

# Climate futures: preparing for uncertainty

October 2023

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**Head of Climate Change Caroline Cook discusses the challenges and opportunities posed by different climate change scenarios with two of our partners: Dimitri Zenghelis from the Bennett Institute for Public Policy, University of Cambridge, and the consultancy Independent Economics; and Prof Johan Schot, founder of the Deep Transitions research project.**

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Your capital is at risk. Past performance is not a guide to future returns.

**Caroline Cook (CC):** Good afternoon, everybody, and thanks very much indeed for joining us today to talk scenarios and investment. Specifically, what we're trying to do is construct and use plausible, robust, internally consistent views of the future to help us navigate through the climate and energy transitions.

I'm Caroline Cook. I'm head of climate here at Baillie Gifford, and I'm joined by my colleague Oliver Carr and two esteemed guests who I'll introduce properly in a minute, but thanks and welcome in a bit to Professor Johan Schot and to Dimitri Zenghelis.

Now, I'm keen that we get to their expertise as quickly as possible, but I thought I'd just start with a quick intro to set out the why and the what of our scenarios project. So, bottom line, we think scenario analysis is a good idea, but doing it well is hard. We're going to talk about that. Bad scenarios really can pave the way to false comfort. But doing it well, which is both about the scenarios themselves and the actual engaging and working with the scenarios, can certainly, we think, educate us, it can challenge, it can spark new ideas, and hopefully provide the basis for real decision-making in what is a very messy and uncertain world.

Now, most people on this call will also know that our regulators now think scenario work is a good idea as well, and quite rightly. They want us to think more about the climate and the energy transitions and the associated potential consequences. But I think we're concerned that our sector's pretty immediate lurch to quantitative short-term scenarios has come too early and is proving fundamentally not very insightful and not very helpful.

So we're taking full advantage, I'll admit, of our position as investors in active pretty concentrated portfolios to try and stay in the realm of the qualitative, trying to build story narratives at this stage, not computer models. What we have so far, what Johan and Dimitri are helping us with, isn't an endpoint, but it's certainly educating and challenging us as we go through it. It's supporting new decisions from us, and hopefully I think will also leave us better equipped to explain the setup of portfolios to you, our clients.

Now, what we want to do today is share what we've been up to, talk through some of the narrative scenarios and finish

with hopefully some ideas for action. We're going to spend about 30 minutes in conversation with Johan and Dimitri and then leave a good 10 to 15 minutes for questions that you have.

Before we leap into that though, I just want to set a level playing field. We're going to talk about really three different scenarios today. These are built up from the basic skeletons which are set for us by the regulator and form the foundation of the more complex systemwide narratives that Johan and Dimitri's teams have created for us.

What I'm going to do is just share screen again for a minute so we all get the jargon, and then we'll move on. What you can see here, let's start with this, we've got three scenarios. First, here we have the orderly transition. This is the classic, perhaps idealistic, orderly scenario. And what this describes is full and early acceptance of the science which drives positive policy and very rapid technology uptake. We move apparently seamlessly to net zero by 2050 and manage to avoid significant climate damage.

Then at the other end of the spectrum we have the climate failure of the hothouse world. In this world, everything moves slow and we encounter increasingly severe climate damage, and a lot of capital must therefore be spent on damage recovery and adaptation. If you think about someone aged 23 today perhaps retiring in 2065, they will likely be facing in this world a very much changed global physical geography.

Then last we have the messy middle, the disorderly scenario. There's no smooth glidepath in this scenario but, instead, a dramatic intervention of some kind at some point, and we'll discuss this more today, which comes to drive us back on track. But we still get to net zero emissions around 2050.

So, those are the three skeletons, and around that, how have we built our scenario work? Just over a year ago we sent out a wide call for academic-led partners to develop a set of holistic scenarios for us, ones that included all the physical science and all of society, as well as technologies and policies. The response we got to the call was great. We were delighted to be able to start work with Deep Transitions and Independent Economics.

Professor Johan Schot leads the Deep Transitions collaborative that brings together many researchers across academic disciplines, and is based out of the Universities of Utrecht and Sussex. Probably best described, and this is my shorthand, not his, as economic historians, Johan and his team bring a great wealth of expertise on why transitions happen, but also sometimes why they do not, which is equally important for us here. And they get the measure of the complexity that changing out the world's entire energy system against a background of volatile physical change might bring.

