissions and gives economic actors an incentive to reduce pollution whenever doing so would cost less than paying the tax. The tax is set by assessing the cost or damage associated with each unit of pollution and the costs associated with controlling it.

By contrast, a cap-and-trade system sets a maximum level of pollution and distributes emissions permits among firms. Companies must have a permit to cover each unit of pollution they produce, and can obtain these permits either through an initial allocation or auction, or through trading with other firms.

Economists such as Nordhaus prefer the former option, on the basis higher prices will encourage firms and consumers to find alternatives to carbon-based products as well as encourage new technologies to make those substitutes competitive. While this has become the mainstream view among environmental economists, the profession continues to debate the relative merits of price and quantity instruments. For instance, Harvard professor Martin Weitzman was not alone in arguing quantity instruments were likely to work best, at least under certain conditions.¹

Government inaction

Unfortunately, beyond keeping some members of the economics profession occupied, the debate has been of little practical consequence since government action has been woefully inadequate. It is true a growing number of jurisdictions have implemented a carbon tax or an emissions trading system. As of June 2019, the World Bank reported 57 initiatives, up from 51 a year earlier, a number it expects to grow.² However, they have been devised in piecemeal fashion, if at all, meaning they have struggled to significantly dent emissions.

A September 2018 report from the Organization for Economic Cooperation and Development found the average carbon price across 42 major economies was around US\$8 per tonne.³ The following month, the Intergovernmental Panel on Climate Change, a body that assesses the science related to climate change in order

to guide world leaders, estimated that to be effective any tax would have to range from \$135 to \$5,500 per tonne in 2030, and from \$690 to \$27,000 per tonne by 2100.⁴

All told, the World Bank reckons just 20 per cent of global emissions are covered by a carbon price and less than five per cent of those are currently priced at levels consistent with reaching the temperature goals of the Paris Agreement. It called on all countries to go further and faster in using carbon-pricing policies, which it believes to be the most effective way of reducing emissions.

In 2018, a record number of US-based economists called for a carbon tax of around \$40 per tonne.⁵ Raised over time by more than the rate of inflation, they said this would be the most effective and immediate way of tackling climate change. Led by former Federal Reserve chiefs Janet Yellen and Ben Bernanke, the 3,300 members of the Climate Leadership Council said such a tax would be “very effective” at reducing emissions and would “more than meet the Paris commitment”.

How high is high enough?

Lawmakers face two main issues in taxing domestic polluters. First, since taxes are generally unpopular with businesses and, more importantly, electorates, politicians have found it difficult to set a price high enough to bring about sufficiently deep reductions in carbon emissions. This explains why governments have had most success in reducing emissions through regulations, such as imposing fuel-economy standards on vehicle manufacturers or simply closing coal-fired power stations.

Although Nordhaus showed raising prices through taxation was more economically efficient, regulations tend to be a more

'STICKING' IT TO CARBON: THE PROS AND CONS OF TAXING EMISSIONS

continued

“

A carbon border tax should incentivise big polluting countries such as China and India to do more to curb their emissions

”

palatable political solution since their true cost tends not to be evident. A policy that requires electricity providers to build more renewable energy facilities has visible benefits – more wind and solar – and hidden costs. But a carbon tax that directly increases the price of petrol at the pump or electricity bills brings more obvious pain, and hence is more likely to stir opposition. After all, the soaring cost of everyday necessities, including petrol, last year sparked protests that spiralled into major movements in countries including France, Lebanon, Sudan and Chile.

Second, since pollution is a global externality that does not respect national boundaries, there is a perverse risk that taxes in one country or region might cause global emissions to rise due to “carbon leakage”. Faced with stringent climate policies in their domestic market or home region, polluting companies might simply shift production to countries with less ambitious climate measures for fear of losing out to international rivals.

Putting up borders

As a result, a growing number of economists believe carbon border taxes are needed. Discussing what is essentially a form of tariff, Dieter Helm, a professor of economics at the University of Oxford, tells AIQ: “If you want to tackle carbon leakage, border taxes are the only way.”

While the idea has been around for more than a decade, it is only in recent months it has begun to make headlines after the European Commission said it was considering applying a carbon border tax on imports should “differences in levels of ambition worldwide persist, as the EU increases its climate ambition”.⁶ Under pressure following a big swing to Green parties after climate issues leapt up the political agenda, it said the aim would be to ensure the price of imports more accurately reflected their carbon content.

It might be only a matter of time before other countries take the idea of a carbon

border tax more seriously. Helm believes such a tax could have “deep political appeal” in Washington given US attitudes towards China and bipartisan support for reshoring heavy industries such as steel.

“From both a US and European perspective, what is the point in cutting emissions if you are going to import the stuff from China and other countries which are increasing their pollution fastest?,” he says.

Interestingly, the Climate Leadership Council’s proposal also envisaged a carbon border tax. The plan drew backing from across the political spectrum. Other signatories included former US Treasury Secretary Larry Summers, former Clinton economic adviser Alan Blinder, and Marty Feldstein, a prominent Republican economist and former chief economic adviser to Ronald Reagan.

Aside from dealing with carbon leakage, a carbon border tax should also incentivise big polluting countries such as China and India to do more to curb their own emissions.

Although the EU says any border tax would be designed to comply with World Trade Organization rules, that is unlikely to be straightforward. For instance, putting a fair carbon price on a product as complex as a car would be immensely difficult. Nonetheless, according to Helm, that is not to deny the merit of taxing a small number of energy-intensive products, which is where Brussels is likely to start.

“It need not be fantastically complicated. If you take steel, cement, aluminium, fertiliser, petrochemicals; that’s a huge proportion of the carbon footprint of total trade,” he says.

The other main drawback of a carbon border tax is that the price of goods with high-carbon contents, in this case imported ones, would be likely to rise. However, most economists agree there is no way of shifting from an almost entirely carbon-intensive economy to one that has virtually no carbon in it, and to do it in a very short space of time, without incurring significant expense.

While the price of a wide range of goods would be likely to rise, in some cases sharply, a tax with the potential to bring back long-lost heavy industries at the same time as tackling climate change might seem like too good an opportunity for politicians to pass up. As questions over the benefits of globalisation grow ever louder, could it be that the world is stumbling upon a politically expedient way of tackling climate change?

Either way, what seems beyond doubt is that whether countries ultimately opt for subsidies for clean energy or some form of carbon taxation, they have to do far more if the world is to have hope of avoiding drastic climate change. As Nordhaus told the Nobel committee, policies are lagging “very, very far – miles, miles, miles – behind the science and what needs to be done” ●

1 Martin Weitzman, ‘Prices vs. quantities’, *The Review of Economic Studies*, October 1974, 41 (4): 477-491.

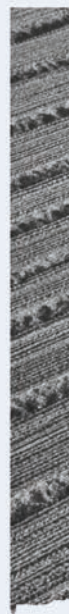
2 ‘57 carbon pricing initiatives now in place globally, latest World Bank report finds’, *The World Bank*, 7 June 2019.

3 ‘Few countries are pricing carbon high enough to meet climate targets’, *OECD*, 18 September 2018.

4 Brad Plumer, ‘New U.N. climate report says put a high price on carbon’, *The New York Times*, 8 October 2018.

5 ‘Economists’ statement on carbon dividends: the largest public statement of economists in history’, *Climate Leadership Council*.

6 ‘EU risks trade fight over carbon border tax plans’, *Financial Times*, 16 October 2019.



SLASH AND BURN: THE LINK BETWEEN LAND USE AND CLIMATE CHANGE

Poor land management contributes to rising global temperatures. But solutions are emerging as new technologies improve farming efficiency and consumers shift towards climate-friendly diets.



SLASH AND BURN: THE LINK BETWEEN LAND USE AND CLIMATE CHANGE

continued

In February 2017, Australia's Liberal Prime Minister Scott Morrison addressed Parliament with a lump of coal in his hand, holding it in the air in the way a preacher might brandish the Bible. "Don't be afraid. Don't be scared. It won't hurt you," he said, taunting his political adversaries. "It's coal."

At the time, the opposition Labor Party was calling for more ambitious renewable energy targets and carbon-emissions cuts. Temperatures had reached record highs and the risk of bushfires was deemed "catastrophic" amid an extensive drought.

Morrison's bullish tactics won the support of coal communities in the key swing state of Queensland, and he was re-elected in 2018. But his outburst would come back to haunt him when hundreds of bushfires ravaged Australia at an unprecedented scale in 2019-20, killing dozens of people and wiping out more than 17 million acres of land, including thousands of homes. The number of wild animals killed or injured could add up to a billion. The fires will also contribute to one of the largest annual rises in carbon concentration in the atmosphere since records began in 1958.¹

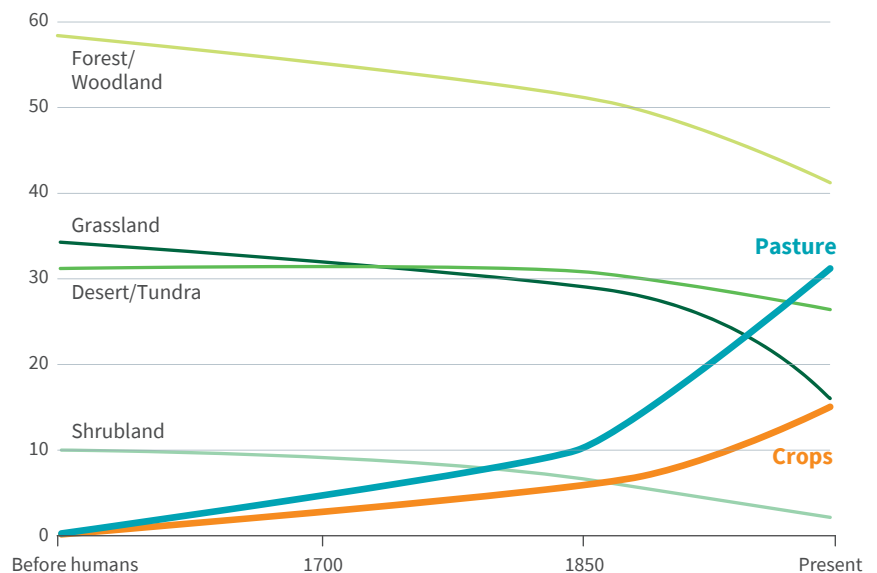
Australia was not alone in making headlines last year because of the destructive power of fire: California and large swathes of the Amazon rainforest were also set ablaze. These cases differ in their individual circumstances, involving a complex web of causes and effects that cannot be easily disentangled. But climate change, coupled with unsustainable land management, is a common factor in all three disasters.

In Australia, rising temperatures have made the land hotter and drier, so infernos are now more likely. And land-use policies that pre-dated Morrison's tenure, such as extensive wildland clearing for agriculture, may have fanned local climate conditions that made the bushfires more destructive.²

On their own, minor policy decisions about how to manage land have little impact on long-term climate trends. Taken together, though, land-use policies can intensify the

Figure 1: Land grab

Agriculture now occupies more than a third of the 135 million square kilometres of land on Earth. Land area (millions of square kilometres).



Source: The Essential Guide to Earth, New Scientist, 2018.

effects of climate change in what scientists have dubbed a "positive feedback loop". Poor land management disrupts ecosystems and contributes to a rise in average local temperatures, exacerbating land degradation in a self-reinforcing cycle that reverberates globally.

Earth, wind and fire

Over 70 per cent of the ice-free land on Earth is directly affected by humans, according to the Intergovernmental Panel on Climate Change's (IPCC) special report on land use.³ Deforestation, agriculture and other forms of land management contribute about 23 per cent of global greenhouse-gas (GHG) emissions. Overall, human land use is the second-largest contributor to carbon dioxide (CO₂) emissions, behind fossil fuels, and the largest contributor to other types of GHGs, such as methane and nitrous oxide.⁴

Conflicts over land use are becoming more prevalent due to rising global consumption. As emerging economies grow faster and catch up with the living standards of developed markets, the world's ability to cope with rising per-capita consumption is being severely tested. A radical change in land management – backed by policies, public support and investment incentives – is required.

However, such a shift looks difficult to achieve in an era of strongman politics. Employing similar tactics to win over his core voters as Morrison in Australia, President Donald Trump formally served notice to quit the Paris Agreement in 2019,⁵ despite the wildfires raging in California.

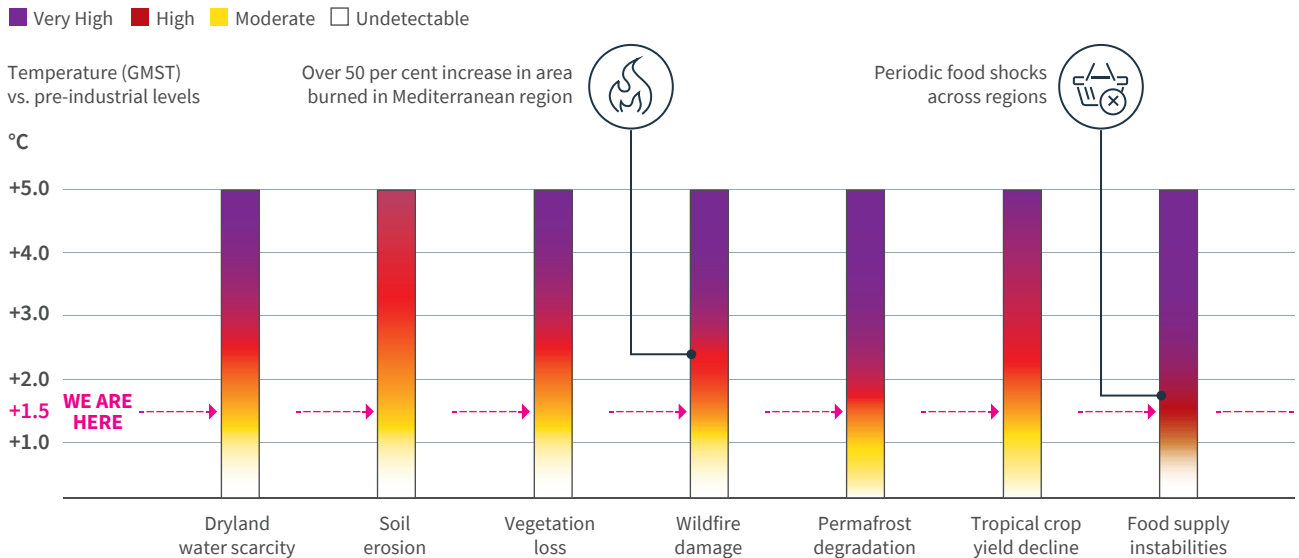
"It is really problematic that the United States is absent," says Ken Alex, director of Project Climate at the University of California at Berkeley and a former senior policy advisor under California Governor Jerry Brown from 2011 through 2018. "Its absence is felt in terms of investments, domestically, and its lack of leadership internationally."

"It gives free rein to other countries to say: 'Well, if the US isn't going to do anything, neither are we.' So, you have a race to the bottom. By not acting, the US gives cover for those who don't want to do anything. Its absence could be devastating," Alex adds.

Another self-styled strongman, Brazil's President Jair Bolsonaro, is easing deforestation restrictions to encourage commerce in the Amazon, where some of the country's largest exports, such as timber, beef and soy are produced. In the first 11 months of 2019, deforestation of the Amazon was at its worst in a decade, with almost 9,000 square kilometres destroyed – a surface area 11.5 times the size of New

Figure 2: Varying degrees of land use risks

A 1.5 degrees Celsius increase brings significant risks to humanity



Note: We're already in the moderate to high risk zone in all categories.

GMST: Global Mean Surface Temperature.

Source: IPCC Climate Change and Land report, 2019.

York City, according to Brazil's National Institute for Space Research (INPE), which uses satellite data to monitor the rainforest. Deforestation clears the way for carbon-intensive agriculture; it also removes trees that soak up more carbon from the atmosphere.

It is little wonder, then, that four years after the Paris Agreement was signed, GHG emissions have continued to rise. The world is far from meeting its stated goal of keeping the average global temperature increase to well below two degrees Celsius above pre-industrial levels, never mind the more idealistic target of about 1.5 degrees Celsius. Significant risks to human societies are already apparent, according to the IPCC.⁶ (See Figure 2.)

"We can convince ourselves everything is changing, but emissions are supposed to be dropping through the floor when in reality they're skyrocketing," says Ed Dixon, head of environmental, social and governance (ESG) for real assets at Aviva Investors.

Land and ocean surface temperatures are estimated to have warmed by about 0.8 degrees Celsius in 2018, and 18 of the warmest years on record have occurred in the past two decades.⁷ Weather conditions globally have become more extreme: unusually cold or hot weather; longer

droughts in certain parts of the world; and more frequent and violent storms in others.

"Beyond their obvious social impact, these disruptions can affect productivity. They affect supply chains and cause damages to properties," says Ben Carr, capital risk director at Aviva. "All of these things could lower GDP at the local level and at the global level, as well as feed through into financial markets."

The hidden costs of food

Food production encapsulates the tangled connections between government policy, corporate land use, climate change and extreme weather. Agriculture is one of the key contributors to CO₂ emissions – and climate change is already impeding crop yields in certain regions.

Yield losses in maize, barley and wheat – three of the most important crops in Eastern and Northern Europe – have fallen by about 24 per cent, nine per cent and two per cent, respectively, in the past 35 years due to long-term variations in temperature and precipitation linked to climate change. According to research led by the University of Minnesota's Institute on the Environment, data from about 20,000 counties and districts globally revealed sub-Saharan crops such as maize and sugarcane tended to yield less. Meanwhile, in Australia, wheat yields

9,000 sq. km

The area of Amazon rainforest destroyed in 2019

SLASH AND BURN: THE LINK BETWEEN LAND USE AND CLIMATE CHANGE

continued

dropped by about nine per cent during the same period.⁸

Agriculture accounts for about half the Earth’s habitable land, with most of that space dedicated to grazing pasture. Managed forests, which include timberland, cover another 37 per cent (see Figure 3).

Current farming practices often involve burning biodiverse forestland and peatland to make way for cropland, which stores less than half as much carbon. Overuse of synthetic herbicides and pesticides leads to further land degradation. Such methods also kill wildlife. Average populations of mammals, birds, fish, reptiles, and amphibians have declined by about 60 per cent in 40 years, a study by the World Wildlife Fund estimates, partly due to agricultural practices.

As demand rises – sometimes in the same regions in which crop yields are falling due to climate effects – the local response in many cases has been to increase the area carved out for agriculture, which could lead to further degradation, contributing to climate change’s positive feedback loop.

Global climate and food production risks will continue to rise in synchrony unless two things happen: a dramatic reduction in land-based GHG emissions and the creation of net CO₂ sinks that remove carbon from the atmosphere. This will require more sustainable land use on the one hand, and a change in global consumption patterns on the other.

“We need to look at all the methods available and to think about sustainability from an end-to-end value-chain

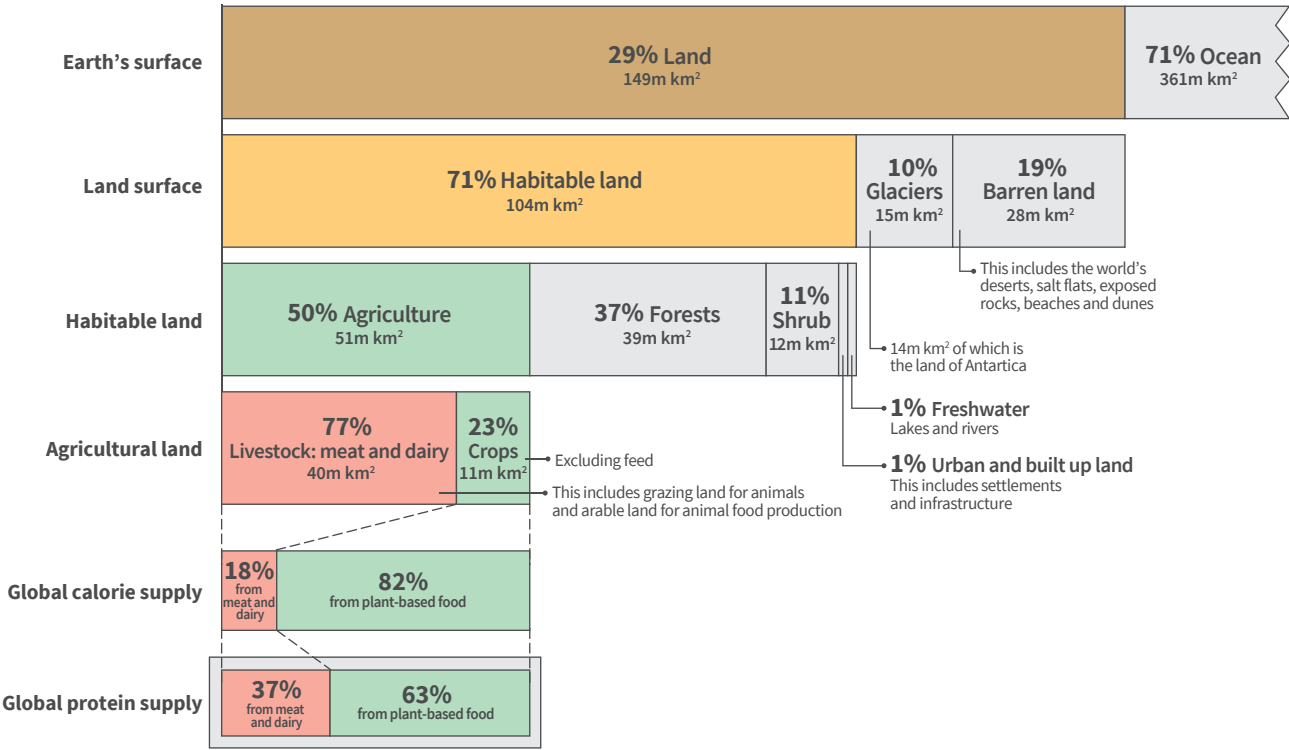
perspective,” says Professor Vicky Pope at University College London’s Department of Science. She previously led the climate predictions programme at the UK Met Office Hadley Centre.

“What resources are we using in terms of water, energy, waste and pollution? What is the impact on the air, water and soil? All of those things can have a negative or a positive impact. We need to look at it in the round and how to bring it all together to create something sustainable. That’s really the change that needs to happen,” Pope adds.

A smarter crop

What would climate-friendly land use look like? According to the IPCC, positive changes would start with smarter

Figure 3: Global land use for food production



Source: Our World in Data, based on data from UN Food and Agriculture Organization (FAO), 2019.



New innovations in land use could help mitigate climate change by removing CO₂ from the atmosphere



land-management techniques, dependent on “site-specific local knowledge, matching of species with the local land, water balance, nutrient and climate conditions”.

New digital technologies promise to make these objectives achievable. One example of progress in precision farming is the work the Indonesia-based Center for International Forestry Research is doing with public and private entities to bring better seasonal forecasting to local farmers. They can use these forecasts to make more-efficient decisions in areas such as timing, variety of crop, how much to plant and the level of fertilisation needed.

“We’re looking at how we can use big data to try and improve land productivity so that we can increase production without further deforestation for land use, and stabilise the forest frontier,” says Louis Verchot, director of forests and environment research at the Center.

Technology has also enabled the combination of renewable energy with agriculture in a symbiotic setup, helping farms cut their carbon footprint.⁹ Sometimes called “agrivoltaic systems”, these facilities can increase water-use efficiency, retain soil moisture and help crops survive peak drought and high temperatures, because the panels shield plants from harsh weather conditions. Compared to bare ground installations, the plants may help keep the solar panels cooler, improving their operational efficiency. Combining agriculture and photovoltaic systems has been shown to increase crop yields and solar energy, when compared to producing food and solar energy separately.¹⁰

Increasingly, farmers are also moving up rather than out. Vertical farming is becoming more prevalent in areas where space is at a premium, such as densely populated areas in Japan. This method brings advantages such as improved water efficiency and reduced use of pesticides, herbicides and fertilisers.

However, these benefits are counterbalanced by higher energy costs, among other issues. And current vertical farming practices are limited to certain vegetables and herbs, so the laws of supply and demand may limit their economic impact for the time being.¹¹

Natural carbon sink

New innovations in land use could also help mitigate climate change by removing CO₂ from the atmosphere. Afforestation (planting new forests) or reforestation (replenishing forests that had been destroyed) could play a valuable role.

Biomass, dead organic matter and soils also sequester carbon (the long-term process of capturing and storing atmospheric CO₂). The Earth’s soils can hold up to four times the amount of carbon stored in all living plants and animals, and more than three times the amount stored in the atmosphere, according to data from Columbia University.¹² Each year, soils remove about 25 per cent of the world’s fossil-fuel emissions.

