



CLIMATE CHANGE: THE INTERVIEWS



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The Experts

The world is finally waking up to the reality of climate change. As bushfires sweep Australia and floodwaters sluice through the streets of Venice, the risks are becoming impossible to ignore.

Such is the scale of the crisis, no single group will be able to tackle it alone. Policymakers, company executives, investors, educators and activists will all need to work together to develop effective solutions. That's why, for this special supplement, *AlQ* has canvassed opinion from world-leading experts in a range of fields.

From the threats to the insurance industry to the pros and cons of nuclear power, from the difficulties in gathering climate data to the psychological barriers to low-carbon living, these interviews provide insights into the implications of climate change for individuals, businesses and wider society.

The views collected here are informative, surprising and – on occasion – contentious. That's as it should be.

We hope you enjoy the read.

Rob Davies, Head of PR and Thought Leadership, Aviva Investors

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AIQ MAURICE TULLOCH



THE INSURER MAURICE TULLOCH

Aviva CEO

The Aviva CEO talks about the difficulties involved in modelling climate risk, the future for public-private partnerships and how communities can protect themselves from extreme weather.

Climate-related disasters are proliferating across the world. When did you start to appreciate the scale of the climate crisis?

The event that really startled me was the wildfire in Fort McMurray, Canada, which began in May 2016. If you've been to that part of the world, you will know there is often snow on the ground at that time of year. But in May 2016, the temperature exceeded 30 degrees Celsius on some days and the ground was tinder dry. You could go back 1,000 years and it would never have been so warm in the spring, that far north. The fire destroyed more than 3,000 homes and buildings and displaced more than 85,000 people; it brought home the scale of the threat.

Why is climate risk so difficult to model?

Part of the reason is the proliferation of ferocious micro-climate systems that are difficult to predict. Take the flooding in Hull in 2013, which coincided with low atmospheric pressure and a high tide that brought water back onshore; within two hours the city was inundated. If that had happened 200 miles further south, the Thames Barrier might have failed.

Over the longer term, climate change has major implications. You have the risk of pandemics, as diseases common in the tropics could spread further north, where people lack resistance to them. Warming oceans will kill off species of cold-water fish that many regions depend on for their food supply, so food security becomes a risk.

According to some scientists, climate change may even increase the frequency of earthquakes, although there is fierce debate on that. If scientists prove there is a link, imagine if an earthquake snapped the natural-gas pipelines that run underneath a major city. How long would it take to put the fires out? The damage such a disaster would cause is almost unimaginable. Modelling all these different scenarios is extremely tough.

How would the insurance industry cope with a climate-related disaster in a major city?

Solvency II, the European Union's regulatory framework, stipulates insurers must hold enough capital to withstand the losses that would occur from the kind of catastrophe that hits once in every 200 years. But some climate-related disasters could be far more costly than that, especially if they hit densely populated urban areas.

A climate-related incident that wipes out the power grid in a major city could take you up to policy limits. While the industry may not go bankrupt in that event, you could see a lot of failures. And on top of that, you have contagion risk, because the industry uses insolvency funds to take care of businesses that collapse, and those could fail as well.

What are the implications of climate change for insurance coverage?

There is an arms race going on in the industry to use data analytics to more-efficiently target various risks and provide cover. The problem is that every insurance company, big or small, has the same ten per cent or so of severe risks that are problematic to insure. Those include climate-related risks. If insurance cannot cover these climate risks, there could be big knock-on effects for the economy as a whole.

Think about it: Across the world, not a spade goes in the ground unless a company has construction insurance. No-one gets a mortgage unless they have mortgage

protection. Everything grinds to a halt if the capital owner lacks insurance against the unforeseeable.

Even where cover is available, it will become more expensive, potentially pricing some people out. In a riskier world, those with more resources will be able to self-insure up to a certain level – provided the market wants to take it – but those without resources won't. There is already a huge protection gap in the African continent, where there is a massive need for micro insurance. My fear is that the climate crisis is creating huge pockets of uninsurability. A day of reckoning is coming..

Will governments have to step in to share the risk and close the protection gap?

Public-private partnerships may become the new norm. Flood Re, founded in 2016 as a partnership between the UK government and several insurers, including Aviva, is the best example. The scheme was precipitated by flooding events across Britain in the late 2000s and early 2010s. It was estimated that up to 350,000 homes would either find it difficult or even fail to get insurance in the future, so the government worked with insurers to enhance coverage.

What would a climate change-resilient city and community look like?

It's all about the readiness of a community to react to a climate-linked event. Start with homes. If your ground floor is at risk of flooding, putting in ceramic flooring and ensuring the electrics are located mid-wall, rather than in the base boards, are important provisions. In many parts of the world, houses are usually built to withstand 70-80 mile-perhour winds; there's nothing to stop homes being built to withstand 150-170mph winds.

The same principle applies to infrastructure. Take road systems. Using slag rather than gravel as the base material can improve resilience to flooding. The costs are incrementally higher during construction, but it costs twice as much if you have to fix these problems later.

Unfortunately, capital markets are still focused on the next quarter, and that short-term mindset makes it difficult to think about investing for the future. Maybe a world of lower-for-longer interest rates will be beneficial, as people will need to be a little more patient and more willing to pay for infrastructure-type investments that deliver a more sustainable cash-flow stream over the longer term. My fear is that the climate crisis is creating huge pockets of uninsurability

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After the disappointing outcome of the UN Conference on Climate Change in December 2019, do you have any conviction we will see a "top-down" solution for the climate crisis?

I have this feeling, given the negativity coming from some of the biggest carbon-emitting countries, we will struggle to get the kind of compromise we need.

On the flip side, however, the real positive is that people are demanding action, even if their governments are sceptical. Movement is happening at the local level. In the US, for example, it is now common for people to pay a little more upfront for their house to make it self sufficient. Many homes now use wind, solar energy or the trickle of a nearby stream to generate power, and then give it back to the grid when they don't need it. That's the future.

What is more effective in encouraging individuals and companies to reduce emissions – the carrot (in the way of incentives) or the stick (with penalties for the worst offenders)?

The carrot always wins. People have to be motivated and believe passionately in what they are doing. The world has used a lot of sticks. What we are seeing from young people involved in climate action today is more about positive motivation and a belief in what's right •



THE ECONOMIST



Professor of economic policy at the University of Oxford

Professor Dieter Helm has written extensively on climate change, most recently in *Green and Prosperous Land: A Blueprint for Rescuing the British Countryside* (2019), and assisted the European Commission in preparing its Energy Roadmap 2050 initiative. Here, he discusses the links between energy, infrastructure, regulation and the environment.