Dimitri Zenghelis has brought his consulting colleagues at Independent Economics to bear on the task. Still working in the narrative form, his team are more conventional, if that's not rude, more conventional macroeconomists with deep policy experience.

Dimitri himself was one of the lead authors on Professor Nick Stern's landmark climate work back in 2007, and is now one of the leaders of the Bennett Institute for Public Policy at Cambridge. He really helps I think bridge between qualitative and ultimately us potentially going back into the quantitative.

So I'd like to ask Dimitri and Johan to join us and really kick off by asking them why they responded to our call and why the project was of interest. Maybe, Johan, I can start with you.

**Professor Johan Schot (JS):** Thank you, Caroline, and thank you for the opportunity to talk here with your clients. Well,

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before the call we had engaged with Baillie Gifford for several years already. I'm an historian by training and have done a lot of history work, and it started with James Anderson being interested in my research, which was basically about disruption. And James saw himself as an investor in disruption in the long term, which is I guess also a mark of Baillie Gifford's investment strategy.

So, with his help, we developed a historical model that we tested also against historical evidence for how does major change happen. For example, we looked at the history of the car and why the electrical vehicle didn't win in the past, because in 1900 it looked like the electrical vehicle would outcompete the gasoline vehicle at the time. Why? Because it was low maintenance, it was far more easy to operate, and in fact it was in use more than the gasoline car. In the end, it didn't work out for, you may argue, technological reasons, because of the battery. But that was not the whole story.

The whole story was that the gasoline car was used for racing, touring in the countryside, while the electrical vehicle was used for city transport and was very efficient there, but there was a competitor for the city use, which was public transportation that worked much better.

On top of that, the electrical vehicle was also seen as a female car, while the gasoline car was seen as a man's car, was adventurous. It broke down a lot, but that was not seen as a problem because you could show your skills by repairing. So the car was a plaything for men touring and racing in the countryside and became very successful for that purpose, while in the city the electrical vehicle was outcompeted by public transportation.

Later, if you look at the European story post-Second World War, because at that point the gasoline car again was not very dominant, the future after the Second World War many Europeans thought would be public transportation. It turned out to be different, because the users were longing for the car. They didn't like the public transportation anymore. It was seen as a socialist option. It was branded as such, for example, by the Marshall aid, and this was an effect of the Second World War. So the shock of the Second World War really changed the future of the mobility system.

This is just some anecdotes about the history of these systems we looked at and the factors that shaped their destiny. When we developed a kind of model of how change happens, we started to apply that to the future. But we didn't do that on our own. We did that together with a set of investors. 16 investors came together to explore what these kinds of historical insights would mean for the future. And we developed a new type of transformative investment philosophy together with them.

And then came this call, or your call, to respond to, which for us was an opportunity to look again at our work and deepen it.

**CC:** Fantastic. And Dimitri, from your side?

**Dimitri Zenghelis (DZ):** Yes. It's very similar actually to Johan. This began through a recognition of the limitations of conventional economic approaches, static optimisation approaches, cost-benefit approaches, and I'll say a little bit later on what I mean by that kind of economics jargon. But effectively, approaches that treat the economy as having a fixed structure, fixed production possibilities, fixed technology costs, fixed tastes and preferences.

And that's what most models that are used to assess most projections and simulations, including climate change, are founded on. There are different types of models, but that's the basic essence. And it was pretty obvious that when you're looking at disruption, when you're looking at tipping points, which either because you've had dramatic changes in the

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climate or because you've had dramatic changes in the kinds of socio-technological systems that you rely on in your economy, those disruptions and changes completely change the structure of the economy.

So we felt that any economic model, which is most economic models, that begins along the lines of let's assume we know the tastes and preferences and technologies in 2050, then what's it going to cost to decarbonise, is very much along the lines of that old joke about the scientist and the engineer and the economist who are washed up on a desert island after a shipwreck and find themselves confronted with an unopened tin of beans which washes ashore.

And I won't drag you through the machinations of the joke, but I will cut to the punchline. The punchline is they turn to the economist and say, how would you open the tin of beans, and the economist responds, assume we have a tin opener.

Well, we really have been assuming we have the understanding of the economy, rather than thinking about what the pathways to build that economy and what the processes of innovation and change are. And in that regard, I think Baillie Gifford are absolutely right, and in this sense perhaps are not as conservative or as mainstream economists as some would think. You are absolutely right to note that the NGFS and other scenarios, which are supposed to be stress testing future assumptions, are just not imaginative enough and they don't account for the fact that these risks are correlated. And again, we'll say a little bit more in a minute.