“Modern farming practices are stripping out that carbon extremely fast,” says Dieter Helm, a professor of economic policy at Oxford University, whose new book, *Green and Prosperous Land: A blueprint for rescuing the British countryside*, addresses land use. “The corollary of that is there is a huge opportunity to put the carbon back into the soil. Higher carbon content in the soil roughly translates to higher biodiversity, so it’s a kind of no-regret policy to focus on soil heavily.”

About half of the planet’s topsoil may have been lost in the past 150 years through erosion, compaction, loss of soil structure and nutrient degradation.¹³ These trends are worsening, but small changes could make a big difference in restoring the soil’s ability to capture carbon. Controlling farm equipment traffic to reduce soil compaction, returning organic matter to soils and rotating a more diverse group of crops may help reduce degradation, for example.

Other techniques can directly enhance the rate of carbon sequestration in the soil. Adding biochar, a super compost, or ground silicate minerals could increase the carbon content stored while improving crop yields, according to IPCC.¹⁴

Opportunities to sequester carbon also exist at the borders of land and water, in mangroves and coastal wetlands. Dorothee Herr, manager for oceans and climate change at The International Union for Conservation of Nature, has argued “the same area of coastal wetlands can be more efficient as a carbon sink than most terrestrial forests”.¹⁵

The key is to focus on regenerative agriculture, which “has applications everywhere in the world because almost every jurisdiction in the world has agriculture”, as Ken Alex puts it.

Cutting consumption

While managing existing farmland more sustainably will make a difference, it will not be enough by itself to meet the Paris Agreement targets. A sea change in global consumption patterns is also needed.

“The crucial point is that it’s not the carbon production we should be focused on. If we want to be sure we’ll no longer be contributing to climate change, we need to target net-zero carbon consumption,” says Helm.

Of the one billion people living in the most developed economies in North America, Europe, Japan, Australia and New Zealand, the average per-capita consumption rate of resources is estimated to be about 32 times that of those living in emerging economies, according to Jared Diamond’s recent book, *Upheaval*.¹⁶ Italy’s population of 60 million consumes twice as much as one billion Africans, Diamond points out.

If the average per-capita consumption of emerging nations is set to increase, then those of developed markets will need to fall accordingly. And, since one of the main drivers in the rise in GHG emissions is agriculture, any attempt to reduce it in

SLASH AND BURN: THE LINK BETWEEN LAND USE AND CLIMATE CHANGE
continued

“Sustainable land use will require concerted cooperation among public and private sectors”

the aggregate must include a drastic shift to a less carbon intensive – and often healthier – diet.

“The simplest solution is that we avoid wasting food and, secondly, reduce our meat consumption, particularly beef and lamb, which has the added benefit of being healthier. A chunk of the land that is currently being used as grazing pastures

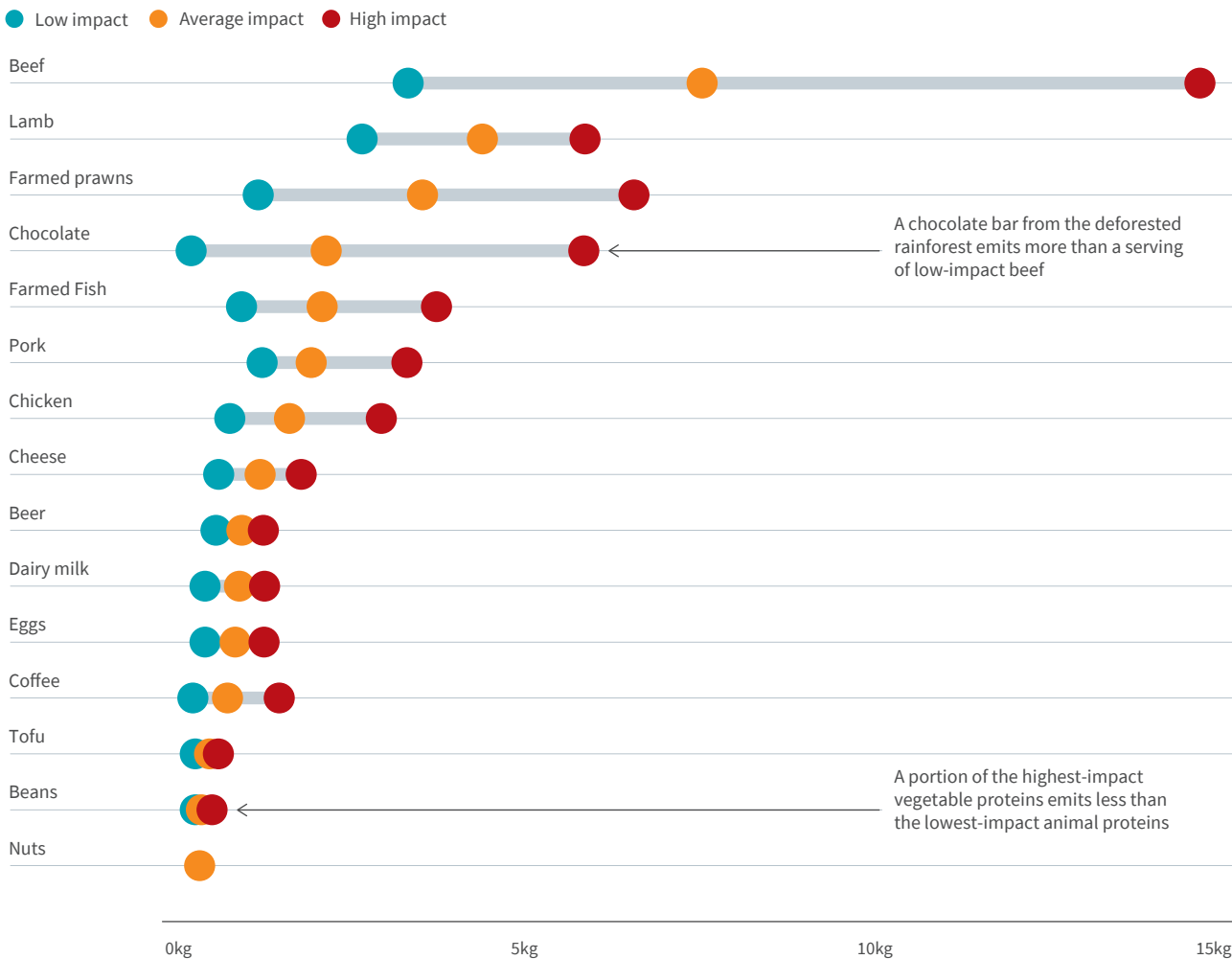
can then be returned to woodlands,” says Eugenie Mathieu, senior responsible investment analyst at Aviva Investors.

“The beauty of reforestation is that it solves two of our most pressing problems in one go; if you don’t cut down trees – and indeed plant more of them – it’s the cheapest way to absorb excess carbon emissions and slow the catastrophic decline in biodiversity

we’ve seen in recent decades,” she adds.

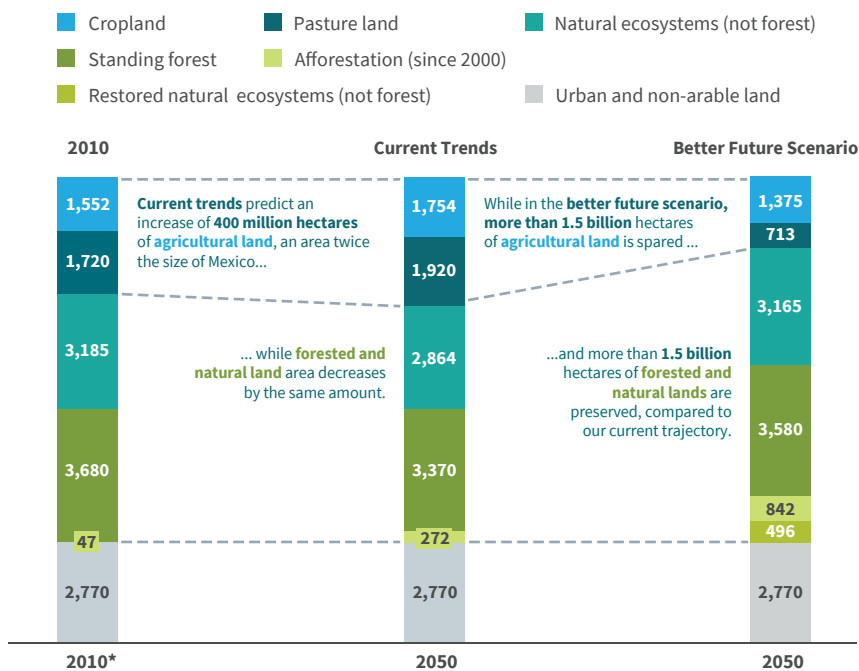
Raising cattle uses 20 times more land and produces 20 times more GHG emissions than growing beans.¹⁷ Meat products have larger carbon footprints per calorie than grains, as indicated in Figure 4, because of inefficiencies in transforming plant energy to animal energy. In addition, more water is required for cattle, which release methane.¹⁸

Figure 4: The carbon footprint of food products
Kilograms of greenhouse-gas emissions per serving



Source: Poore & Nemecek, Science, 2018.

Figure 5: Total surface land use, million hectares



*Baseline data forecast from 2000

Note: According to IIASA estimates, parts of the permanent pastures, as defined in the IPCC 2019 Special Report on Climate Change and Land, are pastures without significant contribution to total livestock production and thus are included in the land use classification 'Natural Ecosystems Land'. The 'Pasture' land use classification includes only grassland utilised for agricultural production.

Source: International Institute for Applied Systems Analysis (IIASA), Global Biosphere Management Model (GLOBIOM), 2019.

Raising cattle produces
20x
more GHG emissions
than growing beans

Eating less beef will not, on its own, reduce individuals' carbon footprint if other life choices aren't taken. Other components such as fossil-fuel consumption, transportation options and air-travel habits also count. One of the most important decisions in this respect is where to call home. There is some evidence that on a per-capita basis, city dwellers may enjoy efficiency benefits, such as public transportation, and leave a smaller carbon footprint than their rural counterparts.

However, this varies widely throughout cities worldwide. In Europe, city dwellers consume about seven per cent less carbon than their rural counterparts when other factors such as household characteristics are controlled.¹⁹ In cities like Hong Kong, however, urbanites have an average per-capita carbon footprint estimated at more than four times that of China's.²⁰ One of the main reasons is they tend to be wealthier. They live and work in more carbon-intensive buildings. They travel more. And they eat more meat.

Investing in land use transitions: Risks and opportunities

Transitioning to more-sustainable land use will require concerted cooperation among public and private sectors – as well as behavioural shifts among individuals – to ensure carbon emissions are reduced across the supply chain.

Using models based on the most current scientific evidence, the IPCC estimates the world will need to produce less carbon in aggregate than the planet can absorb in a net-zero emissions scenario by about 2050. There is room for optimism, despite the foot-dragging by governments in Australia, Brazil and the US. Last year, the UK became the first major economy to pass legislation to meet the net-zero goal by 2050, and 20 other nations have adopted net-zero targets in various forms.²¹

"Net zero is a positive step forward in the sense that it gives everyone much clearer signage, direction and purpose," says

Darryl Murphy, managing director for infrastructure at Aviva Investors. "What's perhaps more important to me is that investors understand how they can help governments in their pathway towards net-zero emissions."

Businesses are already under increasing pressure to reduce Scope 1 and Scope 2 emissions. Scope 3 emissions, which concern indirect emissions up and down the supply chain, are the most difficult to measure, but artificial intelligence (AI) and satellite imaging are opening up ways to track land use and its climate impacts.

"Ideally, we need to move to a day when companies can apply new technologies to know exactly where the commodities they're purchasing come from," says Mathieu. "The information is there. You can look at high-resolution satellite images, for example, to see whether specific fields in the Amazon have been deforested in the last ten years or so; it is that traceable."

Satellite images showing the clearing of Amazon-adjacent wooded grasslands

SLASH AND BURN: THE LINK BETWEEN LAND USE AND CLIMATE CHANGE

continued

owned by the Harvard Management Company, which manages the \$40 billion Harvard University Endowment, led to a public outcry last summer and the university came under pressure to divest its holdings.²² As more data becomes available, investors will need to scrutinise it to monitor the various risks.

“When you look at a company, it’s important to determine what the impact of climate change is by assessing both physical and transition risks on its enterprise value. Then you can think through what that might mean for specific equity or corporate bond exposures,” says Aviva’s Carr.

Land-use transitions required to battle climate change could also yield opportunities. The Food and Land Use Coalition, an environmental consultancy, estimates a variety of businesses could thrive by creating the new value chains needed for regenerative agriculture and introducing products to support the shift to more plant-based diets. The sector could be worth an estimated \$4.5 trillion a year by 2030.²³

A good example is the consumer trend towards veganism, which is creating opportunities for investors in plant-based foods. In the US, sales increased by about 11 per cent to \$4.5 billion in 2019, as data from the Good Food Institute and the Plant Based Foods Association shows.²⁴

Plant-based alternatives to meat and dairy reported the most growth, at ten per cent and six per cent, respectively. Their success has prompted traditional meat producers such as Tyson Foods, the largest meat producer in the US, to invest heavily in “alternative proteins”. In 2019, the company introduced its first line of a plant-based nugget and a “blended” burger patty combining Angus beef and pea protein.²⁵

Back to nature

Lowering the carbon footprint of global food demand, advancing more sustainable farming practices and implementing other land-management improvements are imperative to mitigate climate change risks.

A report from the Food and Land Use Coalition illustrates the stakes. In a “Better Future” scenario, around 1.5 billion hectares of forest and natural land could be restored by 2050 without impacting global food security. However, if nothing is done 400 million hectares of natural ecosystem will be lost to agricultural usage (see Figure 5).

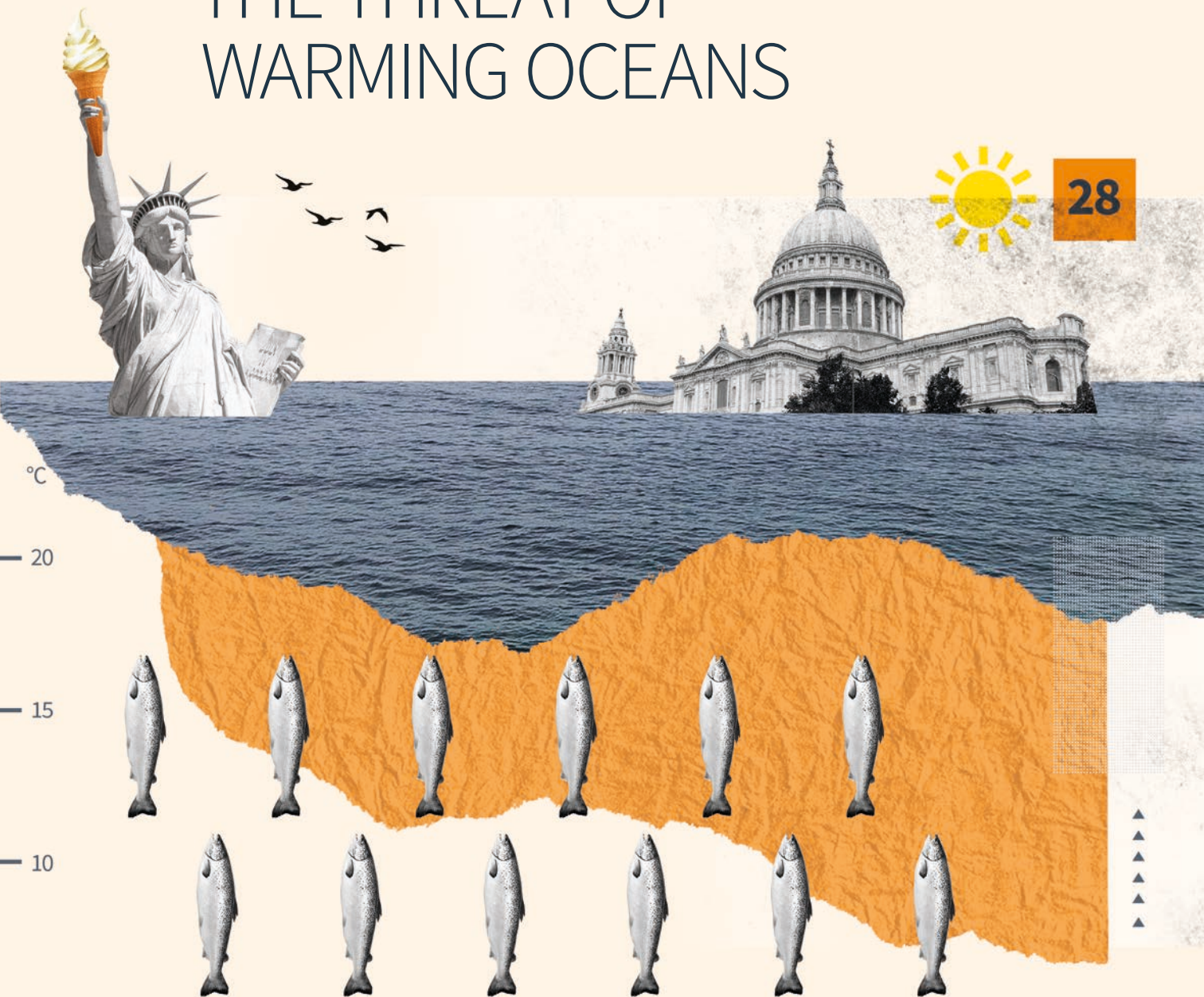
“*A pathway to net-zero emissions does exist – and it is lying beneath our feet*”

The long-term perils of climate change represent the most important global challenge in this decade and beyond, calling on the 193 United Nations member states to work together. The solutions require a careful balance between adaptation and mitigation strategies at a local level. They also require improvements in land-use efficiency and reductions in the carbon intensity of consumer food choices. But, encouragingly, a pathway to net-zero emissions does exist – and it is lying beneath our feet ●

- 1 Grahame Mudge, 'Australian bushfires help push forecast 2020 CO₂ rise', UK Met Office, 24 January 2020.
- 2 'Accelerating land clearing is increasing bushfires and droughts and compounding Australia's extinction crisis: 300 scientists call for immediate action', Ecological Society of Australia, 2019.
- 3 'Climate change and land', IPCC, 2019.
- 4 'Global greenhouse gas emissions data', United States Environmental Protection Agency, 2010.
- 5 Lisa Friedman, 'Trump serves notice to quit Paris Climate Agreement', The New York Times, 4 November 2019.
- 6 'Summary for policymakers of IPCC special report on global warming of 1.5°C approved by governments', IPCC, October 2018.
- 7 'Global climate change: vital signs of the planet', Earth Science Communications Team at NASA's Jet Propulsion Laboratory, California Institute of Technology, 13 December 2019.
- 8 'Climate change has likely already affected global food production', Public Library of Science (PLOS), 31 May 2019.
- 9 'Techno-ecological synergies of solar energy for global sustainability', Nature Sustainability, 9 July 2019.
- 10 'Techno-ecological synergies of solar energy for global sustainability', Nature Sustainability, 9 July 2019.
- 11 Erik Kobayashi-Solomon, 'Investing in vertical farming: five take-aways', Forbes, 5 April 2019.
- 12 Renee Cho, 'Can soil help combat climate change?', Columbia University's Earth Institute, 21 February 2018.
- 13 'Growing better: ten critical transitions to transform food and land use', The Food and Land Use Coalition, September 2019.
- 14 'Land degradation: IPCC', IPCC, August 2019.
- 15 'Mangroves and marshes key in the climate change battle', The International Union for Conservation of Nature (IUCN), February 2, 2017.
- 16 Jared Diamond, 'Upheaval: How Nations Cope With Crisis and Change', (Penguin Random House UK, 2019).
- 17 Richard Waite and Daniel Vennard, 'Without changing diets, agriculture alone could produce enough emissions to surpass 1.5°C of global warming', World Resources Institute, 17 October 2018.
- 18 'Carbon footprint factsheet', University of Michigan Center for Sustainable Systems, 2019.
- 19 'Household carbon footprint patterns by the degree of urbanisation in Europe', IOP Publishing, 30 October 2019.
- 20 'Global gridded model of carbon footprints (GGMCF)', Norwegian University of Science and Technology, 2018.
- 21 'Net zero: the scorecard', The Energy and Climate Intelligence Unit, 1 January 2020.
- 22 Alexandra A. Chaldez, 'As the Amazon burns, students call on Harvard to divest from farmland holdings', The Harvard Crimson, 29 August 2019.
- 23 'Growing better: ten critical transitions to transform food and land use', The Food and Land Use Coalition, September 2019.
- 24 Monica Watrous, 'Trend of the year: plant-based foods', Food Business News, 27 December 2019.
- 25 Jeannette Settembre, 'Tyson, America's biggest meat producer, is taking a bite out of the vegetarian market', MarketWatch, 15 June 2019.

Image credit, p.35: Man with chainsaw image by Olivier Girard/CIFOR.

HOT WATER: THE THREAT OF WARMING OCEANS



“

Carbon in the atmosphere is what we all worry about. But it's the oxygen in the ocean we've forgotten about that may also ultimately determine our fate on this planet

”

Professor Dan Laffoley,
International Union for Conservation of Nature



HOT WATER: THE THREAT OF WARMING OCEANS *continued*

As the challenges posed by climate change continue to loom large, due attention should be given to oceans, not just the solid ground under our feet and the air we breathe.

In a corner of Newfoundland's south coast known as Fortune Bay, where aquaculture dominates the local economy, workers at Northern Harvest Sea Farms started to see an unusually large number of fish dying in its ocean pens last September. Initially, they suspected sea lice as a possible culprit,¹ but following an investigation the region's chief aquaculture veterinarian concluded a "climate event" caused an estimated 2.6 million salmon to die.²

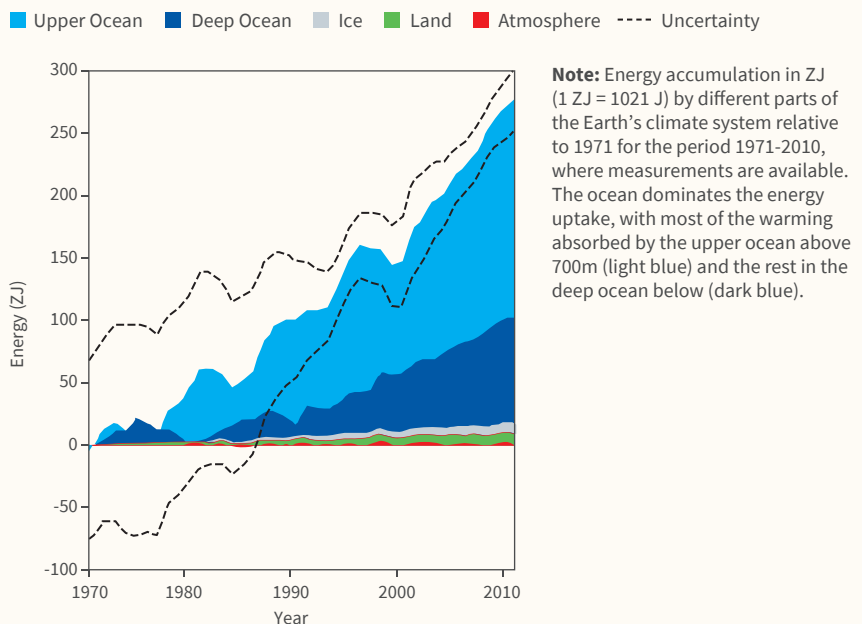
Atlantic salmon usually thrive in ocean temperatures ranging between about two degrees Celsius and 12 degrees Celsius: Surface water temperatures in Fortune Bay had reached between 18 degrees Celsius and 21 degrees Celsius, the upper end of the danger zone for salmon.³ A period of unseasonably high temperatures led the fish to crowd at the deeper and cooler part of the sea cages, where they suffocated from a lack of oxygen.⁴

"We spent a full week on the south coast from September 26th to October 3rd," says Don Ivany, director of programmes for Canada's Atlantic Salmon Federation. "In the vessel we were on when we were monitoring this, the captain of the boat indicated the dead fish underneath his boat were nine fathoms deep. That's 54 feet of rotten fish on the bottom. It was a feeling of shock."

A shield from the effects of climate change

What happens to the oceans is not just a problem for Newfoundland's fish farms. It is one that reaches almost every corner of the global economy. Life began in the ocean, and more than 40 per cent of the

Figure 1: Excess heat absorbed by different parts of Earth's climate system



Source: International Union for Conservation of Nature, 2016.

world's population – including about 12 million people in Greater London – still live within 100 kilometres of the sea. Oceans connect the global knowledge economy, for example, through undersea cable networks. And, despite a meteoric rise in air traffic, the oceans are still the preferred global trade route, supporting more than 80 per cent of traded products worldwide by volume.⁵

Arguably, the oceans are the planet's most valuable asset. And they are getting hotter, more acidic and less oxygenated. "The closer you get to the science, the more nervous you get about the outcome," says David Cumming, chief investment officer for equities at Aviva Investors.