What are the key impediments to the sustainable energy transition?

They are numerous. The transition requires a laser focus upon the causes of climate change, principally consumption; the focus should be on carbon consumption as a starting point, rather than on territorial emissions.

Secondly, and within that framework, the countries most responsible for emissions need to make reductions. That means China, the US and India. And then it's about finding mechanisms to bring about the technological changes required – in particular, market mechanisms like a carbon tax, especially at the border.

How might a carbon border tax work?

It need not be fantastically complicated. If you take steel, cement, aluminium, fertiliser, petrochemicals; these products account for a huge proportion of the carbon footprint of total trade. A carbon border tax is a vastly superior bottom-up way of addressing a country's true carbon footprint compared to the top-down approach behind the Paris Agreement, which has so far failed to limit the growth of carbon emissions and consumption. "Top down" clearly hasn't worked.

A carbon adjustment is economically efficient, and the only way to properly address countries' carbon footprint, because it doesn't matter where you buy the steel from, whether it's British steel or Chinese steel. A carbon border tax has the potential to encourage genuine economic cooperation through the spreading of carbon prices globally.

Is a carbon border tax the most effective way of tackling "carbon leakage"?

There is no other way. If you wish to pursue territorial carbon-reduction targets for carbon production, you may well increase leakage and increase global warming.

The UK's Committee on Climate Change states, erroneously, that when we get to net-zero emissions [the government target for 2050] we will no longer be contributing to climate change. That's utterly wrong, unless every country in the world is at net zero in 2050. We will continue to buy petrochemicals from abroad, steel from abroad and cars from abroad. Given we have less coal in our energy mix than most of the countries from which we import these products, the risks of climate change will go up, not down, as a result of pursuing net zero domestically without a border adjustment.

If you want to tackle carbon leakage, border taxes are the only way. 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.

The EU is looking at a carbon border tax. What are the chances the US would consider one?

Actually, I think quite high. First, let's move away from the hype about how America is President Trump and somehow America is the evil player in this game. We're in a world of "China first", "Russia first", "America first" and so on. Nationalism is not the preserve of the US. No American president – Clinton, Bush, Obama or Trump – has been willing to sign up to an international agreement on climate change. I don't want to defend any country's approach on climate change, but I would like to correct the public rhetoric that if only we could get rid of Trump somehow the US is going to pursue a different policy.

Now let's consider the point about cutting emissions from both a US and European perspective: What is the point in cutting emissions if you are going to import stuff from China and other countries that are increasing their pollution fastest? If you really want to find a way Americans could start to commit to international climate change goals – and in a way that will get the necessary votes in Congress – levelling the playing field with a carbon border tax between the US and China has deep political appeal.

So why doesn't the US have a carbon border tax yet?

If you ask a slightly different question, "Is reshoring happening?", then the answer is yes, on a significant scale. One of the reasons reshoring is taking place is the price of energy is much lower than it was. And that's because of shale gas, which I'm not defending or supporting. But reshoring from China is happening in a stepwise fashion. Car production is coming back, so are petrochemicals, aluminium and fertilisers, among other industries.

Is all this happening fast enough? Absolutely not. Is Trump's trade policy, which has nothing to do with climate change, encouraging reshoring to the US? Yes. But the real reason reshoring is happening is because of the digitalisation of almost all economic activities. In a robotic world you don't need any labour, and therefore you will want to locate your production closer to consumers, rather than cheap labour markets in southeast Asia or China.

Fundamental shifts are taking place. World trade is currently declining, and reshoring is happening. The net carbon effect of this is beneficial, relative to the other way around.

What is your view on EU farming subsidies in relation to climate change?

In *Green and Prosperous Land*, I suggest public money should be spent to provide public goods, not private goods. Therefore, I'm very critical of

The climate change story is much worse than people are currently projecting

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Common Agricultural Policy (CAP) funding, as most of the money pays farmers to own land, rather than to produce things for the public benefit. I'd like to see farming subsidies spent on providing public goods, which often have to do with soil, biodiversity and water. So that's the first thing.

In respect to land use, the way to think about climate change is not purely in terms of emissions, but also in terms of sequestration. Our natural environment, indeed our planet, has been sequestrating carbon for millennia. All the fossil fuels are sequestrated carbon. 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. Taking that into account, the climate change story is much worse than people are currently projecting.

Do you see roles for individuals and companies in improving the situation?

Absolutely. The climate initiative starts with you. When you get up in the morning, you can make choices about what your carbon consumption is. And there are plenty of companies that want to be net zero. Well, they should really think through what net zero is: What is their carbon footprint – not just what comes out of the factory chimney, but out of their entire supply chain? The challenge for companies that want to move beyond greenwashing, to genuinely make sure that they're not causing any more climate change, is really demanding. But that is where people are going to shine the torch ●



THE NUCLEAR ADVOCATE

MICHAEL SHELLENBERGER

Author and activist on environmental policy

With governments under mounting pressure to decarbonise their electricity networks, US author and activist Michael Shellenberger argues nuclear energy has a vital role to play.

You advocate greater use of nuclear energy in addressing the climate crisis. Why?

To move to 100 per cent renewables would mean returning to an agrarian society. That would be devastating for the natural environment, because of the land-use impact alone. What nuclear does is provide a way to have a high-energy society that produces close to zero carbon.

Even if you're not apocalyptic about the risks of climate change, you want to keep your emissions low to prevent temperatures rising too high. Even most climate sceptics would say a four-degree rise in global temperatures from pre-industrial levels is significant. The two most important tools to solve that problem are natural gas and nuclear, because they replace coal.

Eventually, I think nuclear will be able to produce hydrogen gas that can be pumped through the existing natural-gas infrastructure for use in cooking, heating and transportation. There are engineering problems that must be solved, but the basic physics of it are possible. You could potentially power up hydrogen fuel-cell cars at home. Nuclear could even be used to desalinate water or recycle waste water.

Why did you become a pro-nuclear activist?

The Nuclear Pride Coalition [an alliance of independent and non-profit pro-nuclear organisations] has done 33 "Stand up for Nuclear" events. It's extremely important that people who care about the environment, who care about technological progress, understand nuclear is the best of all the energy technologies. Nuclear has been deeply misunderstood and defamed. It's still early days, but we're starting to see politicians and the media showing up at our meetings, and that's what it takes to build a coalition of supporters.

There are supposed to be lots of issues around nuclear. But in reality, it's just about getting public support and arguing the case that we need it.

Do policymakers need to do a better job at communicating to people that nuclear is a safe way of generating power?

Generally, what we find is that support for nuclear fundamentally turns on whether you think it is needed. If you go to comparatively poor countries like India and China and ask people, "Should we have nuclear energy?", they are enthusiastic supporters because they see it as a way of providing abundant amounts of cheap energy.

If it is so safe, why are so many countries scaling back their nuclear ambitions?

Countries such as Germany, South Korea and Japan are mostly doing so out of fear. Yet our biggest fears turned out to be totally wrong. It's a Cinderella story. I think nuclear is the most beautiful source of energy, because it has such a small environmental footprint, even if some people don't see it.

The irony is that many of the people who are concerned about climate change often hate nuclear, because they are apocalyptic about nuclear in the same way they are apocalyptic about climate change. If you are saying that climate change will bring about the end of the world, then even a Chernobyl-scale meltdown pales in comparison to that risk.

But I see attitudes changing at both ends of the spectrum. Within the US Republican Party, there seem to be fewer and fewer climate deniers. I think the party

knows climate denial is a problem in terms of winning in places like Pennsylvania and Ohio. These are important swing states with millennial suburban voters who care about climate change.

What about other concerns, such as cost and how to safely dispose of the waste?

To me, waste isn't an issue; I think that problem is solved. The waste is kept on-site now; there's no reason to move it. As for the cost, the answer is to build nuclear reactors on existing sites, as it's far easier to get planning approval and NIMBYism can be a problem in building in new areas.

This is partly why I'm so fanatical about defending the nuclear plants we have. If you look at the US, UK, France and elsewhere in Europe, we already have enough places where nuclear could easily produce double or triple the amount of energy it presently does, without the development of any new sites. A lot of these plants have plenty of room for more reactors. One of its strengths is that nuclear is so energy dense. What is a two-gigawatt plant right now could be five, ten, 15 gigawatts in the future.

But the plants we have already are fine; they will get better, but you can say that about every technology. Nuclear represents a significant improvement over natural gas in the same way natural gas is a significant improvement over coal.

What can the nuclear industry do better?

We need to stop trying to change the design of reactors. When new reactors are developed, only a few of each design are built. It's crazy. We know the only thing that works to make nuclear cheaper is to build the same reactor over and over again, using the same construction managers so they don't have to re-learn everything – like the Koreans did, like the French have sometimes done and like the Russians are doing.

What risks, if any, do you see in poorer, politically unstable countries using the technology?

There's a weapons proliferation issue, which is related to the collapse of the global system. The US and the Soviet Union prevented the bomb from spreading by promising a nuclear shield to protect their allies. But that system is now in serious question. If the European Union falls apart, if NATO falls apart, what happens to the nuclear shields? If I were a vulnerable Nuclear is the most beautiful source of energy, because it has such a small environmental footprint

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country right now, I would definitely want to have a nuclear option, both for energy and for weapons.

But the countries I see doing nuclear in a big way, the ones that really matter for climate change, are China and India. They already have the technology. Rwanda is in discussions with the Russians about getting a nuclear plant, but the big issue there would be finding Rwandans who could run it. It's more likely it would have to be run, at least initially, by Russians.

At a moral level, I think poorer countries should be able to use whatever forms of power they want. I found out the Democratic Republic of Congo, which has a per-capita annual income of \$561, has a climate plan. When I learned this, I felt offended on behalf of Congo. At a moral level these countries should not have any climate commitments; they should use as many fossil fuels as they need for their development. The moral obligation to use nuclear and natural gas should fall especially on rich countries •

AIQ GEOFFREY BEATTIE



THE PSYCHOLOGIST GEOFFREY BEATTIE

Professor of psychology at Edge Hill University

Professor Geoffrey Beattie is an academic psychologist, writer and broadcaster. He coauthored *The Psychology of Climate Change* (2019) with Laura McGuire. Here, he discusses the psychological barriers to climate action and how they might be overcome.

What are the psychological factors that influence the way people think about climate change?

The problem with human beings is we have this desperate desire and mechanism to stay optimistic about our future. When we are confronted with existential messages, we find a variety of means of dealing with them. One is to ignore them. When you ask people to read climate change messages and you measure their level of dispositional optimism, those who are more optimistic tend to read the messages more quickly and also focus on parts of the message that attack the science of climate change. There's an unconscious intentional bias towards focusing on the good news.

Another psychological mechanism is that, while people may think climate change is happening, they think it is not going to happen to them. Some messaging campaigns have actually reinforced that. If people are sitting around reading stories about their children and grandchildren being affected, that emphasises this notion of temporal displacement. Images of polar bears on small icebergs don't help either; they suggest it's going to happen somewhere else.

Our bias towards staying optimistic affects memory, it affects processing of messages. And it seems like the people designing the campaigns around climate change are not considering these cognitive biases and building them into messaging campaigns. There is an inordinate emphasis on the future; it needs to be much more about the here and now.

Given this innate optimism, does there need to be a balance between emphasising the urgency of the problem and scaring people into paralysis?

Telling people their house is on fire isn't necessarily great, because people find ways of dealing with it and, as I say, some will just ignore it. Or, they manage to deny it could possibly happen to them, and that in some sense helps them to get through their everyday lives.

The climate change discourse at the moment is really about doom and gloom. Greta 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.

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. If you can show people how the behaviours they engage in impact the environment, and encourage them to change those behaviours, then that could make an enormous difference.

Climate change denial is less prevalent than it was, but it hasn't disappeared. What are the psychological factors at work in climate denial?

You can give the same message to different people and they're going to interpret it differently. Take the recommendations from scientists and the Intergovernmental Panel on Climate Change. Not everyone understands terms like "extremely likely" or what the concept of scientific probability actually means; it's not like death and taxes, science never gives you 100 per cent certainty. Then there are the "merchants of doubt". Certain scientific facts have been manipulated by big companies with vested interests.

Part of it involves a complete misunderstanding of what climate is, and the relationship between climate and weather. Every time it gets really cold, people say, "Oh, I don't really believe in global warming". These conceptual terms don't help. "Global warming" implies it's getting warmer and warmer, and not that there is going to be more extreme weather; I sometimes like using the term "climate chaos", because it better captures the fact there is going to be more unpredictability.

How can individual consumers be persuaded to make climate-friendly choices?

Part of the problem is that we've had decades upon decades of connecting emotionally positive things with a high-carbon lifestyle. You don't get rid of that in an instant just because people recognise climate change is important. In all the research we do, everyone says they care deeply about the environment and their carbon footprint – and yet they remain emotionally invested in the high-carbon lifestyle. There seems to be a discrepancy.