As human activities such as burning fossil fuels release more greenhouse gases (GHGs), less heat is directly reflected back to space. Part of the excess heat is absorbed by the Earth's atmosphere, but nearly all of it ends up in oceans (see Figure 1). Ocean heating is also more concentrated in the uppermost part, where most of the wildlife lives (see Figure 2).

A 0.6 degrees Celsius increase doesn't sound like a lot, until it is considered from the perspective that the oceans account for more than 70 per cent of the Earth's surface and over 90 per cent of the planet's total inhabitable space. In addition, it takes

a larger amount of energy to raise seawater temperatures because of its higher density compared to the same amount of air molecules, much as it would take longer to heat up water on the stove than heating up the same volume of air with a hair dryer.

If the heat absorbed by the uppermost 2,000 metres of the oceans between 1955 and 2010 were to be absorbed in the lower ten kilometres of the Earth's atmosphere, the average temperature would have risen by an estimated 36 degrees Celsius rather than the current estimate of about 0.8 degrees Celsius.⁶ Put another way, researchers at the University of Oxford estimated the heat currently going into the oceans is equivalent to between three and six atomic bombs per second.⁷

"We're an ocean planet," says Professor Dan Laffoley, principal advisor on the global marine and polar programme for the International Union for Conservation of Nature (IUCN). "Historically, our understanding of climate change has been largely gained by looking up into the atmosphere and across the land, but we haven't looked down at the ocean to see how fundamentally important it is and how thorough the support it provides is to everyone to some degree or another."



The impact of the oceans in regulating global climate is far larger than we previously thought



Under water

When seawater heats up, its volume expands in what's known as thermal expansion and raises the sea level; in addition, warmer water accelerates the melting of sea ice and ice masses from below as well as from above by the warmer air molecules, again leading to higher sea levels. Global tide gauge records and satellite images suggest oceans are between seven to nine inches higher on average than they were in 1870, with about a third of that added in the past 25 years.⁸

As residents from Venice, Miami, Houston and, most recently, Jakarta know all too well, rising sea levels are making coastal cities worldwide more vulnerable to flooding, especially when combined with more frequent and powerful storms resulting from climate change.

"From the perspective of both infrastructure and, perhaps more importantly, real estate, some of the highest-value assets in the world tend to be ones that are most at risk, because people tend to build them by the seaside or other waterways such as rivers," says Laurence Monnier, head of quantitative

research for real assets at Aviva Investors. "If we continue on a business-as-usual basis, the risk to the value of these assets is enormous."

In certain regions, rising sea levels are made worse by sinking cities. In some cases, such as Houston and Jakarta, the depletion of groundwater sources has gradually weakened the support system underneath, while high-rise buildings weigh on the land from above. Jakarta is now one of the fastest-sinking cities in the world, with about 40 per cent of the city below sea level.⁹

In London's case, human activities such as draining wetlands are also an issue, but the city is also sinking for very different geological reasons. Since the glaciers in the north of the UK have melted, there is essentially less weight bearing down on Scotland, so it is slowly rising at a rate of about one millimetre per year. The seesaw effect has the opposite effect on London, which is sinking accordingly.¹⁰

Unlike Houston or Jakarta, however, London has the Thames Barrier, its primary flood-defence system. Opened in 1982,

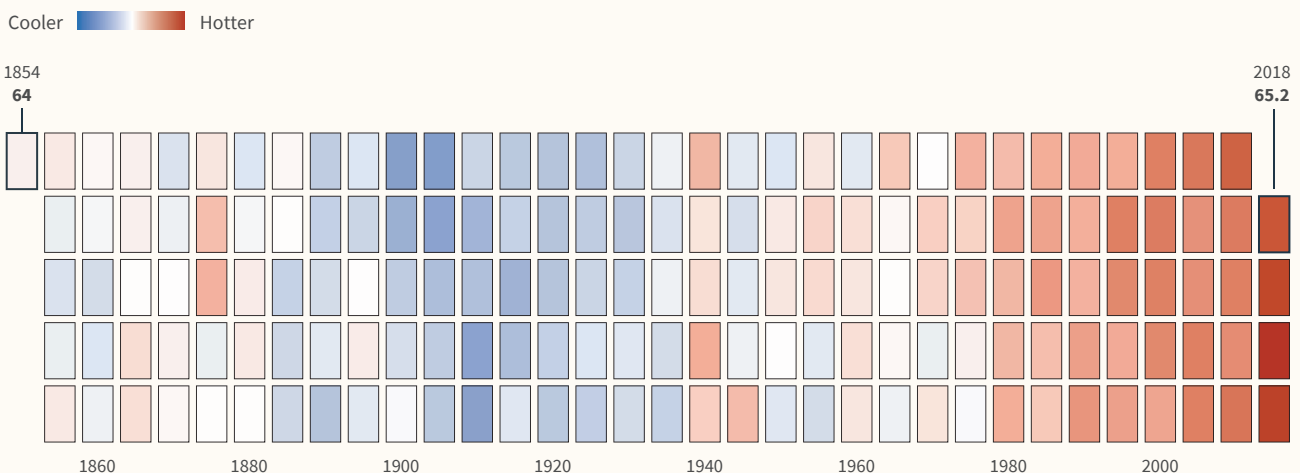
it was designed to protect London from a once-in-100-year risk of high flood levels up to 2030 by blocking high tides and storm surges from the North Sea. In its first ten years of operation, it was used about once or twice a year. With the increasing threat of higher sea levels on its doorstep, however, it is now used about six or seven times a year.¹¹

The economics of ocean heating

Protecting areas along the coast, next to rivers and in proximity to other bodies of water, is becoming more challenging across the world. In the UK, for example, six of the ten wettest years on record have occurred since 1998, according to the UK Met Office.¹²

"It is becoming increasingly evident that the impact of the ocean in regulating global climate is far larger than we previously thought," says Professor Vicky Pope of the University College London's Department of Science. Pope previously led the climate predictions programme at the Met Office Hadley Centre.

Figure 2: Sea surface temperature vs. 20th-century average, degrees Fahrenheit



Source: National Geographic, 2019.

HOT WATER: THE THREAT OF WARMING OCEANS

continued

Observations alone, however, cannot help us understand future risks and make decisions, she says. That's where climate models are needed. According to the Met Office, the south of England will likely experience relatively higher sea level rises than the north, as predicted in the Christian Aid report on sinking cities (see Figure 3).

Equally important, though, is to recognise the models themselves have limitations. They might help us to understand possible future climates and the risks involved, but still contain some major uncertainties. "For example, if you look at those maps, they don't give you one number, they give you a range," says Pope. "That range reflects the uncertainties. The point, though, is that even at the bottom of the range, it's quite a big change. Then the question becomes: Do we want to take those risks?"

Similar to the adaptation strategy behind the construction of the Thames Barrier, when it comes to investments it may be more prudent to overestimate rather than underestimate climate change risks, Monnier says.

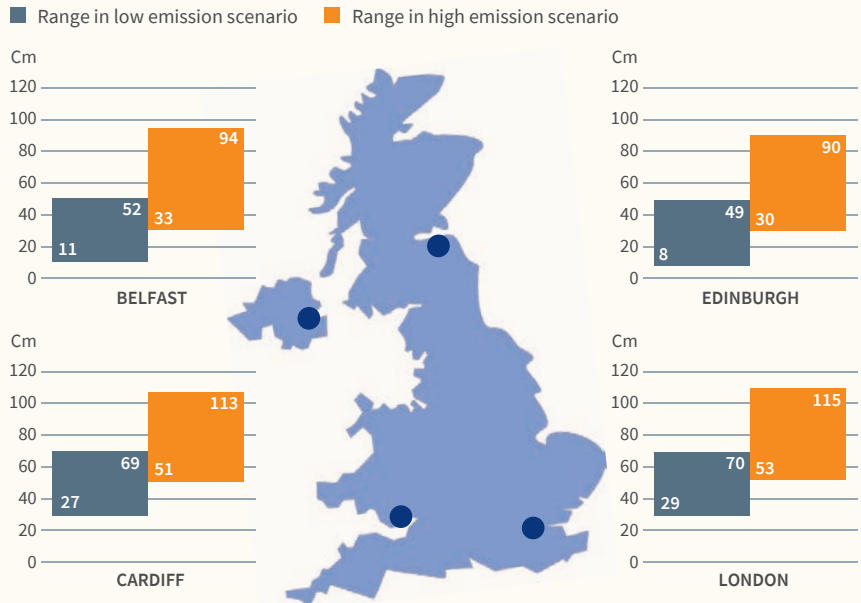
"I remember when we met with a client about investing in an offshore windfarm, one of the questions asked was on the risk of storms and high winds to unearth the cables connecting the wind turbines," Monnier adds. "When we finance or build a new piece of infrastructure, we need to be forward thinking about climate change risks."

Ben Carr, capital risk director at Aviva, believes climate change is an increasingly important consideration for all insurance companies. "Those physical changes over time can have a big impact on our business models. Some people will no longer be able to afford to purchase insurance on certain assets because the risk has become too high," says Carr. "We need to understand all of those things to adapt our business."

Property is a good example, he adds, because the physical risks such as

Figure 3: Sea level rise in the UK (by 2100 relative to 1981-2000)

Increase will generally be greater in the south than in the north



Source: UK Met Office, 2019.

flooding or coastal erosion directly impact the market price. When investing in real estate debt, these risks could increase the probability of default, again affecting returns. "The way I think about climate change is that it is the delta of weather-related risks," he says.

Cumming adds that his equities team gauges climate change risks of sectors, industries and companies. They include factors such as the location of their physical assets and the potential impact of sea level rises; changes in weather patterns; and supply-chain contingency plans for extreme weather events.

As the role of ocean heating in climate change becomes better understood, its implications for investments are set to rise globally, not only for the valuation of physical assets – particularly in infrastructure and real estate – but also for entire sectors such as seafood, tourism and pharmaceuticals, where marine-derived drugs are an important new frontier.

Among the main climate-related threats to wildlife from these industries are large-scale changes to the ocean caused by human activities. When the ocean absorbs a large amount of carbon dioxide, for example, it can upset the water's pH balance upon which nature depends.

Agricultural runoff presents another challenge, because it can promote algae growth and reduce available oxygen for other organisms.

More recent research revealed the scale of deoxygenation is far worse than previously understood, Laffoley says. Because ocean heating affects the uppermost layer of water, the warming effect acts as a hot lid on the ocean and stops oxygen from getting to the deeper layers. In some hot spots, oxygen loss has been recorded at up to 50 per cent.

"In addition, when the ocean heats up, the metabolism – and therefore respiration – rate of the wildlife increases," Laffoley adds. "So, we have a situation in which the oxygen needed goes up in an environment that is itself struggling to get enough oxygen. This is a problem no one is really talking about, and fundamentally, it has great consequences for those of us living on land."

For example, ocean heating has been linked to the unusual oscillations in the sea-surface temperatures between the two sides of the Indian Ocean. This likely contributed to Australia's "notably low humidity, which enhances potential evaporation and increases fire danger" in 2019, according to Australia's Bureau

“

We have to accept this as the new normal, so we are ready to deal with it

”

of Meteorology.¹³ The same climate conditions also caused higher-than-average rainfall in eastern Africa, flooding the Horn of Africa. At least 250 people died and an estimated three million were affected by the devastation.¹⁴

Back in Canada, where unusually warm ocean temperatures led to Northern Harvest's salmon die-off,¹⁵ local residents lost jobs because the company no longer needed to process salmon. It had to write off about seven million Canadian dollars in lost fish stock, and spent an undisclosed amount on the additional clean up of thousands of tonnes of decaying matter leaking out to the ocean. The company's license to operate was also suspended.¹⁶

“We must act as if this temperature peak is not an isolated event,” says spokesman Jason Card. “We have to accept this as the new normal, so we are ready to deal with it.”

Figure 4: ‘Earthrise’



Source: NASA, photo taken by Bill Anders on December 24, 1968.

The blue planet

More than 50 years ago, on Christmas Eve 1968, Apollo 8's Bill Anders took a photograph of Earth rising just as Mission Commander Frank Borman turned the spacecraft on the far side of the moon. Taken with a Hasselblad still camera fitted with a 250-mm telephoto lens, ‘Earthrise’ revealed the planet for the first time in colour as it appeared from deep space.

The photo changed how the world saw the planet and became a symbol of global unity. It was also credited with helping launch the environmental movement, with Earth Day first held just over a year afterwards. The world again needs to refocus its attention on the blue planet, with particular emphasis on the blue ●

- 1 ‘Harbour Breton fish plant workers concerned for the future after Northern Harvest fish die-off’, Atlantic Salmon Federation, 26 September 2019.
- 2 Brett Bundale, ‘Death of 2.6 million salmon in Newfoundland reignites debate over fish farming’, 15 November 2019.
- 3 ‘Atlantic salmon, *Salmo salar*’, Department of Geography, McGill University, 2007.
- 4 ‘Salmon group presses for thorough environmental review of N.L. fish farming expansion’, The Canadian Press, 18 October 2019.
- 5 ‘Review of maritime transport 2017’, United Nations Conference on Trade and Development, October 2017.
- 6 ‘Explaining ocean warming: causes, scale, effects and consequences’, International Union For Conservation of Nature, September 2016.
- 7 Damian Carrington, ‘Global warming of oceans equivalent to an atomic bomb per second’, The Guardian, 7 January 2019.
- 8 ‘Global climate change: vital signs of the planet’, NASA's Jet Propulsion Laboratory, California Institute of Technology, September 2019.
- 9 ‘Sinking cities, rising seas: a perfect storm of climate change and bad development choices’, Christian Aid, 5 October 2018.
- 10 Ibid.
- 11 Ibid.
- 12 ‘Top ten UK's hottest years all since 2002’, Met Office, 31 July 2019.
- 13 ‘Special Climate Statement 72– dangerous bushfire weather in spring 2019’, Australia Bureau of Meteorology, 18 December 2019.
- 14 ‘Why the floods in East Africa are so bad’, BBC, 2 December 2019.
- 15 Vince McDonagh, ‘Warm seas, not sea lice, led to mass salmon deaths’, Fish Farmer Magazine, 8 October 2019.
- 16 ‘Licences yanked for troubled N.L. salmon farm amid revelation of 2.6 million dead fish’, CBC, 11 October 2019.

AN INCONVENIENT TRANSITION

Despite deafening calls for countries and companies to step up to fight the climate crisis, research suggests individuals – especially in the developed world – could also make a massive difference if they committed to getting by with less. But will they?

The world is at a crossroads. Science suggests time is running out to reduce carbon emissions and avoid reaching a tipping point for the planet. Momentum has never been so strong, from individuals around the globe demanding change, to countries committing to carbon neutrality by 2050, and investors and companies coming together to transform the economy. Yet so much still needs to be done to achieve the transition to a low-carbon economy.

Forecasts by McKinsey put fossil fuels at more than 60 per cent of the energy mix in 2050 if investment in these sources continues,¹ and little progress is being made in other areas of the economy – from industry to food production, building and transport.²

Fiona Reynolds, chief executive officer of the United Nations-backed Principles for Responsible Investment (PRI), states: “A clear gap has emerged between the ambitions we set, and the actions practically required to secure the results we so greatly need. This ambitions gap presents one of the key challenges in the transition to sustainable energy. At this point, even with full implementation of existing Nationally Determined Contributions (NDCs), we now expect temperatures to rise to 3.2 degrees Celsius, according to UNEP’s annual Emissions Gap Report.”

Tackling emissions is a massive and complex challenge, with geopolitical and strategic risks to mitigate, psychological barriers to overcome, and tough economic, social and investment decisions to make. Developed countries

are responsible for most of the greenhouse gases in the atmosphere today and have the financial and technological means to effect change. Yet, while struggling to curb their own emissions, they are simultaneously asking emerging markets to forgo cheap energy sources such as coal, and thereby limit their own social and economic development. Balancing historically contextual fairness with the immediacy of the action required will be no mean feat.

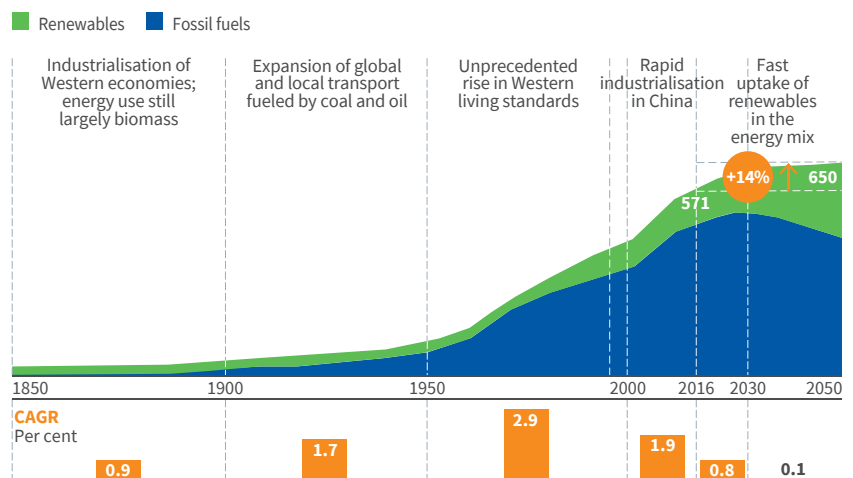
The difficulty of taking a long-term view

Individuals often rely on governments and institutions to put in place the legislation

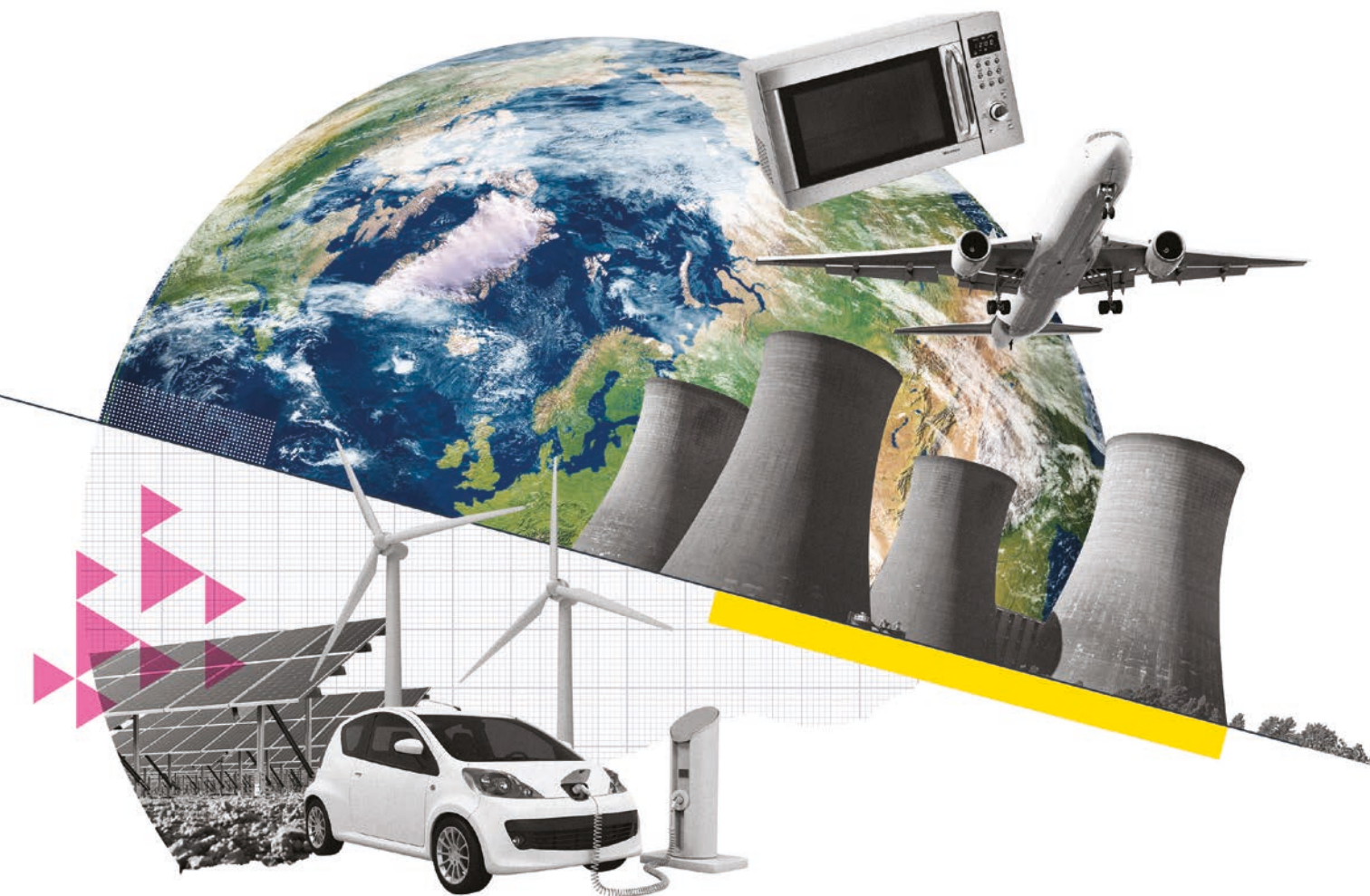
that will force them to change their behaviour, because it is hard for them and companies to take a long-term view. Public companies are under pressure to deliver profits on a quarterly basis, and risk being overtaken by competitors if they increase prices to fund more sustainable products. For individuals, it is psychologically difficult to embrace change on such a scale (see Apathy, anger, action: The psychology of climate change, p.18).

As Paul Lacoursiere, global head of environmental, social and governance (ESG) research at Aviva Investors, puts it: “Bluntly, we’re in this mess because governments have categorically failed

Figure 1: Global primary energy demand
Million terajoules (TJ)



Source: McKinsey Energy Insights' Global Energy Perspective, January 2019.



to sufficiently prohibit activities that harm people or the environment.”

Unfortunately, the path to solutions is not that simple. Countries must balance environmental decisions with economic, social and security concerns. A rapid transformation could destabilise economies and lead to job losses and social upheaval.

“Things like electric car subsidies tend to mainly benefit the rich, and it costs a lot to public finances,” says Antoine Dechezleprêtre, assistant associate professor at London’s Grantham Institute of Climate Change and the Environment. “There’s also the opportunity cost for politicians: Do you want to build a new hospital or do you want to put a few more electric cars on the road?”

The lobbying barrier

Another obstacle is that governments in the developed world are subject to intense lobbying against the

low-carbon transition. In the US, neither major political party has taken strong action because of the influence of fossil-fuel lobbyists in Washington.³ In Europe, the game is often one of regulatory capture: companies manoeuvre so a particular climate policy will favour their sector or their firm.

“We’ve seen it in the way permits are allocated in the aviation industry, where the algorithms we use are heavily favourable to the incumbents rather than the newcomers,” explains Professor Richard Tol from the University of Sussex. As a former member of the Intergovernmental Panel on Climate Change (IPCC), he is a joint winner of the Nobel Peace Prize for contributions to knowledge on global warming.⁴ “easyJet and Ryanair emit much less CO₂ per passenger-kilometre than [companies like] British Airways, but these companies successfully lobbied the European Commission and their governments to have an allocation boost in their

favour, hurting easyJet and Ryanair.”

Although lobbying is hardly new, Tol supports the idea of simple climate policies to limit the influence lobby groups have. “The more complicated you make climate policy, the easier it is to create rents.”

Mitigating the risks of negative lobbying is in fact a priority for investor groups like the PRI and Climate Action 100+.⁵ “We’re facing calculated, negative corporate climate lobbying, which is working against our efforts, slowing political, financial and business action on climate change,” says Reynolds. “The effects are currently being played out in the US, where recent Securities and Exchange Commission (SEC) proposals could see the rollback of shareholder rights, creating new roadblocks for investors to signpost critical ESG issues with corporate leaders. Counteracting big corporate lobbying is a key priority for 2020 and beyond.”

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Members of Climate Action 100+ have made this a key focus when engaging with companies. Getting firms to lobby in support of meaningful climate policy is as fundamental to the group's action as getting them to commit to emissions reduction targets. As illustrated in its latest report, there is still work to be done (see Figure 2).

A strategic resource with geopolitical implications

Energy is deeply political in many countries because it is such a strategic resource. Economies, social stability and national security – including the armed forces, intelligence, communications and hospitals – all depend on a reliable supply. While the largest exporters of fossil fuels are mostly resisting the low-carbon transition, more than 80 per cent of the world's population has the opportunity to put an end to their dependence on oil and gas imports and become a key driver of change.⁶

In turn, as the transition accelerates, it could have a profound impact on geopolitics. "It is one of the undercurrents of change that will help to redraw the geopolitical map of the 21st century," according to the Global Commission on the Geopolitics of Energy Transformation. "The new geopolitical reality that is taking shape will be fundamentally different from the conventional map of energy geopolitics that has been dominant for more than one hundred years."⁷

Change on such a scale suggests huge disruption, but even countries that stand to benefit remain cautious, continuing to prefer coal to support economic development rather than moving straight to renewables. As the Geopolitics of Renewables report states: "Renewables will also be a powerful vehicle of democratisation because they make it possible to decentralise the energy supply, empowering citizens, local communities, and cities." Not all governments will look favourably on this possibility.