I've worked with a few companies on this, including Unilever and Tesco. When Tesco introduced its carbon label scheme [in 2007], it was convinced it would work because people were telling the company they cared deeply about the environment. But it turned out people were not interested in the carbon label. That scheme was perhaps premature, but companies and governments need to really look at how to change people's behaviours in a deep and meaningful way, by studying attitudes towards the environment and considering how to sell green lifestyles in a different way. You need the right information, the right primers and pointers, but you also need the right implicit attitudes as well, something that says; "Here's a different way of thinking about things."

Are there any examples of messaging campaigns that have successfully changed the way people think about an issue?

Anti-smoking campaigns were ludicrously effective. The pioneers of smoking campaigns were happy to talk about the underlying psychological motivations of smokers and tried to analyse what they were. **66** The climate change discourse at the moment is really about doom and gloom

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They recognised early on that what people said about smoking didn't necessarily match with what they did. If you ask people why they smoke, they probably don't know. All the campaigns were about influencing these underlying motivations.

But smoking is relatively easier, because you know what you have to do: you have to stop smoking. With climate change, people aren't quite sure what to do and what the impact of individual action might be. What do you do? Just leave your car in the garage and walk to work? This could be difficult. There is no basis for cooperative action, and as these are big issues to do with society and culture, you have to trust others to cooperate. Concerted action requires someone to take the lead, with no guarantee that others will do the same. We need informational campaigns about what's possible to achieve and which provide a positive aspect to the whole issue as well as an idea of how, together, we can solve this.

What would be your advice to individuals who are struggling to make greener choices?

What we need to do as individuals, in terms of our behaviour as consumers, is to slow down our decision making. We have to be consciously aware and work out how we can influence the future through our patterns of action. And if we have to interrupt our ready-made implicit attitudes, then so be it. We need to be more reflective in our everyday actions



THE SCIENTIST

FRIEDERIKE OTTO

Acting director of the Environmental Change Institute and associate professor in the Global Climate Science Programme, University of Oxford

Dr Friederike Otto's work – which considers whether human activities are increasing the likelihood of extreme-weather events – has wide-ranging implications, from environmental-damage claims to postdisaster reconstruction.

How has the science of climate attribution changed since you began working in the field?

It's changed from something people had suggested was theoretically possible to something that is now being done at scale. This is mainly down to the change in computing power; you can run large ensemble simulations of climate models to look at weather, not just once or twice but several hundred times.

To get something sensible out of climate models, we also needed to develop methodologies to establish the relationships between an attributable weather event, the damages and the event people experience. We have developed a protocol where we use different models and methodologies, based on climate and statistical modelling. These can be combined with observational data and synthesised for an assessment of what the role of man-induced climate change is in an event people have just experienced.

Is climate attribution possible for all extreme weather events?

No. It is possible for assessments for heatwaves, large-scale rainfall events, flood events and droughts. We are beginning to develop methodologies for windstorms, but that's quite difficult at this stage. We cannot carry them out for hail, or things occurring on small spatial scales: we just don't have climate models that can reliably simulate these events.

In the developed world, particularly Europe and the US, the network of weather stations and observed data is quite dense, and the quality of the observations is high almost everywhere. There are weather observations for about the last 100 years. That is not the case in other parts of the world. Without observational data, you cannot evaluate whether the climate model is up to the job, because you don't know what the model should be showing. This makes confidence in attribution assessments in developing countries much lower than in Europe and the US.

Can you give examples where you are certain human activities have contributed to more extreme weather?

One of the strongest examples is in the occurrence of European summer heatwaves. We have conducted a few studies in different parts of Europe, using different methodologies. In many places, climate change is making the heatwaves we have experienced recently orders of magnitude more likely.¹ Climate change is a real game changer.

We have also seen the impact in the rainfall brought by hurricanes in the Gulf of Mexico. We have seen between a doubling and three-fold increase in the likelihood of extreme-rainfall events. We have looked at the droughts in Southern Africa and found climate change played a large role in changing the likelihood of these events.² In other droughts in Brazil or East Africa, our analysis suggests climate change did not play a major role.

One possible extension of this work is in calculating damages. Is there much interest from clients?

Using the word "clients" implies the users will pay. We do not have clients in that sense. We work a lot for the Red Cross; many of the studies were initiated because the Red Cross contacted us and said: "We have huge damages from a storm or a drought or a heatwave. The question is whether to relocate or re-build." That hinges on whether it was a freak event or the harbinger of more to come in a changing climate.

We have had conversations with commercial companies. But because we do research, our models and our results are publicly available. This is important: when we do studies quickly, we do them without peer review. We need to be super transparent, so everyone can redo what we do to ensure scientific integrity. Commercial clients don't really like that aspect, which has made working directly on projects with – say – the insurance industry difficult, because it wants to keep that information closed.

You have been producing curves exploring "non-linear" relationships between a climate event and potential damages. Can you explain this work?

What we can do with these attribution methodologies is not just stop at the meteorology, but go down the subsequent pathways as well. For flooding, we have looked at the rainfall, river discharge and the inundation that followed, and found the relationships are not linear. In principle, you could carry out these studies for all sorts of damages.

We have also looked at the other end of the spectrum – mostly we look at the overall effect of man-made climate change, including all the greenhouse-gas and aerosol emissions from the beginning of the Industrial Revolution. But we have done analyses at a country and regional level. For example, how much did the actions of the US or Europe change the likelihood of a specific extreme event? And we have even looked at a company level. How much might one company be responsible for?

Of course, there are a lot of political, social and legal questions that influence the outcome. When we did the country study, you could use all the emissions since the beginning of the Industrial Revolution. Or you might 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 Intergovernmental Panel on Climate Change 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 is the one you might want to use in court, or for any other purpose?

Without observational data, you cannot evaluate whether the climate model is up to the job

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These are sensitive areas, geopolitically and commercially. Are people actively working on them?

Yes. I've just been in Dundee at a conference of lawyers who all have live climate-litigation cases. I wouldn't say it's massive yet, but it is growing rapidly.

What are the limiting factors, from your perspective?

Now that we have the scientific methodology, we need to work with people in adaptation planning – that's where there is a huge gap in knowledge transfer. We will need to work with lawyers too. How will we transfer this into legal language, so it's most useful? How do we do the translation backwards and forwards between real intervention points in the real world? We need funding and manpower to work on these interdisciplinary questions.

You have been working collaboratively to deliver event attribution in almost real time. You need to work fast – how do you do it?

Every time we do a rapid study, we ask colleagues around the world: "Do you want to join in? It would be fantastic if you would provide your data." They also know society is asking pressing questions on climate change and it is important to answer them. We drop everything else for a short time, don't sleep much – and just do it •

^{1 &#}x27;European heatwave made up to 100 times more likely due to climate change,' University of Oxford, 2 August 2019.

^{2 &#}x27;Anthropogenic influence on the drivers of the Western Cape drought 2015–2017,' Friederike E L Otto et al. Environ. Res. Lett. 13.

AIQ FIONA REYNOLDS



THE RESPONSIBLE INVESTMENT EXPERT FIONA REYNOLDS

CEO, Principles for Responsible Investment

As CEO of the United Nations-backed PRI, Fiona Reynolds heads the world's leading proponent of responsible investment. She discusses how capital markets can contribute to the green-energy transition; the relative responsibilities of developed and emerging economies; and the PRI's priorities for 2020 and beyond.

What are the main impediments to the transition towards sustainable energy, particularly in emerging markets?

In 2016, we set a goal of holding global average temperatures well below two degrees Celsius and pledged to make concerted efforts to limit the increase to 1.5 degrees. Yet, more than three-and-a-half years on from the signing of the Paris Agreement, a clear gap has emerged between the ambitions we set and the practical actions required to secure the results we so greatly need. This ambitions gap is 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 the UN Environment Programme's (UNEP) annual Emissions Gap Report. In emerging markets in particular (though not exclusively), this gap is exacerbated by other significant challenges: political instability, lack of necessary infrastructure, difficulty in attracting foreign investment and economies dependent on high fossil-fuel sectors, such as coal mining. Furthermore, these countries face the challenge of enabling a just transition – ensuring the interests of workers and communities are fully accounted for in plans to shift to a net-zero economy.

What can individuals, investors, companies and countries do to change the energy mix and reduce emissions in time and at the scale needed?

We need to reduce our emissions by 7.6 per cent annually for the next decade to stand any chance of reaching our 1.5-degree target, according to the UNEP Emissions Gap Report. Achieving this will require critical action at all levels – by individuals, investors, companies and countries. The key is to get all these stakeholders moving together, at pace, towards this common goal.

This process must include setting net-zero targets at a country, investor and company level. We've seen some countries already doing this, including the UK, France, Norway, Sweden and New Zealand, as well as investors in the Net-Zero Asset Owner Alliance and businesses that have committed to the Business Ambition for 1.5C Campaign. But further action is still required.

At the government level, *The Inevitable Policy Response* (*IPR*) forecasts a number of key policies, including rapid reduction in the use of fossil fuels (including bans on coal) and a switch to renewable-energy sources; a transition to electric vehicles from internal combustion engines (including bans); a reduction in deforestation and an increase in afforestation; and a higher carbon price.

What are your views on the relative roles and responsibilities of developed and emerging markets?

Successfully achieving the transition to a low-carbon economy will rely on the efforts of all markets – emerging and developed alike. What's at stake will affect everyone and we'll fail, or succeed, collectively.

However, as the G20 countries alone account for 78 per cent of all emissions, they will undoubtedly need to bear the brunt of the responsibility. They need to legislate for net zero by 2050 and reduce their emissions more quickly. Currently, only two of the G20 – France and the UK – even have net-zero targets, so clearly 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.

How can industry bodies such as the Task Force for Climate-related Financial Disclosures (TCFD) help accelerate the transition?

TCFD has become the principal framework for assessing climate risk and has led to increased harmonisation across the industry. Scenario analysis – TCFD's forward-looking element – has been critical in providing 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.

To encourage investor adoption of TCFD, the PRI has brought in mandatory TCFD-based reporting from 2020 for our signatory base. We continue to need transparent, comparable data throughout the value chain to better manage and reduce emissions. TCFD is contributing to this disclosure, which the PRI strongly supports.

We also see asset owners playing a key role in engaging with managers and companies to ask for better data and more transparency. The Net-Zero Asset Owner Alliance is a great example.

What changes in capital markets are needed to meet the Paris targets?

Reshaping the capital markets in order to meet the Paris targets will require engagement throughout the entire investment chain, from asset owners at the top, to investment managers and the companies in which they invest. We will need to see all actors setting, and working to fulfil, ambitious climate targets, starting by committing to net-zero emissions by 2050. In conjunction, we need the necessary policy measures to come into place to enable capital to flow to finance this transition.

In terms of policy, what are some of the weak spots that need to be fixed urgently? Are there possible "quick wins"?

The IPR shows the pressure for policy action on climate

We need to reduce our emissions by 7.6 per cent annually for the next decade to stand any chance of reaching our 1.5-degree target

will only increase and come from all angles – environmental, social and economic. The longer the policy response is delayed, the more forceful it's likely to be.

Some of the major weak spots we see on the policy side include: financing of coal, a meaningful carbon price, fossil-fuel subsidies and decarbonisation of high-emitting sectors. On the other hand, we see potential for quick wins in emissions standards for vehicles and energy efficiency in homes.

What are your priorities in terms of climate change in 2020, and over the longer term?

The 2020s will be a decade for action and COP26 in the UK will be crucial to this, as countries will submit new NDCs, which need to be far more ambitious. A key priority will be to see more countries with net-zero pledges, and governments, companies and investors stepping up to the plate with increased vigour and ambition to help deliver on them.

Alongside this, we need to see policy action sooner rather than later; the longer this is delayed, the higher the cost will be. In addition, we need to see the asset management community voting in line with asset owners and creating more successful shareholder resolutions.

Finally, we're facing calculated, negative corporate climate lobbying, which is working against our efforts and slowing political, financial and business action on climate change. The effects of this lobbying are currently being played out in the US, where recent Securities and Exchange Commission proposals could see the rollback of shareholders' rights, creating new roadblocks for investors who wish to signpost critical ESG issues with corporate leaders. Further work to counteract big corporate lobbying is therefore a key priority for 2020 and beyond ●



THE ASSET OWNER

ANNE SIMPSON

Director of board governance and strategy, California Public Employees' Retirement System (CalPERS)

Anne Simpson leads the environmental, social and governance (ESG) integration programme at CalPERS, the largest US public pension fund, with total assets of \$401 billion. CalPERS makes investment decisions on behalf of more than two million members, including many of the firefighters who battled the California wildfires in 2019. Here, Simpson discusses the responsibility of companies in fostering sustainable growth.

Why should investors consider the impact of climate change on their portfolios?

We need to move from the "why" to the "how". When you've got Bank of England Governor Mark Carney arguing banking regulators need to look at climate change risks, then financial markets need to start taking the problem seriously. And they need something better than the fabled "piece of string" to measure what is going on.