Figure 2: Climate Action 100+ lobbying indicators by sector

Has the company aligned its own climate policy positions and lobbying activities in support of implementing meaningful climate policy and the goals of the Paris Agreement?			
Sector and (number of companies)	Positioning towards climate policy and regulations		
	Clear Support	Mixed Support	Not Supporting
Oil and gas (24)	0%	33%	67%
Industrials (16)	19%	31%	50%
Mining (13)	0%	38%	62%
Transportation (21)	0%	52%	48%
Utilities (25)	16%	48%	36%
Consumer products (10)	40%	60%	0%

Source: InfluenceMap, Climate Action 100+, August 2019.

To support the transition to clean energy, many experts believe the best solution would be a global carbon tax imposed on all countries (see 'Sticking' it to carbon: The pros and cons of taxing emissions, p.32). Yet even this could pose a problem, as Tol explains. "Even within the EU, we have tradeable permits rather than a carbon tax because we don't want to give up the right of taxation to the EU. It is a sovereignty issue." Beyond that lies a simple fact: nobody wants to pay the price of emissions.

People don't want to pay

For democratic governments hoping to win the next election and for autocratic states aiming to maintain social stability, imposing a carbon tax is difficult politically, because ordinary citizens ultimately have to pay.⁸ So far, the signs point to them not being willing to do this.

Dieter Helm, professor of economic policy at the University of Oxford and a fellow in economics at New College, Oxford, explains the dynamics. "Many [developing] countries rely on exports for their development and we merrily buy the stuff," he says. "The US plus Europe is basically half the world economy. And we prefer to buy their stuff because it's cheaper to produce in carbon-intensive ways than to produce stuff from, say, British Steel, which must meet much higher standards on emissions."

There are complex psychological reasons (which we explore in Apathy, anger, action: The psychology of climate change, p.18),

but one of the key difficulties is that entire societies are built on consumerist principles. For the first time in decades, people are being asked to buy less – or to pay more for what they buy.

"That's why this is substantive and why there is a natural political reluctance," says Helm. "The average income in the UK is £28,000. Most people on £28,000 can't make ends meet and resort to borrowing. And if you say to them, 'Oh by the way you're going to have to pay the cost of your carbon consumption on top', you can see why most of the world's civil unrest at the moment, outside Hong Kong, is caused by rising fuel prices. People don't want to pay. That's really why we're going to end up with three degrees, because the reality of what would have to be done comes home to a very personal point: it's you and me and what we consume."

Investors aren't willing to pay either

A growing number of institutional investors and asset managers are joining the ranks of sustainable investing groups such as the PRI, Climate Action 100+ and many more initiatives, reporting their carbon footprint under the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) framework⁹ and engaging with investee companies to encourage them to commit to curbing their emissions. While this is positive, it is not enough.

Figure 3: Comparison of per-passenger emissions on different routes with the annual carbon footprint of individuals in developing nations

London-Rome
234kg CO₂

Average citizen emits
less CO₂ in a year

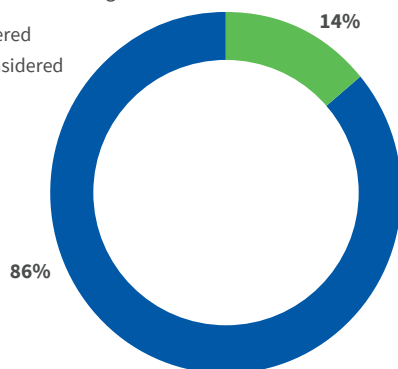
London-Perth
3,153kg CO₂

Source: Atmosfair, The Guardian, July 2019.

Figure 4: Climate change considerations by European asset owners

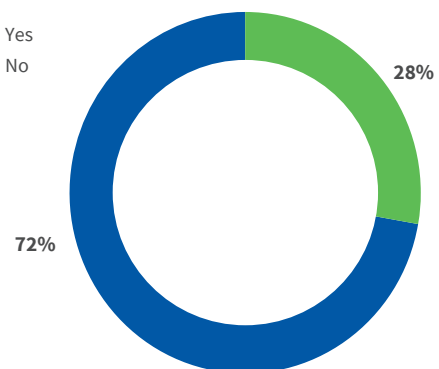
Has the scheme considered the investment risk posed by climate change?

● Considered
● Not considered



If no, is the scheme planning to consider this within the next 21 months?

● Yes
● No



Source: Mercer LLC, 2019 European Asset Allocation Survey.

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In its 2019 European Asset Allocation Survey, Mercer found 55 per cent of pension plan respondents consider environmental, social and corporate governance (ESG) risks in their schemes – and 56 per cent of those were driven to do so by regulation. Voting at annual general meetings and engaging with investee companies came even lower, with only 28 per cent taking these activities into consideration when selecting an asset manager. On climate risk specifically, only 14 per cent declared they had considered it in 2019, and just 28 per cent would do so in 2020.¹⁰

The picture is bleaker still in the US, where ShareAction found in November 2019 that US asset managers often do not use their votes to push companies to tackle carbon emissions. This is all the more concerning when you consider the 20 largest US asset managers account for around 35 per cent of global assets.¹¹

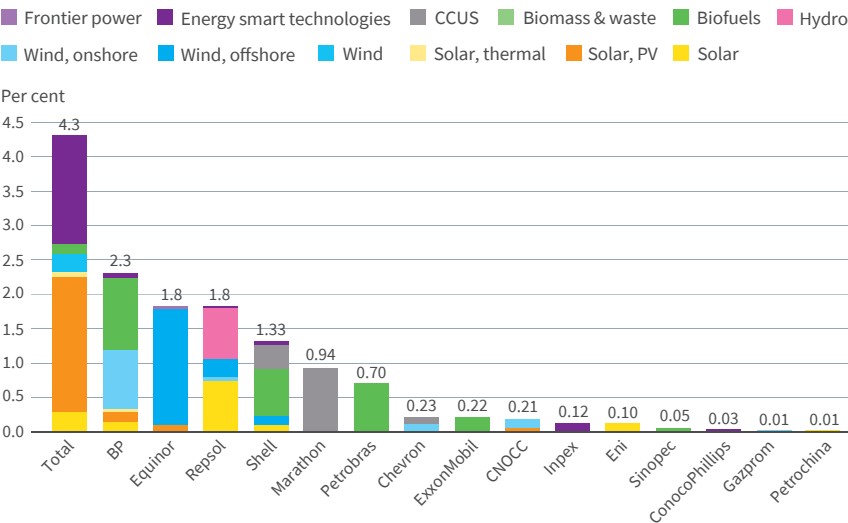
“There’s a paradox,” says Darryl Murphy, managing director of infrastructure at Aviva Investors. “We talk about infrastructure as long-term investments, but maybe illustrating the short-term view of most investors in relation to the energy transition, it’s hard for those investors to really take a view into the future.”

Companies and investors are also reluctant to pay for the transition, particularly if they perceive that moving first will make them less competitive. Yet they are now having to calculate the odds of existing assets – in their companies or in their portfolios – becoming stranded. On the one hand, capital would be lost through the physical impacts of global warming if nothing changes; on the other hand, assets worth a lot of money today, such as oil, may lose all their value if people stop using them (see Stranded! When assets become liabilities, p.25).

It’s the consumer, stupid

If governments and companies are reluctant, who will eventually pay?

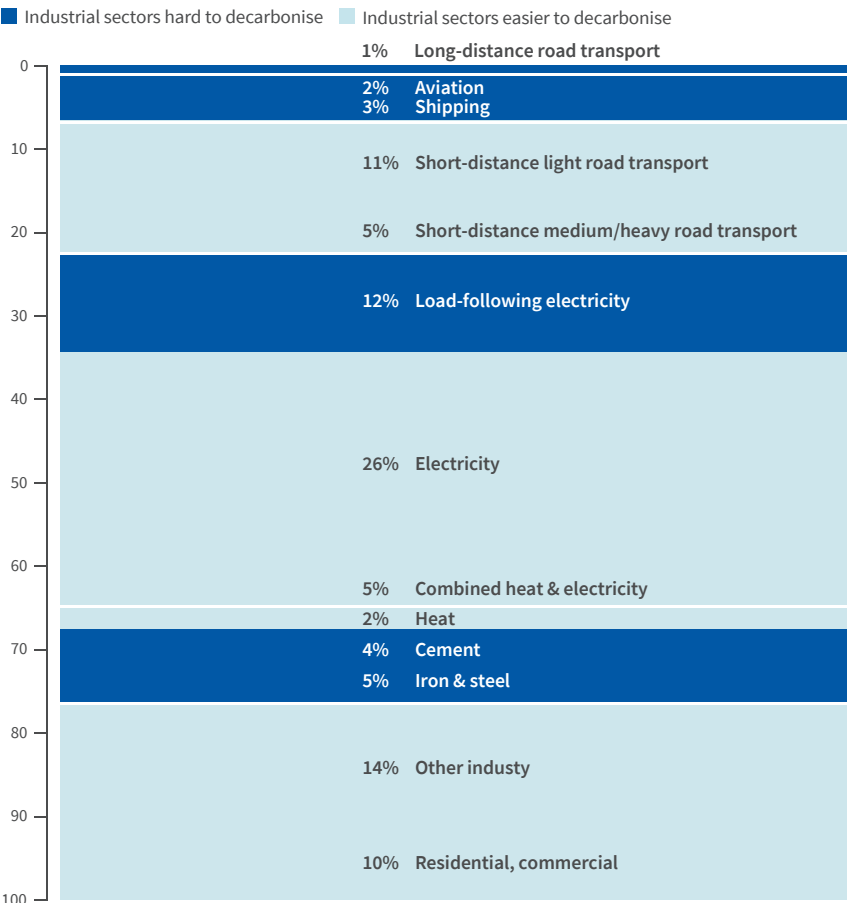
Figure 5: Reported low-carbon investment as a proportion of total company CAPEX (2010-Q3 2018)



Source: CDP (2018), BNEF, company reports, Aviva, October 2018.

Figure 6: Hard to decarbonise sectors

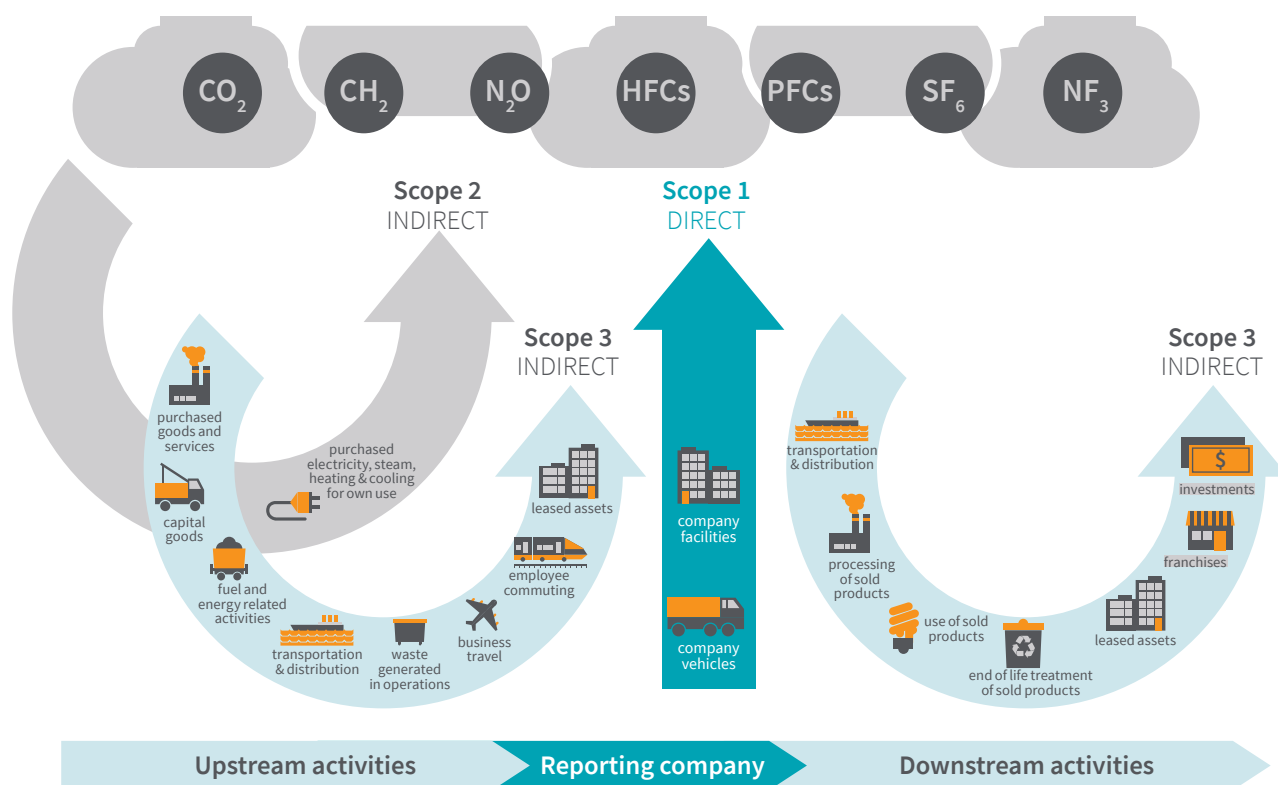
Global fossil-fuel and industry emissions by sector based on 2014 data* (total 33.9 GtCO2)



Note: Global fossil-fuel and industry emissions by sector based on 2014 data¹² (total 33.9 GtCO2). Industrial sectors that are hard to decarbonise are marked in dark blue and sectors that are easier to decarbonise in light blue.

Source: S. J. Davis, et al., ‘Net-zero emissions energy systems’, Science 360.6396 (2018), Exponentialroadmap.org, September 2019.

Figure 7: Sources of corporate GHG emissions (Scope 1, 2 and 3)



Source: WRI/WBCSD GHG Protocol, 2016.

Some believe the only solution is millions of individuals making small changes, while others advocate a top-down approach. In reality, it will likely be a combination of both.

Heavy industry is responsible for around 22 per cent of greenhouse-gas emissions,¹² and around two-thirds of energy consumption comes from buildings and transport.

“Real estate and infrastructure are at the core of the issue,” says Laurence Monnier, head of quantitative research, real assets, at Aviva Investors. “Investment in these is essential to support economic growth but also one of the main drivers for rising energy consumption. You can’t achieve the Paris targets without a radical rethink of these sectors.”

Most future growth in materials production and heavy-duty transport will happen in places such as India, southeast Asia and Africa,¹³ although the European Commission also recognises energy-intensive sectors like aviation and maritime can no longer be exempt from emissions rules.¹⁴

Beyond this, there is a pressing need for individual behaviours to change. “Of course, you’ve got infrastructure and all sorts of other stuff,” recognises Helm. “But our private choices really do matter and we’re not making net-zero private choices at all. Some people are trying, but even not flying for a year is very demanding.”

Another way to pose the question is to ask who should be responsible for Scope 3 emissions. As shown in Figure 7, these are a company’s indirect emissions, stemming from its upstream supply chains and, crucially, from the distribution and consumption of its goods and services. Should a company – or for that matter a country – be responsible for the emissions produced, or should consumers be accountable?

Andrew Medhurst, who leads the UK National Finance Working Group at Extinction Rebellion, argues in favour of taxing production. “I’d like an economic system where the costs of pollution, the damage caused in order to make a profit, gets paid by whoever causes it, not by everybody else.”

Similarly, investor groups like Climate Action 100+ are engaging with companies to encourage them to take responsibility for their Scope 3 emissions.

Glen Peters, research director at the Center for International Climate Research (CICERO), agrees this is important. “When it comes to jurisdiction-type issues, if you are, for example, a British policymaker and you want to reduce your emissions, you can’t do very much about coal power in China. China can [...] so in a sense, for production, the territorial approach is essential,” he says.

But, as the old saying goes, it takes two to tango. “You might see you’re importing a great share of emissions, so there might be policies we can implement in addition to what we do anyway to make our policies more efficient. I tend to think of consumption as ‘in addition to’ as opposed to ‘in spite of,’” adds Peters.

Lacoursiere’s stance is more unequivocal. He believes reducing emissions is a public responsibility, and “compared to producers acting within a legal environment where they happen to be domiciled, to me the

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consumer angle is closer to holding the governments responsible”.

This was also the stance taken by Greta Thunberg in October 2019, when she accused countries of “creative accounting” and Helm agrees. “Our consumption – which is heavily dependent upon on imports – is ultimately causing emissions in countries like China from whom we buy,” he says.¹⁶

Technical fix

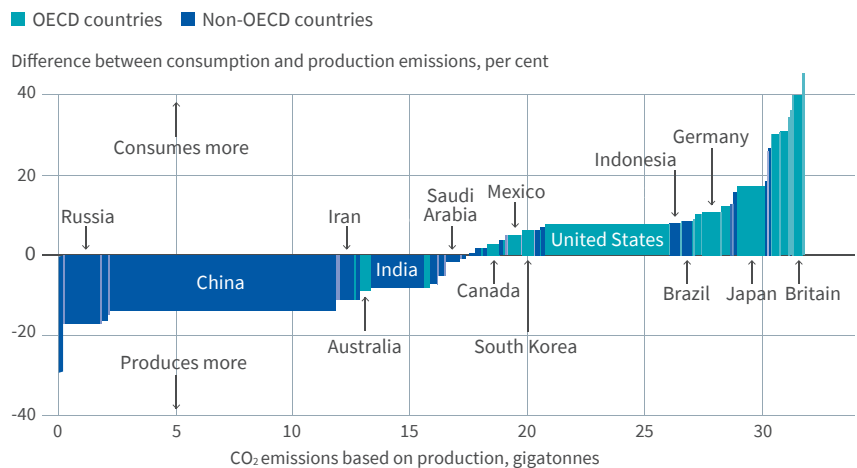
Across sectors, the Global Climate Action Summit’s Exponential Climate Action Roadmap details 36 solutions capable of reducing greenhouse-gas emissions by 50 per cent between now and 2030, with a stated aim of halving them again between 2030 and 2040, and finally reaching net zero by the middle of the century.¹⁷

A number of other organisations present similar or complementary solutions, including Project Drawdown, which aims to show how to achieve net negative emissions globally,¹⁸ and the *Mission Possible* report by the Energy Transitions Commission,¹⁹ which focuses on demonstrating how to reach net-zero CO₂ emissions from harder-to-abate sectors in heavy industry and heavy-duty transport (e.g. cement, steel, plastics, heavy road transport, shipping and aviation).

To achieve the decarbonisation of economies, however, all these initiatives agree finding and implementing solutions for energy is the most crucial step. Whether used for buildings, transport, infrastructure or industry, it is responsible for around two thirds of global greenhouse-gas emissions.²⁰ As such, it is the focus of intense debate.

The Exponential Roadmap report states: “Falling costs of renewable energies, battery storage and efficiency solutions, often driven by digitalisation, will increasingly make these technologies the first choice. The modularity of many of these new solutions means they can be deployed relatively easily and scale quickly compared with large power plants – giving

Figure 8: Global CO₂ emissions from fossil fuels and cement, selected countries, 2016



Source: Global Carbon Project, World Bank, The Economist, October 2019.

them a substantial advantage for infrastructure investment and providing early returns. As prices tumble, by 2030 renewables hold the very real promise of abundant, almost-free energy.”

Solar and wind represent around two thirds of the emissions-reduction scenario used in the report. However, the rest stems from reduced methane emissions and other low-carbon energy. These include new nuclear capacity, hydroelectricity, wave power, geothermal and biomass.

Ed Dixon, head of ESG, real assets, at Aviva Investors, says the latter also has potential. “Investing in energy-from-waste could be a massive growth area. Although it suffers from an image problem, it’s a very financially efficient way of generating income while tackling two environmental issues: landfill and clean energy.”

The Exponential Roadmap report does not mention natural gas, which has been widely used so far as a “transition fuel”, being the fossil fuel with the lowest emissions. This may be because natural gas is now being questioned, largely due to the associated methane leaks (see *Stranded!* When assets become liabilities, p.25).

Intriguingly, the expected share of new nuclear capacity is minimal, estimated at most to contribute 0.22 gigatonnes (Gt) of CO₂-equivalent savings a year out of a total 18.5Gt forecast in 2020 for overall energy production. This highlights a persistent rift between proponents and

opponents of nuclear power as a potential solution to reduce greenhouse-gas emissions (see *Nuclear: From pariah to saviour?*, p.69).

Innovation incentives

Renewables present other challenges, although their advocates claim these could be resolved through further research and development.²¹

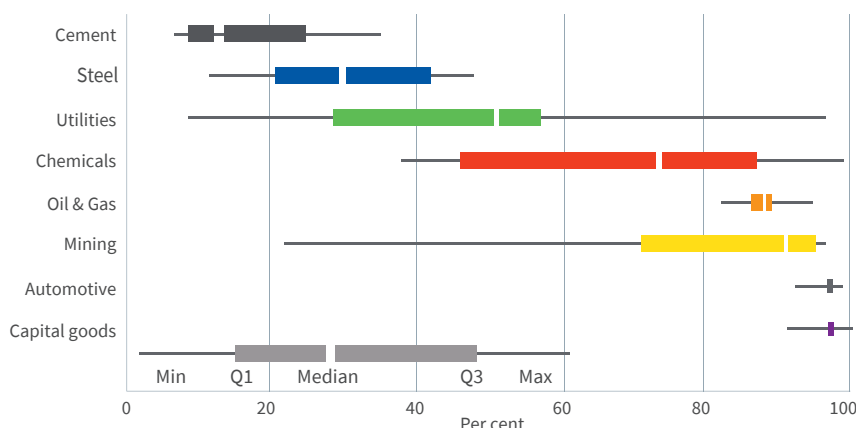
First, some of the raw materials needed to produce solar panels and wind turbines are mined in a high-emission, highly polluting way. Second, solar and wind energy cannot be produced around the clock, and batteries capable of storing the necessary volumes of electricity for days or weeks at a time do not yet exist.

“Another issue with batteries is that the current revenue structure doesn’t provide incentives to innovate and build at scale,” says Monnier.

Finally, the transmission capacity to distribute electricity over long distances is also lacking, making it impossible to harness the regions with the best wind or solar resources. There are also social consequences of building large wind or solar farms close to possibly disgruntled communities.

Dechezleprêtre says incentives remain too low. “As in all areas, clean innovation is about economic incentives,” he says. “There’s a very strong correlation between the level of innovation and energy prices, and we’ve not seen carbon prices

Figure 9: The materiality of Scope 3 emissions to a company's overall carbon footprint



Note: Fossil fuel producers are often seen as the main culprits, but 90 per cent of their emissions are caused by others, namely those who drive, fly and consume products imported from afar.

Source: "Capital Goods report" CDP, Aviva, 2018.

“
Top-down clearly
hasn't worked
”

increasing enough to make up for the recent decline in renewable energy prices.”

He believes clean-energy innovation has decreased due to low energy prices, but also because governments have not been firm on policy, which has created uncertainty around the future market for renewables and other clean technologies.

“R&D support is necessary but not sufficient because, at the end of the day, it's companies, not the state, that will develop and make clean products, and they won't invest in R&D unless they know there is a market for their products,” he says.

Francois de Bruin, sustainable income and growth portfolio manager at Aviva Investors, also thinks incentives could enable funding to move towards clean innovation.

“If you tell insurers, ‘Your capital charge is different based on where you allocate your capital from an ESG or climate perspective,’ watch the capital flow and watch how quickly people organise themselves based on those incentives,” he says.

As an example, carbon capture and storage is an area crying out for R&D. “Every single scenario you see that suggests you can get even close to the Paris Agreement implies masses of carbon capture and storage, but there is no plan for how we get there,” says Steve Waygood, chief responsible investment officer at Aviva Investors.

Emerging markets

Emerging markets face particular challenges in the low-carbon transition. First, a number

are highly dependent on fossil-fuel export revenues and could suffer significant economic damage from a drop in demand. Second, an increase in greenhouse gases is seen as a consequence of their efforts to develop their economies: building infrastructure and urbanising are high-emission activities. Third, even though they already need to budget for significant investments in adapting to the growing risks of climate change, they also face pressure – frequently from outside – to invest in low-carbon infrastructure.

“Particularly (though not exclusively) in emerging markets, political instability, lack of necessary infrastructure, difficulty in attracting foreign investment and economies dependent on high-fossil sectors – such as coal mining – present significant challenges in the transition to sustainable energy,” says the PRI's Reynolds. “Furthermore, they face the challenge of enabling a just transition – to ensure the interests of workers and communities are fully accounted for in their plans to shift to a net-zero economy.”

According to the International Monetary Fund and World Bank, the countries most affected will be those where fossil-fuel revenues typically account for more than 20 per cent of GDP and economic resilience is lacking.

To transition or not to transition?

Given the need to balance economic, social and environmental interests, how

should emerging markets transition to a low-carbon world? In that respect, while a global carbon tax may prove the best answer to force the transition (see ‘Sticking’ it to carbon: The pros and cons of taxing emissions, p.32), three schools of thought conflict as to whether and how it should be applied to emerging markets.

The first contends the crisis is so grave that all states need to contribute to the transition now. This is embodied by the European Union's proposed carbon border-adjustment tax, which aims to prevent stringent emissions rules from putting EU companies at a disadvantage with overseas competitors.²²

Helm sees benefits to this solution. “The question is, do you want to be precisely wrong, and indeed encourage climate change by encouraging a switch from domestic and lower-carbon production of these things in Europe to high-carbon, high-polluting sources by shifting to places like China? Or do you want to be roughly right and also incentivise those countries to impose their own carbon taxes?”

Although a border-adjustment tax may not affect developing markets' domestic economies, it does bar them from developing through high-emissions exports, which has been a key pathway to development for many economies historically. Helm argues that because countries with their own carbon taxes would be exempt from the border-adjustment levy, it would encourage

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them to follow the EU's example. This could be the way to achieve a global transition where the UN's Conference of Parties (popularly known as COP) has so far failed.

"Top-down clearly hasn't worked; most people seem to accept that it won't meet the two-degree target, but we need something else. A carbon adjustment is economically efficient – and the only way countries can address their carbon footprint properly, because it doesn't matter whether you buy the steel from British Steel or Chinese Steel," he says.

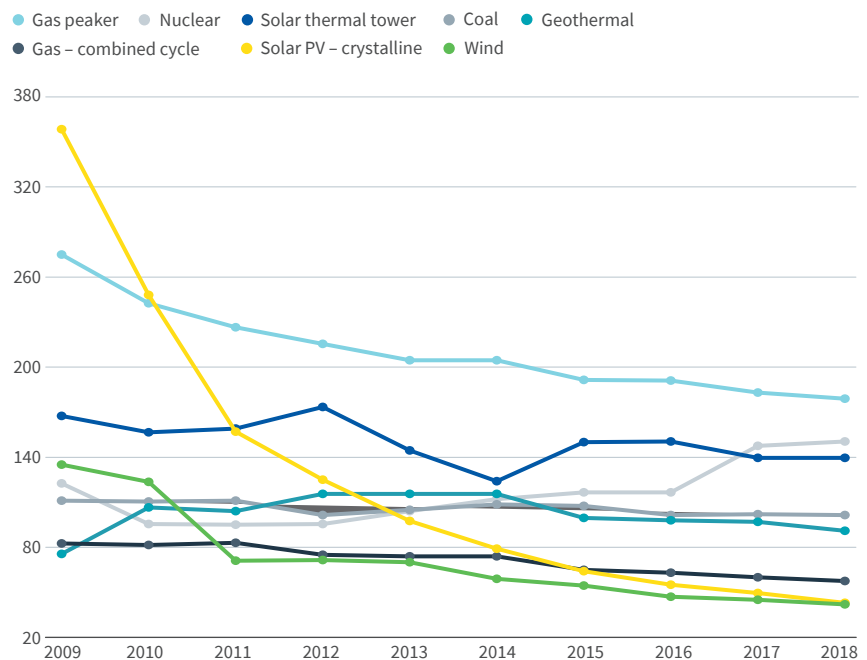
The second school recognises this, but acknowledges rich countries are responsible for the majority of greenhouse gases in the atmosphere today and proposes to subsidise developing economies' low-carbon transition. The PRI is aligned to this idea.

"Successfully achieving the transition to a low-carbon economy will rely on the efforts of all markets – emerging and developed alike," says Reynolds. "However, as G20 countries account for 78 per cent of all emissions, they need to bear the brunt of the responsibility. They need to legislate for net zero by 2050, reducing their emissions more quickly. Currently only two of the G20 – France and the UK – even have net-zero targets, so there's a long way to go. Developing countries then need to closely follow these actions and can already start to leapfrog to clean energy, given the current cost curves."

Peters agrees rich countries should lead by example, by tackling the sectors where emissions are hardest to abate and by investing in solutions to the current problems of storage and distribution for renewables.

"Developed countries can help cover additional costs or help support them putting in the right infrastructure as opposed to putting in coal," he says. "There will certainly need to be some financial and technical help."

Figure 10: Average unsubsidised levelised cost of energy
(mean LCOE \$/MWh)



Source: 'Costing the earth: Renewable costs plummet', Lazard Levelized Cost of Energy Report, November 2018.

Peters can also understand the thinking behind the third school, which believes emerging markets, and particularly the poorest countries, should be allowed to emit as much CO₂ as they need to develop their economies and lift their populations out of poverty.²³

He thinks the energy transition in emerging markets should be context driven. "Say you're using a generator and you get a solar panel, then you can have a light on, or if you're lucky you can maybe put your TV on, or if you're lucky you can have a fridge, whereas if they build the transmission lines over you and you can connect to the grid, you can have your TV *and* your fridge," he explains. "Then there's the question of how you supply the grid. Is it with solar, wind, coal or whatever? So a lot of the grid power in, for example, India will still be from coal-powered plants, it's a very coal-intensive grid, so that will be worse than solar, but when people plug into the electricity, they prefer 24/7 and as much electricity as they can afford."

Michael Shellenberger, an environmental and nuclear activist, is more uncompromising in his views. As a lifelong conservationist, he is concerned about habitat destruction, but believes poor countries must be allowed to develop.

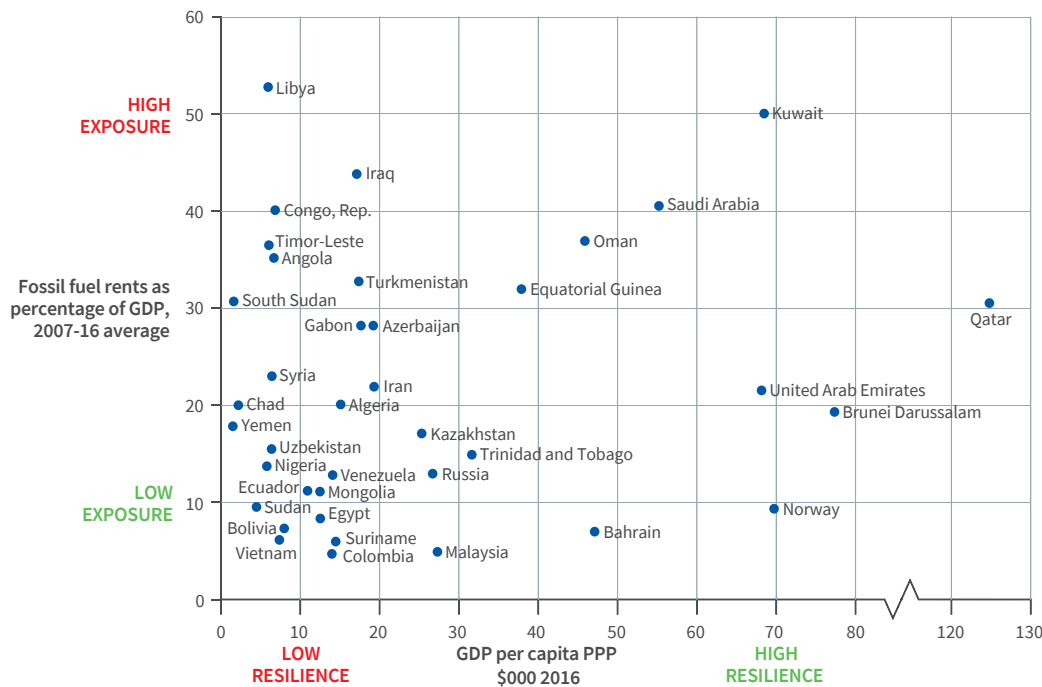
"I find myself frustrated with the narcissism of people in the rich world," he says. "Most people are still not consuming enough energy, and we're kicking away the ladder and lifting the drawbridge. My view is basically: If you're burning wood and dung as your primary source of energy, you can use whatever you want, and you should not be under any climate agreement."

The (carbon) price of development

According to Climatescope's 2018 *Emerging Markets Outlook*: "Faced with significant pressure to expand energy access (India) and keep power affordably priced (China), policymakers will be reluctant to de-commission these relatively new plants anytime soon. And no less than 81 per cent of all emerging market coal-fired capacity is located in these two nations."²⁴

"Those countries are developing, they need more energy consumption to lift out of poverty and so on, and therefore the energy infrastructure they build is often adding to new energy consumption," says Peters. "For example, if you build a wind farm or solar panels, they are providing additional energy as opposed to displacing old energy."

Figure 11: The relative preparedness of fossil-fuel producing countries for the energy transition



Note: Includes countries in which fossil fuel rents account for more than 5 per cent of GDP.

Source: IMF World Economic Outlook database, World Bank, Global Commission on the Geopolitics of Energy Transformation, 2019.

You also have very young coal fleets in China or India, so it's very hard for them to get quick declines."

In the same way, urbanisation and infrastructure construction emit huge amounts of greenhouse gases. "What we're talking about is growth and urbanisation. Every time you pick up a spade and stick it in the ground and start to build something, there's a huge carbon cost," says Dixon.

Developing resilience

Building resilience to global warming also requires robust technology most emerging nations don't currently have access to. As such, they will need support from developed countries to finance investments in adaptive technology, such as flood-control systems, agricultural development and barriers against rising sea levels.

Shellenberger illustrates this with the case of the International Rivers Network (part of Friends of the Earth), which is campaigning against the Democratic Republic of the Congo damming the Inga river because of environmental concerns. "That's how the DRC is going to get electricity and flood control and irrigation and all the rest, so why can't they develop?" he asks.

"And instead they say the DRC should use natural gas, solar panels and wind turbines. None of it makes any sense."

Tol gives similar examples, citing the difference between the Maldives and Tuvalu, an island in the South Pacific. The former has the funds and technical means to raise its islands, and is therefore not at risk of disappearing because of rising sea levels. In contrast: "Climate change is an existential threat to Tuvalu because they are so much poorer. We forget today it is not so much that climate change is the issue or the situation of your low-lying island, but it is really a development issue."

Minsky moment?

A Minsky moment is a sudden, major collapse of asset values marking the end of a growth cycle. American economist Hyman Minsky argued the seeds of any crisis or crash are typically sown in times of stability and calm. For the energy transition, this could be seen as a tipping point that results in a sudden acceleration of the move away from fossil fuels. In this scenario, companies whose business models still depended on fossil fuels would go out of business or see their market value crash as their growth

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Every time you pick up a spade and stick it in the ground and start to build something, there's a huge carbon cost
”

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prospects vanished (see Stranded! When assets become liabilities, p.32).

Waygood explains such a “climate Minsky moment” could come from two sources: sufficient cost reductions in the technologies that can enable the transition; and policy risk, “as governments tighten, either with a cap on carbon trade schemes quicker than the market is expecting, or by invoking a regulation or a standard markets aren’t expecting”.

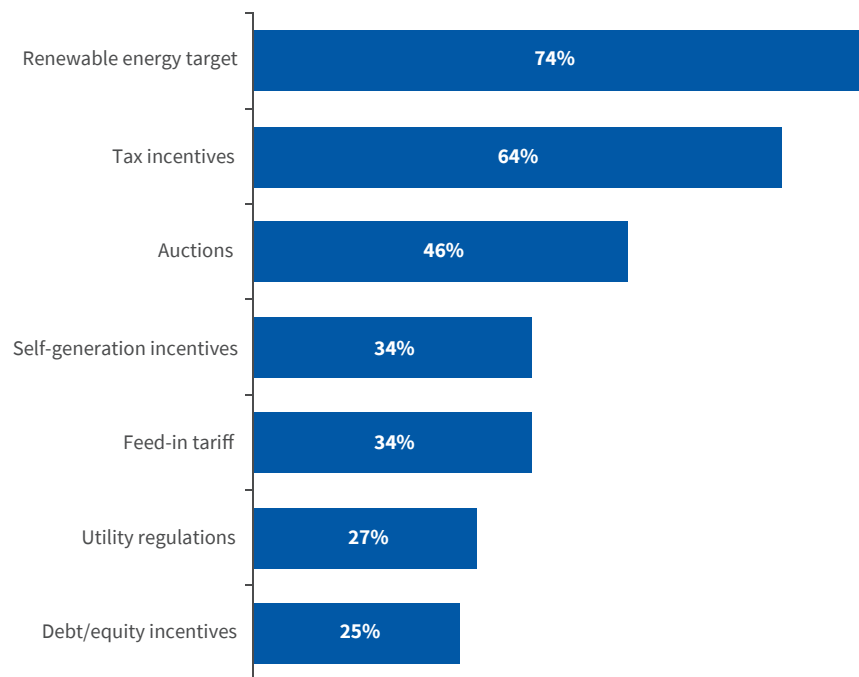
However, as is the case in China – which prioritises coal for social and political reasons despite it being more expensive than renewables – social understanding and acceptance will be key.

An example of the impact regulation can have is the 18 countries studied by Peters et al.²⁵ “There is no ‘silver bullet’, and every country has unique characteristics, but three elements emerge from the group: a high penetration of renewable energy in the electricity sector, a decline in energy use, and a high number of energy and climate policies in place,” say the researchers. “Interestingly, our analyses suggest there is a correlation between the number of policies to promote the uptake of renewable energy and the decline [in emissions] in the 18 countries.”

These are mainly developed nations, but the Climatescope Emerging Market Outlook 2018 report highlights clean-power policies are increasingly common in emerging markets, which are also responsible for most low-carbon power development. In 2017, clean-energy additions grew by 20.4 per cent in emerging markets, while falling by 0.4 per cent in developed countries.²⁶

In wealthier countries, signs of a tipping point are also emerging. For instance, 2019 should post the largest fall in electricity production from coal on record, in a reduction greater than coal-generated power in Germany, Spain and the UK combined.²⁷ *Bloomberg* reports that, even in the US, the “green economy”

Figure 12: Share of emerging markets using clean-power policies



Source: BloombergNEF, Climatescope, November 2018.

employs around four per cent of the workforce and generates \$1.3 trillion in annual revenue.²⁸

Private sector pressure

Investors and companies have a key role to play as well. “In the US there are companies driving change, more than the government,” comments Jaime Ramos-Martin, global equities fund manager at Aviva Investors. “Companies are leading the change because, at the end of the day, it’s a risk-management issue. In Europe, businesses have a voice. In the financial sector, companies are realising they need to answer and be more transparent about how they manage this risk.”

Francoise Cespedes, equities portfolio manager at Aviva Investors, agrees change is happening at all levels. “This is linked to the fact companies are becoming much more vocal about how climate change may affect their business operations; and the fact people are also taking a closer look at how they consume. They want the products they are consuming to be more environmentally friendly.”

While the responsibility weighing on investors is significant, opportunities exist to increase allocations to

companies leading the transition, those offering solutions to help people adapt to a warmer planet, and companies in traditional industries that have taken early action to rebalance their businesses.

Cespedes also sees opportunities in less obvious candidates, such as independent power producers, particularly renewable-only energy suppliers; efficient energy suppliers and buildings; and sustainable transport, railway equipment in particular.

Are you sitting comfortably?

In a recent issue on climate change, an editorial in *The Economist* summed up the challenge. “Reversing the 20-fold increase in emissions the 20th century set in train, and doing so at twice the speed. Replacing everything that burns gas or coal or oil to heat a home or drive a generator or turn a wheel. Rebuilding all the steelworks; refashioning the cement works; recycling or replacing the plastics; transforming farms on all continents. And doing it all while expanding the economy enough to meet the needs and desires of a population which may well be half again as large by 2100 as it is today.”²⁹

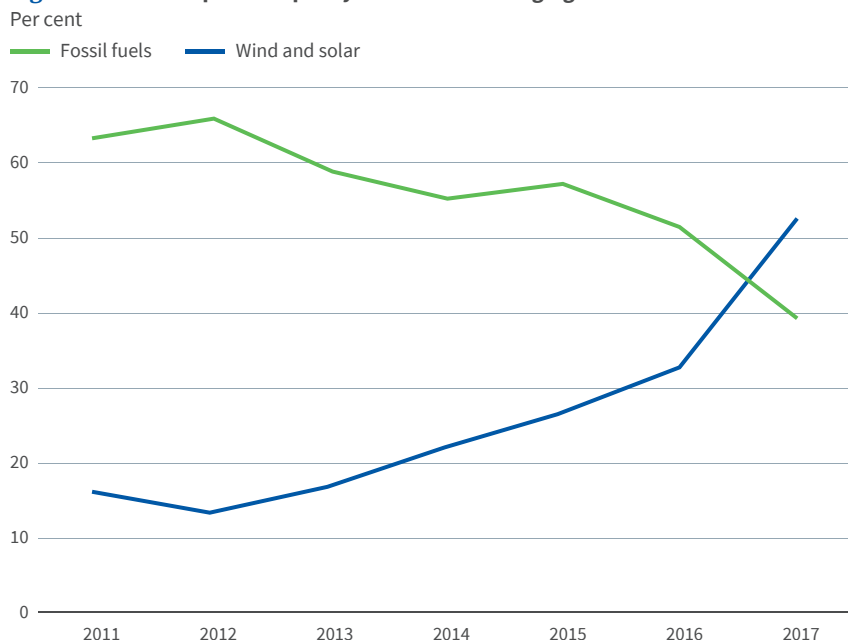
This will be a difficult and, for many, an inconvenient transition – one that needs to be carefully and appropriately managed. The decisions consumers make will have an impact on its direction and trajectory. But as Reynolds says: “At the government level, The Inevitable Policy Response (IPR)³⁰ forecasts a number of key policies. [It] shows that the pressure for policy action on climate will only increase and come from all angles – environmental, social, economic – and the longer the policy response is delayed, the more forceful it’s likely to be.”

To be effective, policy will have to combine planning, research and incentives as well as regulation, particularly incentives aimed at changing behaviours.³¹ The Exponential Roadmap reiterates policy must include measures to mitigate the social and economic risks from the transition. It encourages policymakers to adopt comprehensive policy packages to push on all fronts at once, including removing fossil-fuel subsidies, but also stopping unsustainable infrastructure investments, promoting energy efficiency and clean energy, and supporting people whose livelihoods are disrupted.³² And for emerging markets to fully participate in the transition, the *Mission Possible* report notes access to capital will be essential.³³

Despite the scale and complexity of the transition, it is one that is already underway and, by taking stronger action, governments can change the fundamentals in the energy mix – for investors, consumers and companies.

“The only way you’re going to change [fossil-fuel use] is to change the market fundamentals and to make it less valuable for that activity to be done, globally, for good, for all, for ever,” concludes Waygood ●

Figure 13: Annual power capacity additions in emerging markets



Note: Non-fossil fuel and non-wind/solar capacity additions were accounted for by nuclear, geothermal, biomass and large hydro projects.

Source: BloombergNEF, Climatescope, November 2018.

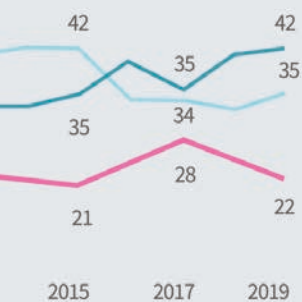
- 1 'Global Energy Perspective 2019: reference case', McKinsey & Company, January 2019.
- 2 Johan Falk, Owen Gaffney et al, 'Exponential climate action roadmap', Exponentialroadmap.org and Global Climate Action Summit, September 2018.
- 3 Billy Nauman, 'Moral Money: What if Gore had won?', Financial Times, December 2019.
- 4 'The Nobel Peace Prize for 2007', NobelPrize.org, Nobel Media AB 2020, 12 October 2007.
- 5 '2019 Progress Report', Climate Action 100+, September 2019.
- 6 Anatol Lieven, 'How climate change will transform the global balance of power', Financial Times, 5 November 2019.
- 7 'A new world: The geopolitics of the energy transformation', Global Commission on the Geopolitics of Energy Transformation, 2019.
- 8 Simon Kuper, 'The myth of green growth', Financial Times, 24 October 2019.
- 9 Task-Force on Climate-related Financial Disclosures, backed by the Financial Stability Board.
- 10 '2019 European Asset Allocation Survey', Mercer LLC, 2019.
- 11 Annalisa Esposito, 'US investors failing to engage on climate change', Morningstar, 4 November 2019.
- 12 See Stranded! When assets become liabilities, p.32.
- 13 'Mission possible: Reaching net-zero carbon emissions from harder-to-abate sectors by mid-century', The Energy Transitions Commission, November 2018.
- 14 Sam Fleming and Jim Brunnsden, 'Brussels eyes easing bank rules to spur green lending', Financial Times, 27 November 2019.
- 15 Percentages may not add up to 100 per cent due to independent rounding.
- 16 'Greta Thunberg accuses rich countries of "creative carbon accounting"', The Economist, 17 October 2019.
- 17 Johan Falk, Owen Gaffney et al, 'Exponential roadmap: Scaling 36 solutions to halve emissions by 2030', Exponentialroadmap.org and Global Climate Action Summit, September 2019.
- 18 Project Drawdown.
- 19 'Mission possible: Reaching net-zero carbon emissions from harder-to-abate sectors by mid-century', The Energy Transitions Commission, November 2018.
- 20 'Mission possible: Reaching net-zero carbon emissions from harder-to-abate sectors by mid-century', The Energy Transitions Commission, November 2018.
- 21 Billy Nauman, Anna Gross, 'Credit rating agencies focus on rising green risks', Financial Times, 27 November 2019.
- 22 Sam Fleming and Jim Brunnsden, 'Brussels eyes easing bank rules to spur green lending', Financial Times, 27 November 2019.
- 23 Kenneth Rogoff, 'The case for a world carbon bank', Project Syndicate, 8 July 2019.
- 24 'Emerging Markets Outlook 2018', BloombergNEF Climatescope, November 2018.
- 25 Glen Peters, Corinne Le Quéré, Pep Canadell, Jan Ivar Korsbakken, Robbie Andrew, 'Eighteen countries showing the way to carbon zero', The Conversation, 25 February 2019.
- 26 'Emerging Markets Outlook 2018', BloombergNEF Climatescope, November 2018.
- 27 Justin Rowlatt, 'Coal: Is this the beginning of the end?', BBC News, 25 November 2019.
- 28 Eric Roston, 'America's 'Green Economy' is now worth \$1.3 trillion', Bloomberg, 15 October 2019.
- 29 'The past, present and future of climate change', The Economist, 21 September 2019.
- 30 'Preparing investors for the Inevitable Policy Response to climate change', PRI.
- 31 Martin Wolf, 'There is one way forward on climate change', Financial Times, 5 November 2019.
- 32 Johan Falk, Owen Gaffney et al, 'Exponential roadmap: Scaling 36 solutions to halve emissions by 2030', Exponentialroadmap.org and Global Climate Action Summit, September 2019.
- 33 'Mission possible: Reaching net-zero carbon emissions from harder-to-abate sectors by mid-century', The Energy Transitions Commission, November 2018.



CLIMATE DATA: SEEING THROUGH THE FOG

Big data is heralded as the answer to almost every problem, so why not the climate crisis?





What would an algorithm tell us if we asked it to solve the climate crisis? It is a nice idea to think we could outsource such a gigantic problem to a machine. In fact, artificial intelligence experts have already started to ask this very question.¹

Google famously used computing power to improve its energy efficiency.² However, while incremental progress will be made through endeavours such as this, the quality of the data will likely hamper its success: as the saying goes, “rubbish in, rubbish out”.

In this A/Q article, we look at the potential for all forms of data – big, micro and alternative – to be translated into meaningful information and then collected and presented in a way that encourages tangible, action-driven outcomes. Challenges arise over privacy, ownership and responsibility. While individuals have a clear role to play in shifting consumer behaviour to a more sustainable footing, we expend the bulk of our attention on governments and companies.

Challenges of collecting data

Let’s start with the difficulties in obtaining the right data from companies, and the reasons why there is a growing clamour for mandatory rather than voluntary reporting. According to the Smith School of Enterprise and the Environment at Oxford University, levels of emissions disclosures range from 67 per cent of large companies in developed markets to just 25 per cent of small firms in emerging economies.³ Climate Action 100+, an investor initiative to

pressure the world’s largest greenhouse-gas emitters to take action on climate change, states companies in the oil and gas sector are among the least transparent – only 63 per cent report their emissions data to CDP, a climate-change data collection and assessment programme, and just 38 per cent conduct and report on climate scenario planning.⁴

Glen Peters, research director at the Center for International Climate Research (CICERO) in Oslo, believes this gap in reporting needs to be filled by regulation. “At the end of the day, a company is rationally going to operate within the laws it has, unless it sees some competitive advantage in going faster than what regulation may require. So, the political/regulatory framework is pretty important, and one thing is to try and push it towards putting stronger limitations on CO₂ emissions and so on, which then forces all companies to act.”