We're in the middle of constructing our first assetowner report for the Task Force on Climate-related Financial Disclosures (TCFD). CalPERS was an early and prominent supporter of the TCFD, because there needs to be a globally recognised framework for climate-risk reporting.

However, we are all having to improvise, because there isn't a consistent base of reporting around the world. Our view, as a global institutional investor, is that sustainability data needs to be included in mandatory reporting. Doing so would ensure consistency, reliability, and integration with the financials, and allow us to make comparisons between companies and sectors over time. Right now, we just can't do that.

We've articulated the case for mandatory reporting of not only financial capital, but also the human and physical capital at risk from climate change.

How can companies be incentivised to provide more relevant information on their climate change exposures?

The current situation is entirely unsatisfactory, and we're very pleased certain markets intend to make TCFD reporting mandatory. We have argued climate risks need to be included in the considerations that go into Form 10-K [a document summarising a company's financial performance], which is required by the US Securities and Exchange Commission (SEC).

However, this pressure has not triggered an improvement in reporting. The reason, at least in the US, is the fear of liability. We need some form of safe harbour for reporting. Businesses perceive a first-mover disadvantage: Why would they stand up and say, "Wow, look at all my climate change risks and exposures", when such disclosures are not a requirement for all their competitors? Whether it is the SEC or the International Accounting Standards Board, it really is time for regulators to step up and address this.

How might TCFD reporting evolve, particularly around Scope 3 emissions?

Scope 1 and 2 just make sense. Let's take a company like Shell. Scope 1 concerns the emissions associated with its extracting oil, gas and so forth. Scope 2 is about the energy the company uses when it refines that product. The big emissions, however, come when Shell passes that refined product to its customers; that's Scope 3. It encompasses utilities, transport, transportation, airlines, etc.

Thanks to Climate Action 100+, an investor initiative to which CalPERS is a signatory, Shell has agreed to take responsibility for its Scope 3 emissions. This means it will need to be in dialogue with other sectors of the economy.

How will other sectors of the economy have to adapt?

We need to bring overall demand for fossil fuels down. That will have to happen in a mixture of different ways, from energy-efficiency gains to substitution of fossil fuels for renewables in certain areas. The net-zero concept is important because it involves an acceptance that the carbon emissions associated with certain essential functions need to be offset in some form or another.

Does the focus on greenhouse-gas emissions mean we are overlooking other climaterelated risks, such as water pollution?

What we have 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, because of the heightened risk of wildfires.

We need to bring emissions down. To meet the goals of the Paris Agreement, we need about an 80 per cent cut in emissions. The latest United Nations Environment Programme report estimates we need an eight per cent cut every year for the next decade.

How does all this fit into your investment process?

We've started to reconsider how we think about the physical risks of climate change: what I call "ZIP-code risk". We need to assess the exposure of our assets to the physical changes brought about by climate change, such as sea-level rises, extreme-weather events, drought, you name it. Interestingly, the insurance industry has been way ahead of us in this regard, because it has had to price that ZIP-code risk for the purposes of writing insurance.

We want to encourage companies to start reporting on the resilience of their assets to these risks. For example, we are building a framework with one of our managers to look at meteorological data, and are starting to map the related climate risks to our portfolios. We have quite a simple framework at the moment, but it is progressing.

Are you looking at big data and artificial intelligence to help collect and analyse climate-related information?

No, is the answer at this stage. Al requires many data points that can then be recognised in a pattern that

The clock is ticking. We can't be fiddling while Rome burns

provides indications about the future, often more accurately than we as human beings can manage. That's Al's advantage. However, to apply this to monitor climate information, we would have to work out what the underlying data should be, such as what the observations are to begin with, where you make the observations and the quality of those observations.

One initiative that is very interesting and innovative is Carbon Tracker's collaboration with Google on using satellites to track carbon emissions. If we start to use technology in that way – and I believe Singapore's regulator is doing this as well – it might be possible, for example, to verify or to validate whether certain loans are associated with the destruction of rainforests for the purpose of palm-oil production. That makes perfect use of big data.

However, using AI to track Scope 3 emissions is far more complicated, and there is much room for error if consistent reporting standards are not integrated into financial reports. We're back to the question of "how long is a piece of string?", and we need to make sure the string is at least long enough to cover Scope 3 emissions.

What are the key changes you would like companies to make?

What we're calling for at Climate Action 100+: 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 ●



THE BEHAVIOURAL EXPERT

CASS R. SUNSTEIN

Harvard University professor and founder and director of the Program on Behavioral Economics and Public Policy at Harvard Law School

A legal scholar who served in the Obama administration as a regulatory tsar, Sunstein is best known for his work in behavioural economics; he co-authored, with Richard Thaler, the bestselling book *Nudge*. His research on the psychological and social influences on decision making has informed policy efforts to tackle climate change.

You write about how social conformity leads certain information or behaviours to "cascade" through groups. How does this work?

Most of us have no direct or personal knowledge of a zillion things that are relevant to our survival. For example, I recently travelled to a place I'd never been before, and went swimming in the water, having been assured there were no sharks there. I had no reason to know this was true, I just relied on others who seemed trustworthy.

Many of the things we think are just a product of what's been said by people we think we can believe. And if a lot of people say something, we would have to have a lot of private information to form the basis of the belief that they're wrong. That simple point shows how ten or a thousand or sometimes millions of people can be convinced of something just because they are relying on the beliefs of others, forming a very loud chorus. People add their own voices to this chorus through conforming.

Could you give an example of the cascade effect?

I'll use an example that has a little controversy associated with it: genetically modified (GM) food. The scientific consensus, and there's no reason to think it is wrong, is that GM food poses no health risks (there's also near consensus that the environmental risks are very modest, although there are some people who think there's a really small risk of serious ecological harm). Notwithstanding that, there are a lot of smart and educated people in democratic nations who think they will get sick if they eat food with GM organisms in it. That pervasive belief is the product of a cascade; people are following signals given by relevant others, people they trust, like their neighbours or friends.

Does climate change pose a particular problem here, given that action depends on people trusting in the dry and technical discipline of climate science?

Climate change is the largest "conforming problem" the world faces today, so let's try to unravel it a little bit. The idea human activity makes the planet hotter just isn't intuitive. 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.

There are a few things going on that aggravate the problem. One is the collective action problem. If an individual does something to reduce their greenhousegas emissions, the impact on global warming is very modest, and people get that. To overcome that you'd need a social norm that says: "This just isn't the kind of thing we do, we not going to rely on excessive amounts of energy or use coal for our energy rather than solar or wind."