Experience also suggests pressure from investors, civil society and activist groups is effective. Participants at the Smith School of Enterprise and the Environment’s 7th Sustainable Finance Forum argued: “All of these groups could drive progress by asking more of the right questions of companies on topics of sustainable supply chains.” They added the use of sensory data was “potentially transformative for the sustainable finance system, with investors and activists able to use data to drive change in corporate practices, revolutionise corporate reporting, track natural capital and improve supply chain

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“

A company is rationally going to operate within the laws it has

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CLIMATE DATA: SEEING THROUGH THE FOG

continued

management”⁵ (More on this later.) The California Public Employees’ Retirement System (CalPERS), the largest public pension plan in the US, which manages pensions for more than two million California public employees, retirees, and their families, was a founding member of Climate Action 100+, and an early supporter of the Task Force on Climate-related Financial Disclosures (TCFD). Anne Simpson, director of board governance and strategy at CalPERS, agrees the voluntary nature of reporting is failing.

“Our view as a global institutional investor is that these types of sustainability data need to be included in mandatory reporting. The reason for that is to ensure consistency, reliability, integration with the financials, and to allow us to make comparisons between companies, sectors and over time. Right now, we just can’t do that,” she says. “You can treat one company as a proxy for another in theory, but in practice it’s really giving you a very unsatisfactory view. We can put together a fancy model or an algorithm, but really this is not acceptable to us as fiduciaries.”

Paul Lacoursiere, global head of environmental, social and governance (ESG) research at Aviva Investors, has the same view.

“The disclosure of ESG metrics is nowhere near the level of disclosure of financial metrics. It’s not a requirement, and without a clear deadline analogous to what is required for financial reporting, ESG metrics tend to be significantly lagged,” he says. For investors trying to analyse relevant ESG information over a one-year period, Lacoursiere estimates only 20 to 30 per cent would be available. “At this point, not all companies disclose even basic environmental and social metrics.”

In fact, ESG ratings provided by external providers are nowhere near as reliable as standard credit ratings, from both an information accuracy and a rating consistency standpoint. “MSCI, for example, rates most of the opportunity set,” explains Lacoursiere. “If a company does not disclose

Figure 1: Core elements of recommended climate-related financial disclosures



Source: TCFD, Recommendations of the Task Force on Climate-related Financial Disclosures, May 2018.

a metric, MSCI applies some form of industry related average estimate – in this scenario a company can choose to disclose only its strongest metrics, because it knows MSCI will give it an average grade for metrics it doesn’t disclose. I am uncomfortable with that.”

Lacoursiere would like to see an ESG data framework develop, “as in financial reporting – where there is a base set of statistics under each of the categories required, and the companies must put resources behind measuring and disclosing those metrics, so that it’s a level playing field from one company to the next”.

The TCFD aims to provide more guidance on emissions reporting through its Greenhouse Gas Protocol’s Scope 1, 2 and 3 framework (with Scope 3 including upstream and downstream emissions). Yet it is still not enough, according to Lacoursiere.

“We need more, simply because the TCFD guidelines provide a lot of flexibility around how that report is compiled. So, if every company is using a different methodology, it is not the same as having an accounting standard,” he says.

Not everyone has such a dim view of the progress being made. Fiona Reynolds, CEO of the UN-backed Principles for Responsible Investment (PRI), says PRI is making TCFD-reporting mandatory for signatories from 2020. She argues the TCFD is, slowly but surely, leading to increased harmonisation.

“Scenario analysis – TCFD’s forward-looking element – has been critical in providing both investors and companies with a view of the future and an understanding of how they will be impacted by the transition. This has led, and will continue to lead, to more informed decision making and an understanding of how to align with the goals of the Paris Agreement,” she says.

Led by CalPERS, investor group Climate Action 100+ also works extensively with organisations focused on corporate climate performance – the Carbon Tracker Initiative, CDP, InfluenceMap, the Transition Pathway Initiative and the 2° Investing Initiative – having set up a technical advisory group to develop a relevant set of indicators and analytical frameworks, including science-based emissions targets.⁶

The difficulties of harmonising reporting

One explanation for the lack of guidance and harmonisation is the difficulty in coming up with measures that are relevant across industries in the way accounting measures can be. The Sustainability Accounting Standards Board (SASB) is working on it, as are the TCFD and other environmental standards bodies. However, Lacoursiere argues that even if developing common metrics for emissions is achievable, measuring risk is more complicated.

“If you extend [the framework] to ‘what’s your Value-at-Risk due to climate change?’,

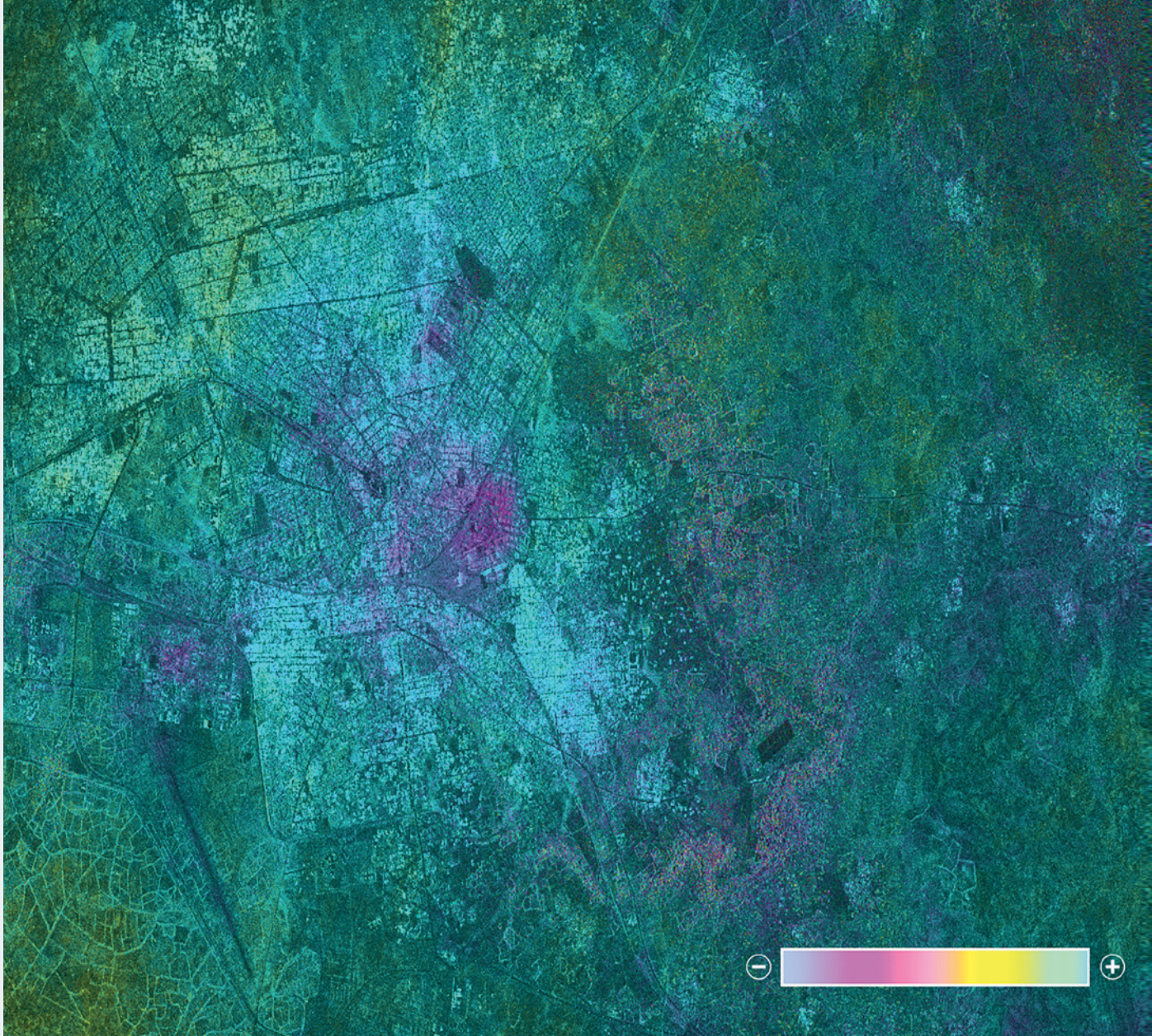


Figure 2: Differential interferogram generated using a pair of RADARSAT-2 images.²⁴

then the underlying analytics become opaque, so the second phase would be more difficult,” he says. “If you went to three different service providers and asked them to give you that statistic, and didn’t let them talk to each other, you would get three very different numbers back.”

In the meantime, the lack of a coherent, compulsory reporting framework may also be stopping the most exposed firms from fully disclosing their risks, as they could put themselves at a competitive disadvantage. CalPERS’ Simpson believes businesses have not improved their reporting because they believe there is a first-mover disadvantage. “If you say, ‘Wow, look at all my risks and exposures’ – why would I do that when it’s not a requirement for all companies?” she says.

In the US and elsewhere, companies have a fear of liability too. “The TCFD is looking at physical risk, transition risk and litigation risk. Obviously, if a company discloses that it has some litigation risk it could be self-fulfilling, so we’ve seen hardly any disclosure in that area,” says Steve Waygood, chief responsible investment officer at Aviva Investors.

Similar differences in disclosure are found at a country level. “Developed countries have to report on a regular basis on their emissions, and there’s a quite detailed and standardised way they do that reporting,” says CICERO’s Peters. “But developing countries don’t have to do that, or they don’t have to do it so often, and that makes our life that much harder as researchers to figure out what’s going on.”

“Businesses have not improved their reporting because they believe there is a first-mover disadvantage”

CLIMATE DATA: SEEING THROUGH THE FOG

continued

Competing frameworks

To solve these issues, a common, prescriptive regulatory framework is needed, but this still seems some way off. “Even though there are these initiatives, it’s all very unharmonised and un-comparable from a research perspective,” says Peters. “Companies or countries can basically say what they like and still get away with it. You can always find a way to define your emissions so that they’re going down.”

Rhonda Brauer, a securities lawyer, ESG consultant and co-author of the Council of Institutional Investors’ *Sustainability Reporting Frameworks: A Guide for CIOs*,⁷ explains: “The reporting frameworks include, among others, CDP, the Global Reporting Initiative (GRI), the SASB and the TCFD.

“In terms of the ongoing efforts by the framework sponsors to align with each other, the most prominent example is the Corporate Reporting Dialogue’s ongoing two-year effort: the Better Alignment Project. While the participating frameworks have agreed on some common principles, we are not yet near a place where one or more of the actors will merge or leave the market,” Brauer adds.

The Financial Times in November noted these organisations are all trying to push their framework to become the one industry standard,⁸ making life difficult for those trying to report, and undermining the work to improve disclosures.

Rather than consolidating, harmonisation efforts seem to be needlessly multiplying. A group of central banks launched the Network for Greening the Financial System (NGFS) in April 2019 which, among other recommendations, urged for globally consistent disclosure; the World Benchmarking Alliance was set up in 2018 to show up the best and worst performers on the UN Sustainable Development Goals;⁹ and the European Union is working on a region-wide taxonomy to help companies and investors define relevant metrics for sustainability. Programmes also comprise

the Impact Weighted Accounts Initiative and a project by the CFA Institute to establish standardised ESG reporting for asset managers, similar to the CFA’s Global Investment Performance Standards.

Lacoursiere is slightly more optimistic about convergence, particularly in Europe, where regulators have more appetite to force the issue. “Through the European Securities Market Authority, I think we’ll see convergence within the next five years. All the financial regulators within that network are looking at requiring asset owners to disclose those statistics, which will have a trickle-down effect to asset managers and then companies themselves. I’m a bit more sceptical we’ll see that in North America or in Asia in the next five years, [although] the trend is encouraging.”

Brauer agrees the onus is on regulators to force the issue. “If regulators played a more active role in standardising compulsory sustainability reporting, not only would it end the ‘survey fatigue’ about which companies complain, but it would also create a common playing field for the reporting,” she says. “The resulting disclosure could be audited by accounting and engineering firms, several of which are already active participants in the different framework organisations. Such audits should also help to respond to those who criticise some of the current voluntary disclosures as ‘greenwashing.’”¹⁰

Although frameworks remain under discussion, the TCFD’s recommendations are a good illustration of the types of data companies should be reporting and investors should be incorporating into their models.

Filling in the blanks: Could sensors and satellites solve the data dearth?

Until the lack of harmonisation is resolved, many are turning to technology to fill the information gap.

“Increasingly, investors are using big data

“*Rather than consolidating, harmonisation efforts seem to be needlessly multiplying*”

to fill gaps so they have better information to support investment decisions,” says Lacoursiere. Yet there is a long way to go. “A lot of the things we’re talking about today are in their infancy, in terms of applying the datasets and machine learning and other analytic approaches to the problem. It’s not a well-developed practice at this point; it’s not something you can buy off the shelf.”

For instance, the US State of New Mexico recently partnered with Descartes Lab to monitor methane emissions to stop leaks and reduce its carbon footprint, but the level of precision needed remains beyond the best technology.¹¹

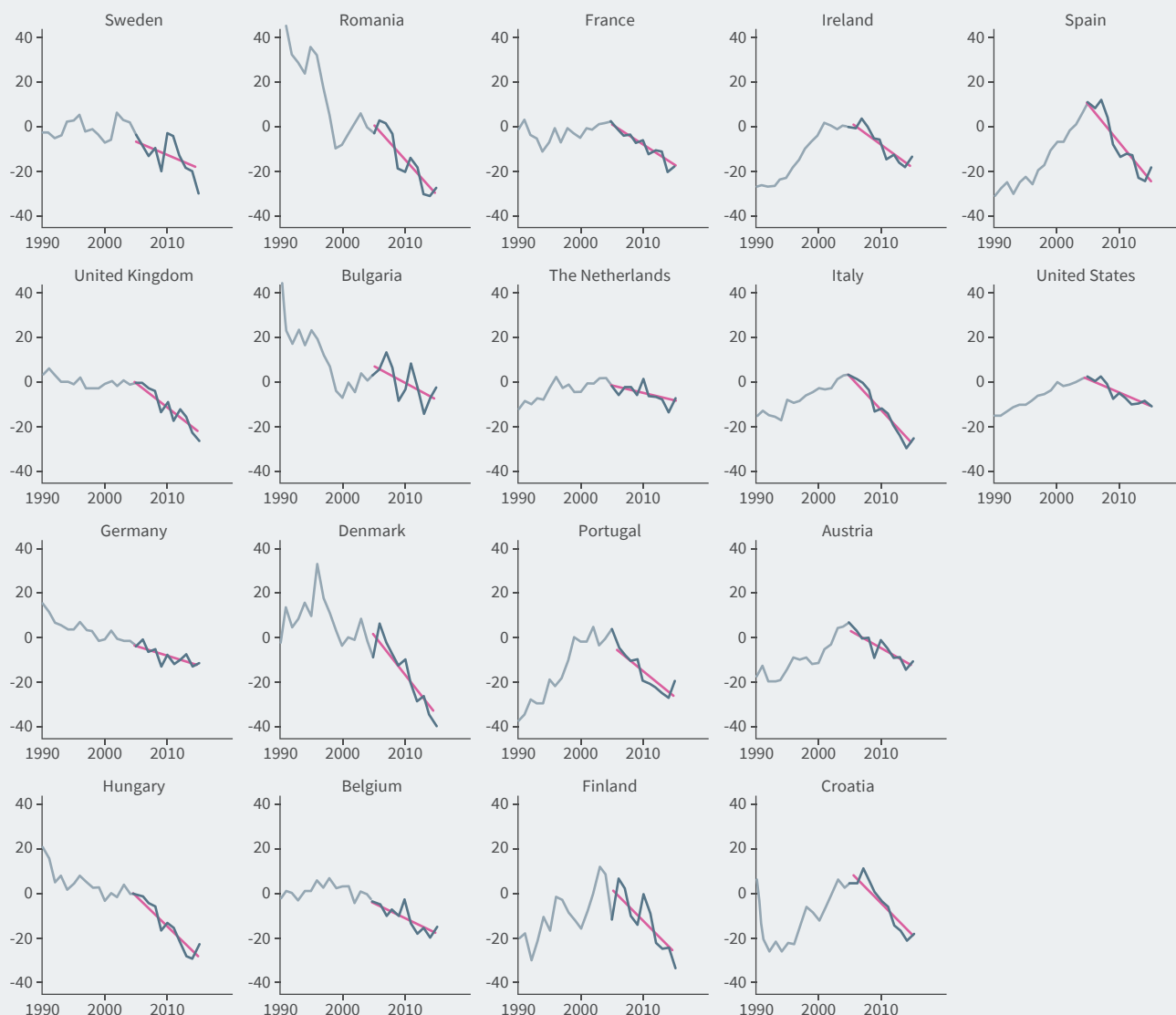
Although the use of satellites, sensors and big data analytics to measure emissions and inform investment decisions is just beginning, much of the data and computer programmes that make it possible exist and are constantly improving. We also know how to use much of it already, from companies predicting consumer preferences to cities monitoring water quality. This could finally bring data-driven emissions regulation within reach.¹²

Whether to measure direct emissions from factories, across a company’s supply chain, or at a country level, an increasing number of options are emerging, including mobile data, big data analytics from online sources, satellite measures and data available from the plethora of sensors scattered around the world.

Government satellites, like the European Space Agency’s Sentinel 5P, and other observation missions, like the US Landsat Missions, measure greenhouse-gas emissions (among many other things) and make the data publicly available. They are complemented by commercial satellites – particularly the constellations of tiny satellites called “cube sats” – whose measures can be bought to analyse all manner of information and, increasingly, drone observations.¹³

For instance, air pollution can be measured through a combination of satellite data and local sensors, and AI analyses of satellite

Figure 3: Changes in CO₂ emissions from fossil-fuel combustion for 18 countries with declining emissions during 2005-2015.
Countries are ordered by how soon their emissions began to decline (percentage change).



Source: The Conversation, Le Quéré et al. Nature Climate Change (2019) based on data from the International Energy Agency.

imagery of shipping routes can track and report illegal activities.¹⁴ Similarly, Planet Labs' 200 Dove satellites use cameras and sensors to monitor the earth daily, with the aim of one day measuring emissions with precision. California is planning on using the Dove satellites to monitor its wildfires, as part of its plan to track greenhouse gases.¹⁵

This type of approach allows analysts and researchers to find and assess relevant data that does not feature in companies' or countries' disclosure reports, such as litigation due to environmental damage,

partnerships with clean or carbon-intensive energy providers, or speeches stating a firm's commitment to better practices. These can be found through scraping (compiling information from online and offline sources) and crawling (using programmes to search across online sources).¹⁶ Using AI to sort and analyse the mass of information gathered could make sense of it without deploying armies of researchers.

"Each individual piece of data may not be that instructive, but when you pull them all together, then you can get a coherent story."

Many are turning to technology to fill the information gap

CLIMATE DATA: SEEING THROUGH THE FOG

continued

This is what we do to some extent when we try and estimate what emissions will be in 2019 before the year is complete,” says Peters.

In a recent *IPE* article, Ben Caldecott, director of the Oxford Sustainable Finance Programme, argued this could be a game changer for investors. “These rapidly growing data mountains can then feed increasingly sophisticated predictive models to generate more and more insights and results.”¹⁷

Caldecott participated in the 2019 launch of the Spatial Finance Initiative, which aims to leverage satellite and other geospatial measurements and use AI to feed these into financial decision making.¹⁸ “This creates a significant opportunity for the financial services industry, including, but not limited to, the effective implementation of ESG practices.”

However, using the example of 18 countries that he and colleagues found to have reduced their carbon footprint between 2005 and 2015 (see Figure 3),¹⁹ Peters explains why this is not straightforward. “Typically, what the algorithm does is to find countries where emissions have gone down and economic activity has gone up over that ten-year period, but over ten years you can have a few economic ups and downs. Some of the ups and downs will relate to economic challenges. Each country will have something unique about it.”

To make sense of the data, researchers need to complement it with other relevant information. Similarly, when using big or alternative data, investors must first determine what to look for, and then how to interpret their findings.

Other gaps remain. Data found online can be biased – for instance, if an issue causes noise on social media without necessarily representing the facts. Physical data gleaned through satellites or sensors still often lacks precision, and raises privacy issues when it comes to exploring a company or country’s activities (including the impact of imported emissions).

Bringing everything together

Whether using reporting, big data, interviewing companies directly or taking a mix of sources, the first step is to formalise the necessary data. Lacoursiere gives the example of financial analysts trying to estimate company earnings ahead of announcements, for instance by tracking a retail company’s mall footfall, or using satellite imagery to measure activity levels at a mining company’s various sites.

“There’s an analogy to that in the climate area, where instead of estimating foot traffic and purchases you are estimating carbon outputs or energy consumption. The framework exists, but I don’t think it’s been rigorously applied to estimating things that we know influence climate change.”

At a country level, tools like the UN’s Emissions Gap Report are making it possible to track reported emissions against countries’ or companies’ commitments.²⁰ However, understanding those commitments can be challenging because some are – perhaps deliberately – ambiguous.

“There are various ways to manipulate data, in a justifiable way, that can make it easier or harder to get to a target,” says Peters. Until that happens, if big data can help refine and improve the accuracy of estimates where companies don’t disclose, it will make it much easier to see through cases of greenwashing.

“Greenwashing is about transparency: the more granularity we have as it pertains to the datasets, the more we can check that. A common language and better inputs should help,” says Francois de Bruin, sustainable income and growth portfolio manager at Aviva Investors.

Peters concurs, to a degree. “You can probably go quite some way by mining data, but to get the structures in place to collect that data can be extremely difficult. You can mine data that’s out there, but the job would be a hell of a lot easier if the appropriate data was collected and reported,” he says.

“

Machine learning could improve investors’ and companies’ climate-risk scenarios

”

He adds it is difficult, although not impossible, to check for data manipulation. “This comes back to data mining. You’re essentially looking for inconsistencies in data; for example, if China says its coal consumption went down while statistics of steel production, cement production, electricity generation show ten per cent growth. I guess accountants and tax officers probably do something similar for companies, essentially trying to find inconsistencies in data streams.”

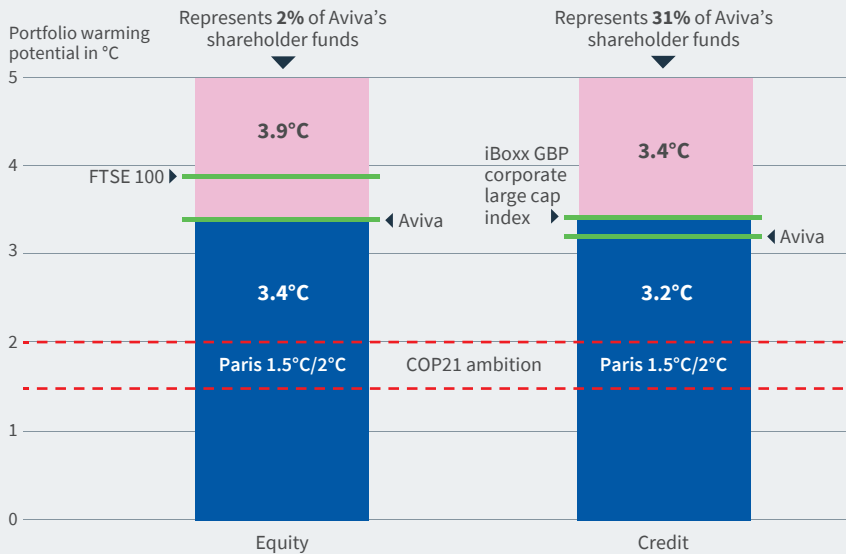
Lacoursiere thinks machine learning could also improve investors’ and companies’ climate-risk scenarios, as it already does for weather forecasting. “It’s an interesting relationship. Historically, a given set of atmospheric conditions would result in predictable weather patterns, but those relationships are changing. Neural networks are very good at identifying changing relationships, so they are naturally suited to the problem.”

He and de Bruin agree human input will always remain indispensable, however. “It has to be both, because there is no defined set of rules an algorithm can simply follow and then decide on our behalf. Interpretation is required,” says de Bruin.

In 2018, the United Nations’ Exponential Climate Action Roadmap said the question now was, “How do we provide governments, businesses and citizens with shared roadmaps that show the way, which can be defined and redefined as we go?”

The report argued all the data needed to create these roadmaps was already accessible, from government policies to public emission statistics and published research. However, the data remains scattered and needs to be collated, analysed and presented under a common framework. “By methodically presenting open data in this way, we can see exactly where we stand, focus on the right actions, hold stakeholders accountable and spread best practice. In doing so, roadmaps become vital tools that can be used to drive action and guide strategies.”²¹

Figure 4: Corporate credit and equities warming potential (in °C) for Aviva's shareholder funds



Source: Carbon Delta, Aviva. As at 31 December 2018.

The FTSE 100 is on course for

3.9°C
warming

Participants at the summit are working on this, and have since published another two roadmaps, the latest presenting 36 solutions to halve emissions by 2030.²² Many show how big data, technology such as sensors and satellites, and AI can radically change carbon emissions:

- Solar, wind, storage and smart grid technology supported by digital solutions will enable electrification, decentralisation and greening of the energy system.
- Digitalisation can improve delivery by optimising shipments, routes and traffic systems.
- Deforestation can now be predicted and detected through digital solutions, which helps form the basis for proactive action through monitoring and improving agriculture, reforestation and peatland restoration.
- Through the use of Internet of Things, AI, 5G and digital-twin technology, the need for more roads and physical infrastructure can be dramatically reduced through optimising existing infrastructure.

Political will is also needed, as well as greater ownership and accountability by companies and investors, among other stakeholders.

Another example in the UN Climate Action Summit 2018 report was on methane leaks. It said: “Solutions to reduce a significant portion of this leakage are generally available, and many are profitable, but aren’t applied at a large scale because return on investment is considered too low. Stronger policy and better monitoring techniques can help close the gap. In particular, the technology industry can play a leading role here, through the use of drones and AI to detect leaks, and to help make sense of the large amounts of data already available.”

Beyond mandatory reporting by companies, de Bruin believes “there has to be a framework for opinion and the only way you can get companies to go the extra mile is to create incentives”.

Meanwhile, Simpson is adamant that accountability is key. “What we’re calling for at Climate Action 100+ is: First, companies need to take responsibility and support the energy transition – and that means being accountable; second, they need to set targets to support the goals of the Paris Agreement; third, companies should all report under the TCFD framework,” she says.

“Let’s take a company like Shell. Thanks to Climate Action 100+, it has agreed to

“*The only way you can get companies to go the extra mile is to create incentives*”

CLIMATE DATA: SEEING THROUGH THE FOG

continued

take responsibility for its Scope 3 emissions. [...] The big emissions come when Shell passes the refined product onto its customers, that's Scope 3: utilities, transport, transportation, airlines and so on. So, by Shell taking responsibility for Scope 3, it means that, as an oil company, it needs to be in a dialogue with other sectors of the economy. Because if demand for oil doesn't go down, Shell can't plan to put itself out of business."

Investors will play a key role

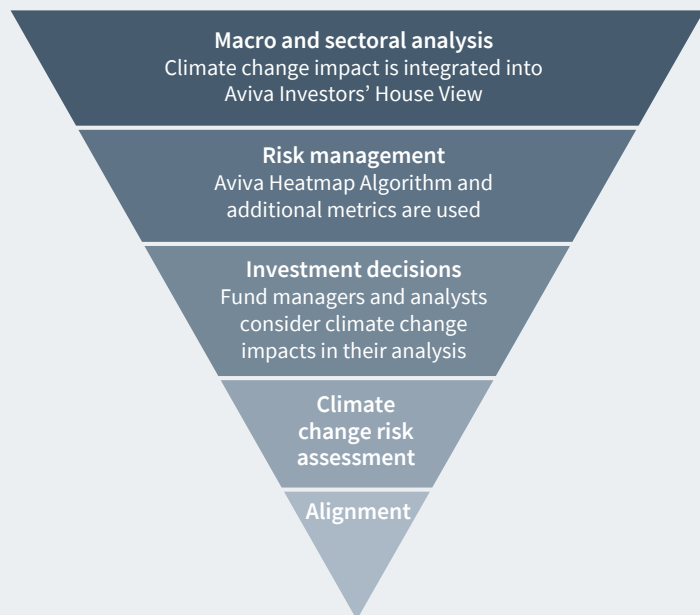
"The free lunch in climate change is akin to free fast food for lunch," says de Bruin. "There is a near-term benefit (low cost) and it meets immediate needs, but longer term you're better off paying for sustainable food groups. As the benefits of disclosure become clear, it should create a virtuous cycle of continued reinvestment; a bit like paying for a healthy, balanced diet."

Investors are increasingly realising this, which is a powerful driver in the search for more and better data. Waygood explains how Aviva compared its portfolios' carbon footprint to that of the London Stock Exchange.²³ "You can see the FTSE 100 is about 3.9 degrees. Our portfolio is better, but still about 3.4 degrees, so that gives you a sense of the gap."

De Bruin explains how this has changed investors' approach. "As any credit analyst will tell you, ESG risks are integral to the risk framework. These are all material risks that are in your framework already, so it's just that we are now explicitly putting it into a category. We are now finally shining the spotlight on exactly what it is that needs to be addressed."

Interestingly, this spotlight is also influencing bondholders' perceived responsibility to engage with companies. "I do think, historically, shareholders would have been seen as the flag bearers, but now, increasingly, debt investors have a role to play," says de Bruin.

Figure 5: Integrating climate risk into investment considerations



Source: Aviva Investors, December 31, 2019.

"Bondholders can say, 'We're not refinancing this time round because we want to see certain levels of disclosure'. Essentially, they are the gatekeepers of the capital."

He also believes large investment firms can use their own data resources to share information and engage with smaller companies. "If they are smaller, they might not have the resources to even consider these decisions. As investors, we might be able to say, 'This is what we are seeing globally, have you considered this and this?' It's a conversation."

Similarly, big data can help investors better understand issues and trade offs in emerging markets, and to then engage with companies locally, which are keen to discuss the climate transition. "From the initial letters that we have sent, we have had responses not from the investor relations teams, but from the CEOs themselves. They want to engage on this topic, they know it's pertinent," says de Bruin.

Better data – and particularly ESG data – also creates investment opportunities. By using an open-architecture framework, de Bruin explains, "If I'm dealing with supplier issues in toys in the US and South America, I can learn from those in Asia"

On the equities side, Trevor Green, UK equities portfolio manager at Aviva Investors, adds: "One of the things we've really progressed with this year is looking at the change in the direction of the [ESG] score because that's the key. It's not about absolute levels, [it's about] who's moving in a particular direction. That brings new investment ideas to light."

Lacoursiere believes the next steps should be companies analysing their business models and value chains using the same approach asset managers are taking today, albeit as practitioners rather than evaluators. "If a company isn't using this info to help make its capex investment decisions, more of them will go wrong. That will just become more apparent as time goes by, and the market will make it more apparent which companies are doing well and which aren't," he says.

"Ultimately, I would like to see a world in which there is no difference between ESG and non-ESG investing, as more financial market participants come to realise the significant financial impact of so-called 'non-financial' information," adds Brauer.

Telling the truth

Of the three demands of climate activist group Extinction Rebellion, the first is

“Tell the truth”. While not everyone endorses all their views, and indeed actions, this maxim has neat parallels with the debate on data and the desperate need for transparency.

“We think that when people understand the emergency that we are in, then they will actually be pushing and supportive of some sort of emergency mobilisation,” says Andrew Medhurst, who leads the UK national finance working group at Extinction Rebellion.

The effects of climate change will have a growing impact on individuals, companies and the economy. As such, it is crucial for investors to assess climate risk when allocating capital. The investment community is slowly but surely heading towards an agreement on compulsory reporting standards. However, there will always be a need for richer and more up-to-date information to augment it, as there are limits to what companies and countries can, and are willing to, disclose.

According to Simpson at CalPERS, the issue is cut and dried. “What we’ve done on the climate change agenda is to take emissions reduction as our priority. The reason for that is simple: we’re on a timetable. The clock is ticking, and we can’t be fiddling while Rome burns, in this case almost literally.”

It is a complex task. Given how much is at stake for investors – whether they are passionate about saving the planet or simply looking out for their financial interests – the need to optimise environmental data collection and analysis has become one of their most pressing objectives ●

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We’re on a timetable.
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- 1 David Rolnick et al, ‘Tackling climate change with machine learning’, November 2019.
- 2 James Vincent, ‘Google uses DeepMind AI to cut data center energy bills’, The Verge, 21 July 2016.
- 3 Elizabeth Harnett, Conor Hickey, Lucas Kruitwagen, Matthew McCarten, Xiao Zhou, ‘Impact and ultra-transparency: measuring and managing the impacts of investments and investee companies on climate change and the SDGs’, 7th Sustainable Finance Forum & 2nd ADI Annual Meeting Summary of Proceedings, June 2018.
- 4 ‘2019 Progress Report’, Climate Action 100+, September 2019.
- 5 Elizabeth Harnett, Conor Hickey, Lucas Kruitwagen, Matthew McCarten, Xiao Zhou, ‘Impact and ultra-transparency: measuring and managing the impacts of investments and investee companies on climate change and the SDGs’, 7th Sustainable Finance Forum & 2nd ADI Annual Meeting Summary of Proceedings, June 2018.
- 6 ‘2019 Progress Report’, Climate Action 100+, September 2019.
- 7 Rhonda Brauer, Glenn Davis, ‘Sustainability reporting frameworks: a guide for CIOs’, Council of Institutional Investors, September 2019.
- 8 Billy Nauman, ‘Moral Money: Friendly fire from ‘warrior accountants’, Financial Times, 13 November 2019.
- 9 Elisabeth Jeffries, ‘Risk metrics jigsaw’, IPE Special Report, November 2019.
- 10 Greenwashing refers to the practice of painting a more positive picture of a company’s ESG credentials than is in fact the case.
- 11 Michael J. Coren, ‘Space-based data on polluters is improving – and Wall Street is taking notice’, Quartz, 16 October 2019.
- 12 Mark Johnson, ‘What climate change looks like from outer space’, Quartz, 26 September 2019.
- 13 Mark Johnson, ‘What climate change looks like from outer space’, Quartz, 26 September 2019.
- 14 Elizabeth Harnett, Conor Hickey, Lucas Kruitwagen, Matthew McCarten, Xiao Zhou, ‘Impact and ultra-transparency: measuring and managing the impacts of investments and investee companies on climate change and the SDGs’, 7th Sustainable Finance Forum & 2nd ADI Annual Meeting Summary of Proceedings, June 2018.
- 15 Michael J. Coren, ‘Space-based data on polluters is improving—and Wall Street is taking notice’, Quartz, 16 October 2019.
- 16 Dewi John, ‘Artificial Intelligence: Solving the riddle with AI’, IPE Special Report, November 2019.
- 17 Ben Caldecott, ‘Viewpoint: Spatial finance has a key role’, IPE Special Report, November 2019.
- 18 Spatial Finance Initiative.
- 19 Glen Peters, Corinne Le Quéré, Pep Canadell, Jan Ivar Korsbakken, Robbie Andrew, ‘Eighteen countries showing the way to carbon zero’, The Conversation, 25 February 2019.
- 20 UN Environment Emissions Gap Report.
- 21 Johan Falk, Owen Gaffney et al, ‘Exponential climate action roadmap’, Exponentialroadmap.org and Global Climate Action Summit, September 2018.
- 22 Johan Falk, Owen Gaffney et al, ‘Exponential roadmap: Scaling 36 solutions to halve emissions by 2030’, Exponentialroadmap.org and Global Climate Action Summit, September 2019.
- 23 ‘Aviva’s climate-related financial disclosure 2018’, Aviva, March 2019.
- 24 Claire Gosselin, ‘Obtaining millimetre precision using satellite sensors: science or fiction?’, Effigis Geo-Solutions, 18 June 2015.

NUCLEAR: FROM PARIAH TO SAVIOUR?

As the old saying goes, desperate times call for desperate measures. Despite lingering public anxiety around safety, there are growing calls for the world to look again at nuclear power as part of the solution to the climate crisis.





A growing number of experts are promoting nuclear power



At 14:46 local time on Friday 11th March, 2011, a massive undersea earthquake struck approximately 70 kilometres off the north-eastern coast of Honshu, the largest island in Japan. Measuring 9.0–9.1 on the Richter scale, the eruption was the biggest ever recorded in a country well acquainted with them, and the fourth most powerful in the world since modern record keeping began in 1900.

Striking at a depth of approximately 29km the quake unleashed powerful tsunami waves that in places reached heights of around 40 metres and which, in Sendai, the largest city in the Tohoku region, travelled up to 10km inland at speeds of up to 700km per hour. Residents of Sendai had only eight to ten minutes of warning, and several thousand were killed, many at evacuation sites, more than a hundred of which washed away. The latest report from the Japanese National Police Agency says the disaster led to almost 16,000 deaths, with a further 2,529 people missing.¹ In total, 121,778 buildings collapsed, while close to another million were damaged.²

Perhaps surprisingly given those grim statistics, the events of 11th March 2011 are probably best remembered for a different reason, at least outside of Japan. Approximately 100km down the coast from Sendai, the Fukushima nuclear disaster was unfolding. Although the plant's reactors automatically shut down on detecting the earthquake, its electricity supply failed, forcing emergency diesel generators to kick in. But almost immediately, the tsunami swept over

the plant's seawall, flooded the basements and knocked them out.

While shutting down the reactors halted the nuclear fission process, without the generators there was no way of removing heat from their core. As a result, three of them melted, triggering hydrogen explosions. The emission of radioactive material forced the evacuation of 154,000 nearby residents, while large amounts of water contaminated with radioactive isotopes spewed into the Pacific Ocean.

Amazingly, just one person is known to have died as a direct result of the incident at Fukushima – a 50-year old worker who succumbed to lung cancer in 2018 after being exposed to radiation. However, it revived memories of the Chernobyl disaster of 1986. In doing so, it dealt a hammer blow to many countries' nuclear industries. Almost a decade on, though, a growing number of experts are promoting nuclear power as the best way of averting what could be a far deadlier threat: man-made climate change.

A green revolution

Governments face a huge challenge in trying to wean their economies off fossil fuels to avert catastrophic climate change. The Intergovernmental Panel on Climate Change (IPCC) said in October 2018 the global economy needed to undergo a green industrial revolution “unprecedented” in scale and scope in just three decades if the rise in mean temperature is to be limited to 1.5 degrees Celsius above pre-industrial levels.³

Central to policymakers' decision-making process is what to do with their electricity-generating networks. According to the Center for Climate and Energy Solutions – an independent, non-partisan, non-profit organisation – the production of electricity and heat accounted for 31 per cent of global greenhouse-gas emissions in 2013, more than twice as much as the next biggest sector – transportation (15 per cent).⁴ Moreover, it is arguably the sector that can most readily be decarbonised.

Decarbonising electricity production is all the more pressing since demand – having already doubled between 1990 and 2016 – is forecast to double again by 2050 as growing numbers of people are connected to grids, as transportation networks electrify at an accelerating pace, and as heating is also electrified.⁵

Canaries in the coal mines

To have a realistic chance of keeping warming within even two degrees, the IPCC reckons at least 80 per cent of the world's electricity must come from low-carbon sources by 2050, in part because Asian and African countries have rapidly expanded numbers of fossil-fuel power stations. Worse still, in the case of China, India and other countries, many of the new plants burn coal, by far the dirtiest way to produce electricity. As a result, 66 per cent of the world's electricity was generated by burning fossil fuels in 2015, a figure little changed from a decade earlier – despite efforts by developed nations to decarbonise their networks.⁶



NUCLEAR: FROM PARIAH TO SAVIOUR?

continued

There, the focus has largely been on wind and solar power. However, while these sources of renewable energy will play an important role in curbing greenhouse-gas emissions, they are unlikely to be the entire solution.

Their intermittent nature, as well as issues storing and transporting solar and wind energy, creates a challenge.

Sometimes the wind is strong, and at other times it doesn't blow at all, while the sun, when it does shine, only does so during the day and rarely when electricity consumption is at its peak.

Additionally, while the cost of storing electricity in batteries is falling, it remains prohibitively expensive, meaning grids that depend mainly on renewables face one of two more realistic options. Unfortunately, neither of these comes cheap. One is to provide baseload, or back-up, from other sources of electricity. The trouble with this option is the cost of providing that baseload rises exponentially as solar and wind's penetration grows, because non-intermittent sources of power are forced to spend increasing amounts of time idle. That helps explain why the UK's Committee on Climate Change, an independent body set up to advise the government, in May 2019 said as much as 40 per cent of electricity generation in 2050 might have to be from non-intermittent sources.⁷

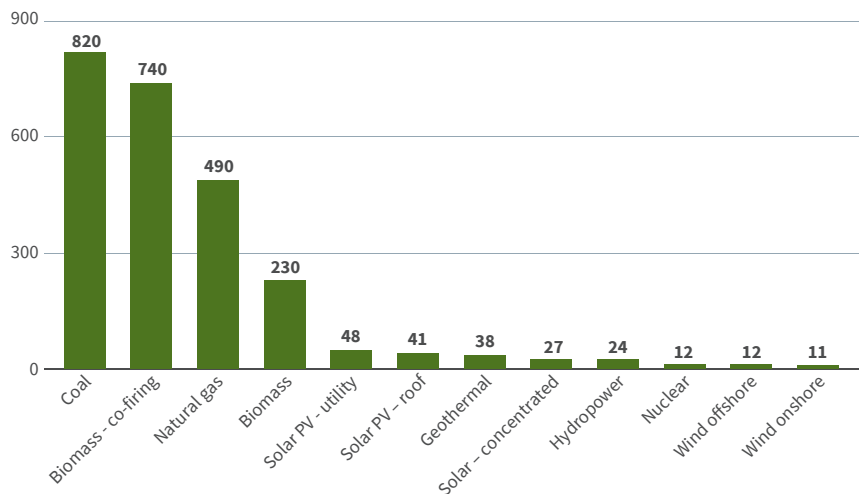
The other option is to build more generating capacity from renewables than is normally required. However, according to a recent report in *The New Yorker*, Steven Davis, an Earth system scientist at the University of California, Irvine, reckons even if Japan built enough wind and solar capacity to generate 150 per cent of its annual electricity demand, energy storage for 12 hours of average use, and a new electric grid, it would still have to find two per cent of its needs from elsewhere.⁸

(Re)enter nuclear

Predictions such as this have prompted some commentators to suggest nuclear, which

Figure 1: Average life-cycle CO₂ equivalent emissions

gCO₂ equivalent per kWh



Source: World Nuclear Association, 2014.

provides a constant and reliable source of power and results in lower carbon emissions than almost any other source of electricity, has an important role to play. In its report, the IPCC acknowledged that not only was nuclear power's share of electricity generation likely to have to increase if the temperature rise was to be kept to 1.5 degrees, several scenarios would rely heavily on it.

However, much as nuclear may seem like an obvious part of the solution to the problem of climate change, there is little sign countries have much appetite for a significant roll out of power plants. That casts doubt on the nuclear industry's ability to deliver the amount of new power needed quickly enough.

According to The World Nuclear Industry Status Report, published in September 2019, nuclear-power generation peaked in 2006, the number of reactors in operation in 2002 and those under construction in 1979. As of mid-2019, there was one less unit in operation than in 1989, with nuclear's share of global electricity generation in 2018 at 10.2 per cent, down from a high of about 17.5 per cent in 1996.⁹

The perception and reality gap

Ever since the world's first commercial nuclear reactor was built at Calder Hall in Sellafield, England, in 1956, the nuclear industry has been dogged by concerns over cost – both of building and decommissioning plants – and dealing

with radioactive waste. However, its main problem has been its safety record, or rather public perceptions of it, in the wake of high-profile accidents such as those at Chernobyl, Fukushima and Three Mile Island.

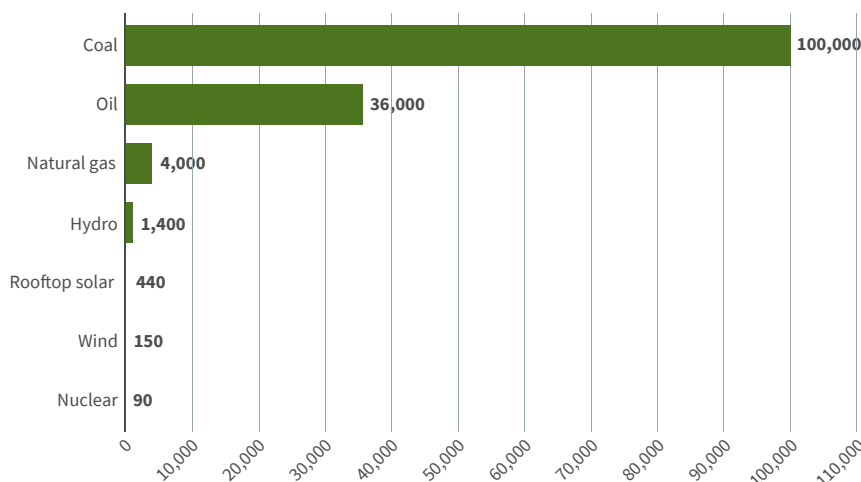
In 1981, four academics interested in the psychology of decision making asked three groups of US lay people from different backgrounds to rank 30 hazards, including riding motorbikes, smoking and handguns. Tellingly, two years after the most significant accident in US nuclear history at Three Mile Island, two of the three groups had nuclear power at the top of their list, while the third had it in eighth position.¹⁰

However, studies such as a 2010 report from the Organisation for Economic Cooperation and Development (OECD) show nuclear power to be among the safest methods of producing electricity.¹¹ Three Mile Island led to no fatalities. While 31 people were killed in the immediate aftermath of the Chernobyl disaster of 1986 and several thousand as a result of cancer since, nuclear's record over more than six decades compares favourably with other forms of energy.

For instance, the OECD in 2016 warned air pollution could cause six to nine million premature deaths a year by 2060 and cost one per cent of global GDP.¹² A 2015 study from the non-profit organization Berkeley Earth estimated that 1.6 million people die prematurely each year in China because of polluted air, much of it from coal-fired

Figure 2: Estimate of historical mortality rates for different energy sources

Mortality rate in deaths per thousand terawatt hour



Source: Forbes, 2012.

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”

power plants.¹³ As for other forms of energy, the failure of the Banqiao dam in China in 1975 is estimated to have killed up to 230,000.

Statistics such as these haven't stopped countries drastically curbing their nuclear ambitions. The World Nuclear Association says the Three Mile Island incident was a “major cause” of the decline in US nuclear plant construction through the 1980s and 1990s.¹⁴ The US Energy Information Administration forecasts nuclear generating capacity will decline from 19 per cent in 2018 to 12 per cent in 2050.¹⁵

The Fukushima effect

Chernobyl may have triggered more public anxiety, but Fukushima dealt the world's nuclear industry its biggest blow. Japan shut down all 54 of its reactors, which accounted for around 30 per cent of its energy mix, in its wake.

Prime Minister Shinzo Abe wants them restarted, arguing nuclear energy will help Japan achieve its CO₂ emissions targets and reduce its dependence on imported gas and oil. The government hopes nuclear power will comprise up to 22 per cent of the overall energy mix by 2030.

But Japan is struggling to restart reactors in the face of strong local opposition and legal challenges amid concern over the technology's safety in a country subjected to regular earthquakes and tsunamis. According to the World Nuclear Association, just nine reactors had

restarted by August 2019, having passed stringent safety checks introduced after the Fukushima meltdown.¹⁶ Although approval is being sought for another 17 reactors to be restarted, the government is unlikely to meet its target of 30 reactor restarts by 2030. In an act of defiance, Abe's own environment minister, Shinjiro Koizumi, called for the country's nuclear reactors to be scrapped altogether.¹⁷

Fukushima's impact was also felt in Europe. Within a fortnight of the incident, Italy put a one-year moratorium on plans to revive nuclear power. Three months later, over 94 per cent of Italians voted in favour of banning new plants. Belgium, Germany and Switzerland opted to phase out nuclear power completely, while even France, one of the technology's oldest proponents, said it would close 20 of its 58 plants.

Decarbonising with nuclear?

Many are now questioning the wisdom of those decisions. Take Germany. Two months after Fukushima, amid widespread protests, Chancellor Angela Merkel announced plans to accelerate the closure of all 17 of the nation's nuclear plants. By 2022, Germany is set to join Italy and Lithuania as the only countries to have abandoned atomic energy entirely. According to a report in *Der Spiegel*, by 2025 it will have spent more than €500 billion on the phase out. The result has been a near 33 per cent increase in electricity prices over the last decade.¹⁸

As part of its *Energiewende* legislation in 2010, Germany set itself an ambitious renewable energy target of 60 per cent by 2050 as it looks to cut greenhouse-gas emissions by 80–95 per cent relative to 1990. However, unable to build renewables fast enough, the decision to close nuclear plants has for now forced it to turn to lignite – a particularly dirty form of coal due to its relatively low heat content. As a result, CO₂ emissions have hardly dropped at all. The carbon footprint of people living in France and Sweden, two countries that still rely heavily on nuclear power, is half that of Germans.