Add to this the conformity pressures. If you are surrounded by and trust in people who think climate change isn't a big problem, or isn't going to affect you directly, or isn't a high priority over other problems, you will think the same. And that makes for the mother of wicked problems. The way the human mind works, and the way social influences work, make it very hard to combat climate change with the kind of artillery that's needed.

Based on your theory, could a social cascade lead to shifts in behaviour at the scale needed to make a positive difference on climate change?

There can be cascades that lead in directions that turn out to be correct. The idea coal-fired power plants create serious health risks – which is now widespread – is true, but it is also the product of a cascade, in that large numbers of people have come to trust the expert view that particulate matter is a) dangerous and b) comes from coal-fired power plants. On these important public policy issues, a nation's direction will turn on the formation (or not) of a large cascade.

How could this work on climate change?

Not terribly long ago, the depletion of the ozone layer was thought to be a very difficult problem to solve. Many people thought of it in the way that climate sceptics now think about climate change.

But, almost on a dime, that changed. Margaret Thatcher and Ronald Reagan led the charge to phase out ozone-depleting chemicals. The reason they did it is that there was a cascade in which ordinary citizens and policymakers, specialists or not, took signals from one another and concluded it was worth it. What drove it was some combination of activism and technical expertise operating hand-in-glove, in a way that was inspiring. As of now, the ozone-depletion problem is close to being solved, compared with where it looked like it would be in the early 1980s. Something like that could happen on climate change.

Your book Nudge brought attention to the power of behavioural solutions to social and economic problems. Could "nudges" make a difference on climate change?

Absolutely. Automatic enrolment onto green energy tariffs, for example, can create very significant movement when it comes to reliance on green energy sources. We know this from one of the world's leaders on climate, Germany, where a number of energy companies are nudging people to use clean energy by automatically enrolling them in solar and wind. People have the opportunity to opt out and go for coal-powered energy, but the data shows they So much of the carbon emission problem is the product of individual consumers' behaviour

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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.

There are other small things that, if aggregated, can make a big difference. When hotels say they are not going to wash your towels or sheets every day unless you ask them to, that's a nudge. The reduction in greenhouse-gas emissions that come from that sort of thing, now that large numbers of hotels are doing it, are non-trivial. 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 significant progress towards less destruction across the planet will be made.

No single intervention can do what needs to be done. But if you aggregate the number of interventions which are usable, including energy efficiency regulations, capable of massively reducing the amount of energy used by refrigerators, microwave ovens or washer-dryers, and combine them with regulations that can dramatically reduce emissions from automobiles, and restrictions on emissions from coal-fired power plants, then huge progress can be made ●

AIQ ANDREW MEDHURST



THE ACTIVIST

ANDREW MEDHURST

Leader of Extinction Rebellion's UK National Finance Working Group

Andrew Medhurst, a member of Extinction Rebellion (XR), outlines the group's three demands of policymakers and argues the private sector should be doing more to respond to the climate crisis.

What would be your utopia?

I'd like an economic system that does not damage the planet, with everybody else sharing the cost. That's not a market system, right? In a proper system, the pollution caused – the damage made in order to make a profit – should be paid for by whoever causes it, not by everybody else.

What are your three demands of government?

First, we want government to tell the truth. We think that when people understand the emergency we are in, they will be pushing for – and supportive of – some sort of emergency mobilisation.

Our second demand is: Act now. Acting now is about the demand to be net zero by 2025. 2050 [the government's target date for a carbon-neutral energy mix] sounds like something you can put off for another ten years, and

that's not what the scientists or officials at the United Nations are saying.

The final demand is a call for a citizens' assembly in the UK. If we have failed to tackle the climate emergency so far, it's in some sense because democracy has structural problems. A citizens' assembly will be supported by experts, receive representations from other citizens and come up with recommendations.

Politicians have had the power to make these changes, but they have not done anything. We do this because everything else has been tried and failed. The United States devoted one per cent of its national wealth to fighting Hitler in 1939. By 1943, it was devoting 43 per cent. That kind of mobilisation is necessary for economies around the world now.

Has Extinction Rebellion engaged with business?

In April, I was involved in an attempt to get business support for XR. It manifested itself in a letter to *The Times*, written by several business leaders, which said: "Contrary to belief, there is business support for Extinction Rebellion." The discussions continued, which resulted in the launch, in September 2019, of Business Declares a Climate Emergency, an initiative by business people to encourage companies to declare a climate emergency. It tries to complement what XR is trying to do with government.

Which kinds of businesses are doing the right thing, in your view?

Part of being a B-corporation is that you change your articles of association to say profit isn't the only motive, that your ecological footprint and doing good for all stakeholders are important too.

Energy provider Ecotricity is a B-corp, and the company has declared a climate emergency. It has signed up to net-zero targets that are consistent with XR's demands. The thing that really pains me is that when I converted to Ecotricity, it cost me an extra 15 or 20 per cent over the cheapest provider. It should be more expensive to get your energy from a fossil-fuel burning energy company than Ecotricity.

How do you react when asset managers and others in the financial industry say they want to play a role in tackling climate change?

There's talk-the-talk and there's walk-the-walk. I'm very happy to hear positive words of wisdom from the

business and financial communities, it just feels like we need to force everyone to do it. That's why we focus our demands on government.

But don't investors have a role to play?

Compared to citizens, businesses have a bigger voice that governments are more inclined to listen to; that's a way in which business can contribute.

There are signs of progress. The Business Roundtable has just said fiduciary duty to shareholders is outdated. *The Financial Times* has said it is "time for a reset" of free-enterprise capitalism. Robert Eccles, a visiting professor at the Saïd Business School in Oxford, says all companies should publish a statement of purpose. Wouldn't it be great if every time a business made a decision it thought about the welfare of our grandchildren rather than its quarterly earnings?

Faced with engaging with companies or divesting their stakes, where should asset managers draw the line?

Just because you divest, it doesn't mean that company doesn't continue to get financed by others. If everybody divested, that would be interesting. Equally, I know of sustainability investment professionals who are still trying to convince companies like Exxon-Mobil to put something in their annual reports about climate change.

It doesn't feel like they are acting quickly enough. Fossil-fuel companies have to stop being fossil-fuel companies, but whether that's more likely to happen through divestment or engagement, I'm not 100 per cent sure.

Some people argue the highest emitters should bear the burden of dealing with climate change. Shouldn't China be doing more?

I often hear: "There are 7.5 billion people on the planet, it's going to be 10 billion by 2050, so India and China are the problem; go and protest outside their embassies."