Multiple studies suggest the policy is costing lives. For example, in a working paper by the US National Bureau of Economic Research in December 2019, three economists sought to find out what would have happened if those nuclear plants had kept running. Their conclusion: it would have saved the lives of 1,100 people a year who succumb to air pollution released by coal-burning power plants.¹⁹

“The social cost of this shift from nuclear to coal is approximately \$12 billion per year. Over 70 per cent of this cost comes from the increased mortality risk. Even the largest estimates of the reduction in the costs associated with nuclear accident risk and waste disposal due to the phase-out are far smaller than \$12 billion,” the report's authors said.

Now it appears even renewables are running into opposition. Construction of

NUCLEAR: FROM PARIAH TO SAVIOUR? *continued*

new wind parks in Germany has collapsed over the past year, in large part due to growing resistance from local activists. In the first nine months of 2019, developers put up 150 new wind turbines across the country with a total capacity of 514 megawatts – more than 80 per cent below the average build rate in the past five years and the lowest increase in capacity for two decades.²⁰

Part of the problem is a perceived lack of land, a problem that could get worse after the German government said it would enforce a minimum distance of 1,000 metres between wind masts and the nearest built-up area. The World Nuclear Association says one of the big benefits of nuclear plants is they take up a fraction of the space required for wind and solar farms. It points out that the UK's Hinkley Point C plant is expected to generate around 500 times more electricity per square metre than the 175-turbine London Array offshore wind farm, the world's largest.²¹

In an op-ed for *The New York Times* in April 2019, Harvard psychologist Steven Pinker, Swedish engineer Staffan Qvist and political scientist Joshua Goldstein said despite it going “all-in for renewables... according to our calculations, at Germany's rate of adding clean energy relative to gross domestic product, it would take the world more than a century to decarbonize, even if the country wasn't also retiring nuclear plants early.”²²

Pockets of interest

While Germany, South Korea and others may have scaled back their nuclear ambitions in the wake of Fukushima and earlier accidents, it would be wrong to conclude the world's nuclear industry is on its deathbed. Japan is bringing its fleet back online, albeit slowly, while France never closed any plants. As for Russia, China and India, they have shown no signs of scaling back their ambitions. Russia currently has 17 plants under construction, China 11 and India seven.

As concerns over climate change rise rapidly up the political agenda in most developed countries, the calls to re-think their policies on nuclear are growing louder. Even some environmental activists are starting to ponder whether nuclear might not be part of the solution.

“My friends in the Green Party might not like me for saying this, but I think nuclear could be part of the transition. You have to wonder whether the environmental movement's opposition to nuclear has done more harm than good,” says Extinction Rebellion's Andrew Medhurst.

For nuclear enthusiasts, there are some encouraging, albeit tentative, signs of a shift. For instance, President Donald Trump in December signed off on the government's 2020 spending bill. It included nearly \$1.5 billion for nuclear energy research.²³

Following the announcement, Dr Rita Baranwal, assistant secretary for the Office of Nuclear Energy, said: “President Trump, Secretary Dan Brouillette and I are dedicated to achieving a US resurgence in nuclear energy. We have the bipartisan support. We have the technology. We have the expertise. Now it's time to get something built – and we need to do it with a sense of urgency.”

An R&D wave

While it is premature to declare the US's nuclear ambitions have been reignited, that hasn't stopped entrepreneurs and investors from pouring billions of dollars into new startups. Some are looking to develop nuclear fusion as a feasible source of energy. Potentially, it could generate much more power than existing technologies that rely on fission (splitting atoms), with much less waste and without the danger of explosions. While this technology still looks some way off, other types of so-called fourth-generation nuclear reactors appear closer to commercialisation. They are small, promise even more safety, and are suitable for modern power grids.

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Even some environmental activists are starting to ponder whether nuclear might not be part of the solution

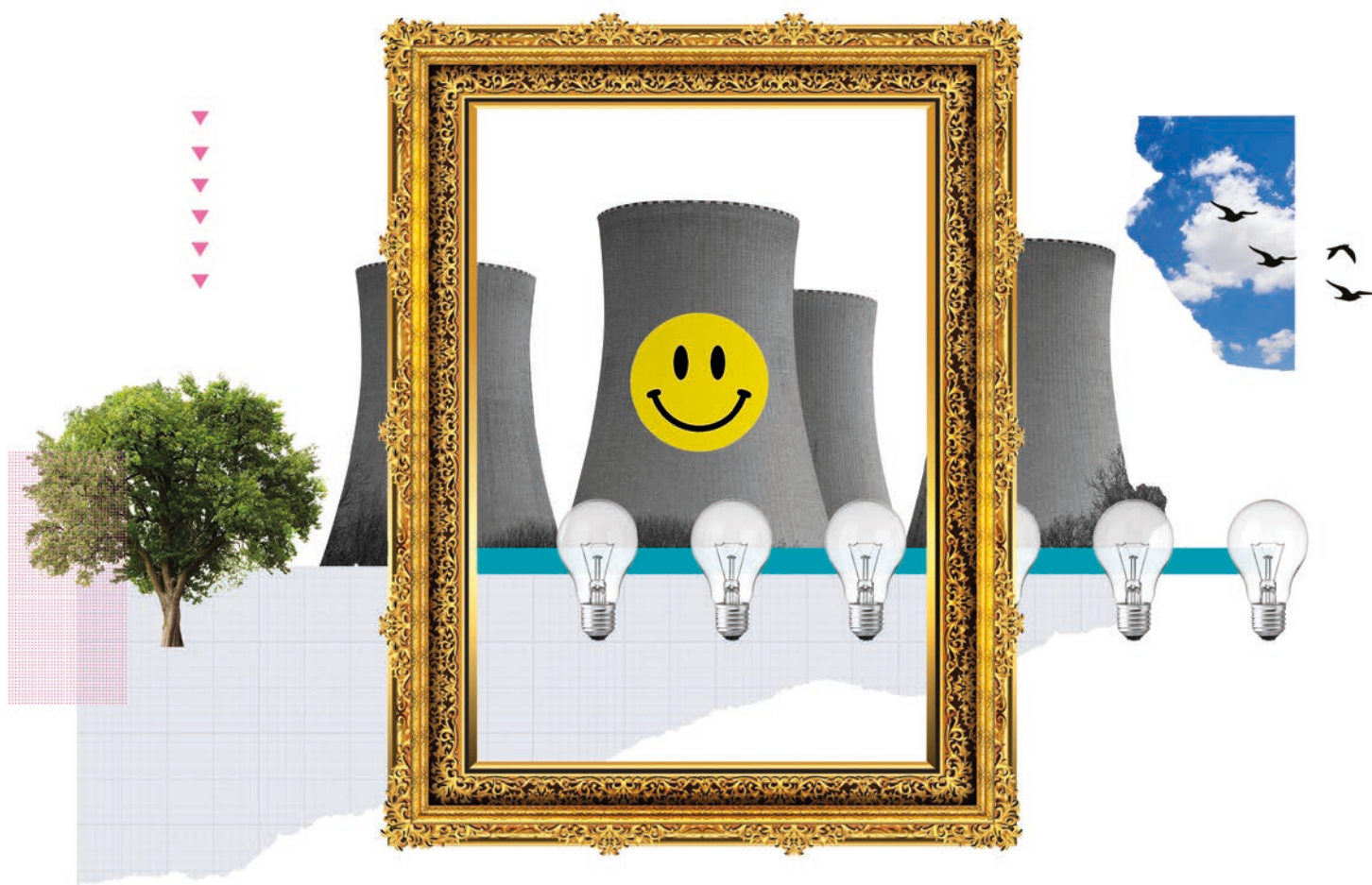
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The most prominent investor is Bill Gates. The former Microsoft chief, who says nuclear power is “ideal for dealing with climate change”, has reportedly ploughed \$500 million into a company called TerraPower.²⁴ It is looking to develop various revolutionary technologies, among them a reactor whose core will be almost entirely filled with spent fuel from other reactors. That would potentially go a long way to solving one of the industry's most vexed issues: how to safely dispose of its radioactive waste. Unfortunately, the US-China trade spat put paid to Gates's engineering plans that were set to start in China, but perhaps the recent agreement will counterbalance that.

NuScale, another startup, is developing a new modular reactor. Instead of one big reactor, it envisages plants running on lots of smaller ones. The company, which says improved safety is one of the key benefits of its technology, has received interest from 20 countries and is in talks with 29 US electric utility companies.

Champions of nuclear power argue a further key advantage is that the steam produced could be used to make hydrogen at little extra cost and without emitting CO₂. According to the US Office of Nuclear Energy, a single 1,000-megawatt nuclear reactor could produce more than 200,000 tonnes of hydrogen each year, meaning ten reactors could supply 20 per cent of US demand.²⁵

That hydrogen could potentially be used by industry as a source of heat. Heavy industry is responsible for around 22 percent of global CO₂ emissions. Roughly 42 per cent of that is the consequence of fossil-fuel combustion to produce heat to make products such as cement, steel and petrochemicals. In November, German steelmaker ThyssenKrupp launched the world's first tests into the use of hydrogen in a blast furnace. The gas will be injected to partially replace pulverised coal at a large scale during steel production.



Hydrogen could also be sold as a by-product to fertiliser producers and could even be pumped through existing natural gas infrastructures to be used for transportation, cooking and heating.

Costing the earth

Whether any of these new technologies get off the ground, let alone make a meaningful contribution towards limiting global emissions, remains to be seen. Even where public concerns over safety can be overcome, worries over cost remain.

For example, as of September 2019, it was estimated the UK's Hinkley Point C reactors would cost £22.9 billion to build. By way of comparison, the Channel Tunnel linking Britain and France cost £4.65 billion, around £15 billion in today's money.

NuScale claims that since its reactors are prefabricated before being shipped to their final destination, there is a significant cost saving. It expects to be able to generate electricity at a cost of about six cents per kilowatt hour, enabling the reactor to

compete with cheap gas-fired power plants.

However, Michael Shellenberger, American author and pro-nuclear environmental activist, has doubts new technologies are the answer if cost is the overriding concern, and he is not alone.

"The only thing that works to make nuclear cheaper is to build the same reactor over and over again, using the same people, the same construction managers – like the Koreans did, like the French have done mostly, and like the Russians are doing," he says.

France's EDF says its Sizewell C plant will be a replica of Hinkley Point C and claims this will significantly reduce construction cost and risk.²⁶

"Its delivery will be dovetailed with Hinkley construction, starting five years after Hinkley so that management can transfer from Hinkley to Sizewell and bring all the skills, knowhow and expertise gained on Hinkley. Likewise, the Hinkley supply chain will 'lift-and-shift' to Sizewell with efficiency and productivity gains from delivering the

same design, works packages, and scheduling," it says.

University of Oxford professor Dieter Helm reckons Hinkley C would actually have cost half as much if the government had been borrowing the money at two per cent rather than the nine per cent cost of capital applied by EDF. Nonetheless, and even though the cost of operating nuclear plants is low once they have been built, cash-strapped governments will have to rely heavily on private finance if they are to be constructed in sufficient number quickly enough.

According to Darryl Murphy, managing director of infrastructure at Aviva Investors, this will not be straightforward as investors will firstly need to satisfy themselves of nuclear power's environmental, social and governance credentials.

"Even if they do that, they then face the problem that historically nobody has been able to build these plants to time and budget."

Murphy says if governments want to attract private investment during the construction

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continued

period, they have to find a way of sharing the risk. That will ultimately expose consumers to the risk of costs overrunning, which will need to be justified.

Nonetheless, he does not see these problems as insurmountable. “After all you’re talking about a very long-term, indexed-linked cash flow, which a lot of investors would love, so the investment case on financials alone is strong,” he says.

As for Shellenberger, he says part of the answer is to build nuclear reactors on existing sites as it makes it far easier to get planning approval.

“This is partly why I’m so fanatical about defending the nuclear plants we have. If you look at the US, Britain, France and elsewhere in Europe, we already have enough places that nuclear could easily produce double or triple the amount of energy it presently does without developing any new sites. A lot of these plants have plenty of room for more reactors. This is what is great about nuclear, it’s so energy-dense. What might be a two-gigawatt plant right now, in the future could be five, ten or 15 gigawatts,” he says.

Reframing the nuclear option

To fully assess whether nuclear should play a role in addressing the climate crisis, one must first understand its complex, divisive and – some would argue – misunderstood past. Chernobyl, not Fukushima, was in large part responsible for this; an event that was brought back into public consciousness last year by a haunting and breathtaking HBO series on the catastrophe. The drama presented Chernobyl as a story of lies and cover ups, as much as a human tragedy.

“To be a scientist is to be naïve. We are so focused on our search for truth, we fail to consider how few actually want us to find it. But it is always there, whether we see it or not, whether we choose to or not. The truth doesn’t care about our needs or wants, it doesn’t care about our governments, our ideologies, our religions.

“

The failings at Chernobyl amount more to human fallibility than to technological failings

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It will lie in wait for all time. This, at last, is the gift of Chernobyl.

“That I once would fear the cost of truth, now I only ask: What is the cost of lies?”

These words were narrated over the final scene of the series by Jared Harris, the British actor who played Valery Legasov, the chief Soviet scientist responsible for investigating the disaster.

The cold passage of time has enabled us to realise the failings at Chernobyl amount more to human fallibility than to technological failings. Our visceral and immediate response to the technology’s power has costs that run deep. First, there are the misperceptions of risks associated

with both the likelihood of accidents and the deadliness of them when they do happen (certainly when accurately compared against fossil-fuel alternatives to nuclear). Second, there is the opportunity cost in research and development that has occurred as a result of this mis-framing. Third may well be the opportunity cost of carbon-emission reduction as a result of its underuse.

None of this is to belittle the risks. Nuclear power is undoubtedly a hot-button issue at a geopolitical level. However, the escalating climate crisis makes it all the more pressing to have an informed conversation about the place of nuclear in the transition to clean energy ●

- 1 'Police countermeasures and damage situation associated with 2011 Tohoku district – off the Pacific Ocean earthquake', National Police Agency of Japan, 10 December 2019.
- 2 'Police countermeasures and damage situation associated with 2011 Tohoku district – off the Pacific Ocean earthquake', National Police Agency of Japan, 10 December 2019.
- 3 'Summary for policymakers of IPCC Special Report on Global Warming of 1.5°C approved by governments', IPCC website, 8 October 2018.
- 4 'Global emissions', Center for Climate and Energy Solutions.
- 5 'Global energy perspective: reference case', McKinsey & Company, January 2019.
- 6 'Electricity production from oil, gas and coal sources (% of total)', The World Bank.
- 7 'Net zero – technical report', Committee on Climate Change, May 2019, p.40.
- 8 Carolyn Kormann, 'Is nuclear power worth the risk?', The New Yorker, 22 December 2019.
- 9 'The annual reports', World Nuclear Industry Status Report.
- 10 P Slovic, B Fischhoff and Sarah Lichtenstein, 'Perceived risk: psychological factors and social implications', Royal Society of London, April 1981 Vol 376, issue 1764, p 17-34.
- 11 'Comparing nuclear accident risks with those from other energy', OECD, 10 September 2010.
- 12 'Air pollution to cause 6-9 million premature deaths and cost 1% GDP by 2060', OECD.
- 13 'Air pollution in China is killing 4,000 people every day, a new study finds', The Guardian, 15 August 2015.
- 14 'Three Mile Island Accident', World Nuclear Association, January 2012.
- 15 'Annual Energy Outlook 2019 with projections to 2050', U.S. Energy Information Administration, 24 January 2019.
- 16 'Nuclear power in Japan', World Nuclear Association, August 2019.
- 17 Justin McCurry, 'Japan should scrap nuclear reactors after Fukushima, says new environment minister', The Guardian, 12 September 2019.
- 18 Philip Bethge, 'Can nuclear power offer a way out of the climate crisis?', Der Spiegel, 7 January 2020.
- 19 Stephen Jarvis, Olivier Deschenes and Akshaya Jha, 'The private and external costs of Germany's nuclear phase-out', NBER Working Paper No. 26598, December 2019.
- 20 'Germans fall out of love with wind power', Financial Times, 17 November 2019.
- 21 'The nuclear debate', World Nuclear Association, April 2018.
- 22 Joshua S. Goldstein, Staffan A. Qvist and Steven Pinker, 'Nuclear power can save the world', The New York Times, 6 April 2019.
- 23 'Analysis: FY2020 Spending Bill points to nuclear resurgence', Office of Nuclear Energy, 23 December 2019.
- 24 Amy Harder, 'Bill Gates faces “daunting” nuclear energy future', Axios, 15 July 2019.
- 25 'Could hydrogen help save nuclear?', Office of Nuclear Energy, 26 November 2018.
- 26 EDF investor presentation

HOW CAPITALISM CAN HELP SOLVE THE CLIMATE CRISIS

Despite the increasing clamour for a global ‘Green New Deal’, Steve Waygood explains why a complementary International Panel on Climate Finance (IPCF) is also needed to if we are to rise to the challenges ahead.



Steve Waygood
Chief Responsible Investment Officer,
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The IPCF should be a capital market-focussed equivalent to the Intergovernmental Panel on Climate Change

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History may well look back on 2019 as the year the world finally woke up to the threats posed by climate change. Yet, with the negotiation failures that occurred at COP25, the year ended on a significant downer. United Nations climate expert Alden Meyer summed things up when he reported an “almost total disconnect” between the science and what negotiators delivered at the 2019 United Nations Climate Change Conference in Madrid.¹

A key question to ask now is how can the capital markets be corrected so that they amplify rather than undermine the ambition within the Paris Agreement?

Recent years have seen huge progress in the thinking in this area, through work by the UN, World Bank, the Organisation for Economic Co-operation and Development, the European Union, Financial Stability Board (FSB) and the national governments of UK, Canada, Norway, China, Singapore and Malaysia. The UK Treasury’s first ever Green Finance Strategy (GFS) was launched in July 2019.²

Yet while these initiatives are welcome, they will be ineffective unless they are part of a more globally coordinated strategy and response. This is why establishing an International Panel on Climate Finance (IPCF) could play a vital role.

The IPCF should be a capital market-focussed equivalent to the Intergovernmental Panel on Climate Change, which focuses on the science around climate change. It would provide market-based analysis on the impact of climate policy. Observations would be secured from the various market disclosures by companies and investment analysts from different sectors and regions. The report would be issued annually and serve as a market test of policy effectiveness. It would facilitate the oversight of Article 2.1c of the Paris Agreement, which calls for the “consistency of finance flows with a pathway towards low greenhouse gas emissions and climate-resilient development”.

In order to be effective, the IPCF should serve three core functions.

First, it should act as a market thermometer. On an annual basis, the IPCF should “take the temperature” of each member state by assessing the global warming potential embedded in its domestic financial markets.

As such, the body would undertake market-based analysis and determine the degree to which global stock exchanges, financial market participants, and capital flows are in line with or deviating from the goals of the Paris Agreement to “keep temperatures to well below two degrees Celsius above pre-industrial levels”. Observations would need to be secured from the various market disclosures by companies and investment analysts from various sectors and regions including, but not limited to, the FSB Task Force on Climate-related Disclosure reports.

HOW CAPITALISM CAN HELP SOLVE THE CLIMATE CRISIS

continued

In effect, the IPCF annual report should serve as a market test of policy effectiveness and be provided to politicians, negotiators and policymakers at each Conference of Parties (COP), to better inform them about the view of capital market participants on the likelihood of the delivery of the Paris Agreement. This report would also better inform businesses, investors and the public.

The IPCF's second function would entail capacity building for member states. Based on its findings, the IPCF should provide bilateral advice and capacity building for governments in relation to two related areas: best practice in the policy options for reducing the global warming potential of their markets in a way that facilitates a just transition; and the production of the member state's own national capital-raising plans.

Third, the IPCF should work closely with the UN, IMF and World Bank to create a global climate capital-raising plan. This would both inform and be built upon national capital-raising plans. The International Energy Agency (IEA) estimates that we need \$1 trillion each year to move the economy onto a net-zero carbon basis.³ To put this in context, the Marshall Plan to rebuild Europe post World War II cost \$13.3 billion at the time, or \$103.4 billion in today's money. The Apollo programme cost \$25.4 billion at the time, or about \$150 billion in today's terms. In other words, the world needs to mobilise four times the Marshall Plan plus the Apollo programme. Each year.

While this is a vast amount of money, the stock of capital in the capital markets is over \$300 trillion. There is no shortage of capital to fund the climate transition. What is lacking is a clear plan and the financial incentives to deliver. The capital-raising plans coordinated by the IPCF would include a view on the infrastructure required, capital involved, and the financing that could be raised via infrastructure investment, project finance, corporate debt, foreign direct investment, equity investment as well as sovereign and multilateral development bank debt.

Every part of society needs to take strong and urgent action in the face of climate change. And while capitalism is viewed by many as the main reason for the crisis we are in, to help solve the massive and complex task ahead we will need to harness the innovation and creativity that a market-based system incentivises. A Green New Deal, complemented by the IPCF, is desperately needed to bring cohesion to the currently confused global climate strategy.

Please get in touch if you want to be part of this initiative ●

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1 “Total disconnect”: Voices from marathon Madrid climate summit, Reuters, 15 December 2019.

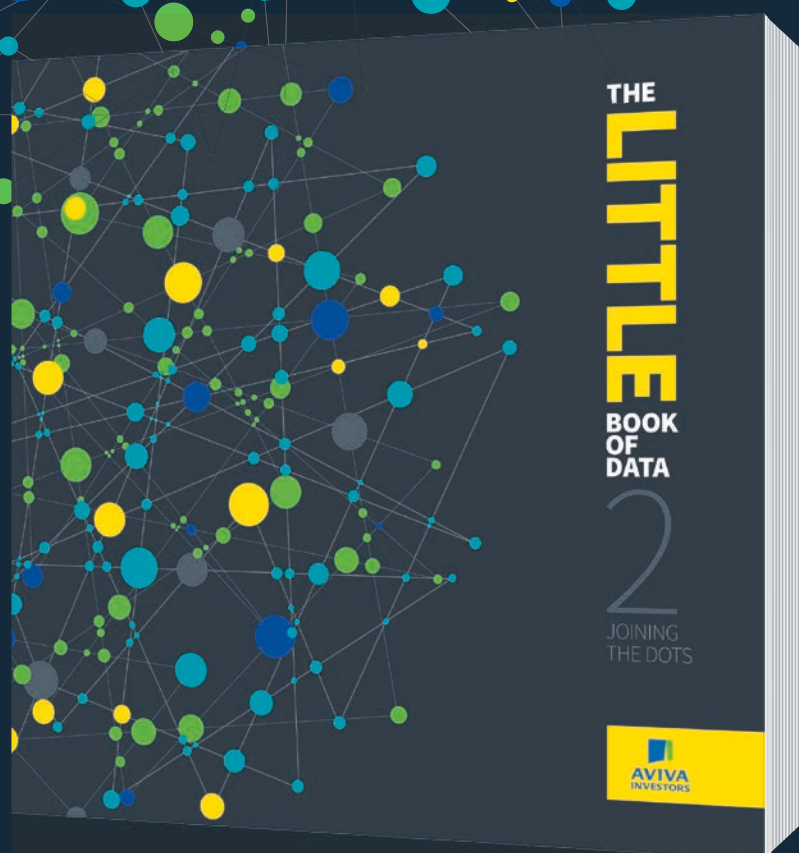
2 ‘Green finance strategy,’ HM Treasury and Department for Business, Energy & Industrial Strategy, 2 July 2019.

3 ‘World needs \$48 trillion in investment to meet its energy needs to 2035,’ IEA, 3 June 2014.

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1.7 Earths.

We are living well beyond our
resources. Ecosystems are being destroyed.

Biodiversity is collapsing. Wildfires raging. Glaciers melting.

Sea levels rising. Carbon dioxide and greenhouse gases stored
in our Earth's core for millennia are flowing out at a rate of knots:
a key threshold – 415 parts per million – has been breached for the first
time in human history. Natural equilibria are being irreparably distorted:
tipping points, butterfly effects and feedback loops loom, with unpredictable
and non-linear effects. Extreme weather threatens to displace communities
and stoke social unrest. We *were* warned. Four decades ago, Nasa's James
Hansen spoke of these dangers – and the scientific evidence of human-driven
climate change dates back even further. Now we are belatedly starting to
recognise the scale of the problem. But global markets and institutions are
proving inadequate to the task, and are in desperate need of fixing. The
rallying cry from the generation most exposed to our failings cannot
fall on deaf ears. We are losing a zero-sum game with the highest
of stakes. It's a Greek tragedy of the commons: one where
free-riding bystanders leave their heads buried. As the
clock keeps ticking, life remains circular: after all,
what goes around WILL come
around.

For today's investor