The statistic I give to counter that is the top ten per cent of the richest individuals on the planet are responsible for 50 per cent of the world's emissions. If they were to reduce their carbon footprint to the EU average – which is hardly going back to the Stone Age – that is a 30 per cent cut in global emissions within a year. So, suddenly, a 50 per cent cut in global emissions in 12 years starts to look very achievable. Politicians have had the power to make these changes, but they have not done anything

How do you see the role of incentives?

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I think behaviours can be changed quite quickly by using economic incentives. If you're not harming the environment, you should be rewarded for that. At this moment in time, you might sleep better at night, but I'm not sure you're being rewarded.

Is there an area of technology you are particularly enthusiastic about?

XR has suffered by not having a good enough view of what the future looks like, in articulating what that car-free city, that more collaborative, communitybased city, might look like.

I'd like to think I've bought my last car. My next driving experience after that might be sharing a car. Most cars sit in driveways for most of the week, so you can imagine a sharing economy where you no longer have the same footprint of individual consumption. For me, technologies are about: "How do we live lives that are just as fulfilled, but with less?"

If you had one thing on your wish list for 2020, what would it be?

I'd love to see a million people on our mailing list sometime in 2020. The social science says we need 3.5 per cent of the population – two to three million people in the UK – to be active with XR before the government will turn around and accede to our demands.

Are you concerned it is already too late to tackle the crisis?

There are people who say it's already too late, but when you're driving towards a wall, the excuse that it's too difficult to stop in time isn't an excuse for not braking (and hard) – we're actually accelerating! It may be too late, but it doesn't mean we shouldn't try to reduce harm and save as much as we can. We owe that, at least, to our children and grandchildren •



THE FUND MANAGER FRANÇOISE CESPEDES

Portfolio manager at Aviva Investors

The climate crisis will create winners and losers. As portfolio manager Françoise Cespedes explains, companies will have to adjust to changing physical conditions and new consumer expectations in a lowercarbon world.

Is the world moving fast enough to tackle climate change?

I'm not sure. Large, powerful nations such as the US and China, along with some European countries, are becoming more nationalist in orientation. They are not cooperating with the wider world, and that is a problem because we need more global cooperation if change is to happen.

As countries turn inwards and focus on their own priorities – which may or may not include the environment – achieving the objectives of the Paris Agreement is going to be much more difficult. If we don't have top-down support, solutions will arrive later rather than sooner.

Of course, we also need more private initiatives. But the move towards the energy transition may take longer than expected because of the lack of cooperation at a policy level worldwide.

How well are financial markets responding to the climate crisis?

Lots of funds are being launched on climate-change themes. This trend is linked to the fact companies themselves are becoming much more vocal about how climate change will affect their operations, partly due to pressure from consumers.

People are taking a closer look at how they consume. They want products to be more environmentally friendly. Companies are taking account of this and changing their behaviour accordingly – not only regarding the environment, but also in respect of social issues – so that they are not exposed to reputational risk and do not lose business as a result.

How do you evaluate companies' capacity to adapt to climate change when assessing potential investments?

We use data from CDP, a non-profit climate-data provider, to measure companies' ability to deal with climate change. CDP scores companies on the extent to which they are operationally exposed to climate risks.

Companies will have to take action to reduce emissions, offset the effects of climate change by investing elsewhere – in reforestation, for instance – or tackle the physical impact where it threatens their day-to-day operations.

Some companies are focusing on reducing their CO_2 emissions – chemical and cement producers that are currently heavy emitters, for example. These firms face the burden of higher CO_2 prices and will have to cut their emissions to avoid paying too much for CO_2 certificates in future, which would damage their financial prospects.

Other companies face immediate practical challenges due to climate change. Take chemical companies such as BASF and others operating on the Rhine. Recently, the water level of the Rhine became too low for them to deliver products to clients; they could no longer use the river to transport goods. These firms will have to find ways to adapt.

What is your view on the role of nuclear power in the energy transition?

We do not exclude nuclear from our climate transition strategy, because nuclear is one way to reduce CO_2 emissions in the power-generation industry. Nuclear is a clean energy in emissions terms. But there are other risks linked to nuclear waste. One issue is that operating nuclear plants could become unfeasible as global temperatures rise. Plants may no longer be able to use rivers to cool generators due to warming river temperatures, for example. And nuclear also poses risks to river biodiversity. So, climate change may impede our ability to use nuclear power.

In my view, the best solution would be to switch directly from conventional fossil-fuel power generation to renewable energy. Some countries, like China, are attempting to move from fossil fuels to renewables without first switching to gas or nuclear. But intermittent power generation from renewables makes this difficult. Battery technology needs to improve to enable the storage of electricity, so that the intermittency problem can be managed.

Where do you see the greatest investment opportunities?

Currently, the fastest-growing market segments linked to climate change are the ones that bring solutions, either in regard to mitigating climate change or adapting to its effects. These include renewable energy, as well as energy efficiency and sustainable transport. These industries are expected to grow much faster than conventional or old-economy industries such as oil and gas.

Independent power producers (IPPs), which only produce power from renewable energy, constitute an interesting new segment within utilities. This is where we see the bulk of investment in future power production being directed.

Are investors beginning to cluster around the same ideas?

There is significant interest in the smaller IPPs, as more investors recognise the need to improve the share of energy generated from renewables. But while the IPPs are not cheap, we don't believe there is a bubble in valuations. Some of these companies have a huge backlog of projects and they tend to grow very fast, but part of the re-rating of these stocks has been driven by massive inflows coming from the recent development of climate equity strategies. Caution is needed in considering new investments.

Where are the opportunities in energy efficiency and sustainable transport?

Buildings produce high CO_2 emissions and there is great potential to make reductions in this area. Think of companies in the materials sector that make insulation **66** Trains and railway equipment should gain momentum in the next few years

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panels, or others that construct electrical components to make buildings "smart" in terms of lighting and air-conditioning use. These capital-goods segments are expected to grow rapidly, and companies with potential for rapid capital appreciation may emerge over the next few years.

On sustainable transport, rail is attractive. Rail travel is currently supported by regulation and we see more young people travelling by train, rather than plane, wherever feasible. Alstom, which provides rolling stock, says it is also seeing lots of goods that previously moved by plane now being transported by train. We expect to see governments make special infrastructure investments within Europe and elsewhere to improve rail routes to replace some mid-haul flights. All of which means trains and railway equipment should gain momentum in the next few years.

Which companies are focusing on adaptation?

Companies like Boskalis, which provides coastal defence equipment to address rising sea levels, come to mind. Air conditioning is another, as cooling technologies will be needed as global temperatures rise. More air conditioning will of course use more electricity but, by using electricity generated by renewables, we can mitigate the carbon footprint of the whole value chain. These are two of the niches that could see value creation in the next few years