But let me put it this way. If I stood in front of you ten years ago and said the cost of solar PV technologies would have fallen by 90 per cent, not 9 per cent, 90 per cent over a decade, such that, together with storage technologies which have also fallen by similar magnitudes, solar PV and indeed wind would be cost competitive with conventional electricity generating technologies in most places at most times, you would have openly laughed. Nobody was predicting something as radical as that. It existed in no stress test scenario. And yet, we all got it wrong.

And there are reasons why we got it wrong, and I think your desire to look at the more qualitative process-driven approach I think gives you a lot of the insights and clues as to why we have been caught unaware, and why we likely will continue to be caught unaware as some of these big changes in the pipeline come to reality.

**CC:** Thanks, Dimitri. And I think what both of you are getting at there is a key element in the way we structured the call, which was that we wanted to really try and broaden the view on what we could define as a climate solution. There's been a very narrow set of climate solutions chosen for the models, which tend to be quite conventional technologies. But there's something bigger, which is around society itself, which becomes a form of climate solution. And it's important that, just as we don't defund technologies, we also actually make sure we support those societal changes which are actually going to drive us towards net zero.

So it was around broadening out the definition of a climate solution, it was about bringing in all the physical science, which often is something that conventional quantitative models can't deal with, particularly when we get these nonlinearities and tipping points, and making sure that we also brought in some difficult topics within society, particularly, for example, around migration and potential conflict, which we've also seen will be players probably in the scenarios and the way that things roll out.

Johan, can I go to you again maybe just to pick up the story in terms of diving a little bit deeper in what you think the qualitative approach really enables us to incorporate and explore into these basic scenario perspectives?

**JS:** Well, the basic point is that quantitative scenarios assume a lot. They have to assume a lot. So they open up the

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assumptions, and one of the things I mentioned before is that after the Second World War in the Netherlands in 1950, there were 300,000 cars. In ten years' time there were millions, because the people were dreaming of owning a car. So their dreams and their longing for the car was built up.

The car was still very expensive. They came out of an economic depression and a war period in which they had learned to save money, not to spend money. So they had to learn how to consume, and still they were willing to spend it on the car. So this market had to be built. It would never have been predicted. It had to be built.

And this is precisely what qualitative approaches can show, is the complexity of all the factors that play a role, but it can also provide a narrative, a plot, because the type of theories we use are the theories that allow you to tell complex stories.

In the work we do, we look at the story of alternatives, so how alternative markets are built, how they develop, the type of policy measures necessary, the type of cultural changes necessary. Then we look at how the dominant incumbents respond, how they open up for change. That's a second plot. The third plot is about these wars and migrations and shocks, climate-related shocks, how they will influence this dynamic, this interplay between the incumbents and the newcomers. So you can have several plots. You can show how they play out simultaneously and influence each other. And that's precisely the type of scenario work we do.

**CC:** I think that's a really important bit of terminology to bring in, this idea of shocks. A system is going along in a certain direction, but what shocks it from one glidepath to another, which is particularly important maybe when we come back to discuss the disorderly scenario, but it also exists in the others in a way that maybe isn't recognised.

Before we actually go on to talk about maybe those three pathways, Dimitri, can I come back to you, because one of the things that we've spent a lot of time talking about as we constructed these scenarios is this continuous pace of technological innovation and how that can accelerate, it moves in a nonlinear direction, it also spreads out and affects other areas of the economy. Maybe just cover that off before we talk about the scenarios.

**DZ:** Yes. Well, we're all familiar, I think we're all familiar at least, with some of the tipping points in the climate system, how you get these nonlinear adjustments where once you reach a certain temperature, for example, methane is released from the tundra, which warms the climate, which releases more methane. And there are many other of these, from Amazonian dieback to icecap melting, changing the albedo effect of reflectivity, that cause these phase shifts. We know they're in the pipeline. We just don't know when they're going to hit.

Less familiar is the understanding that actually when you're looking at nonmarginal structural change, so we're not looking for a cost-benefit analysis of building a bridge across a river, we're looking at where the rest of the world stays the same, we're looking at transitioning our economy completely to move away from, for example, fossil fuels to something totally different, and that there are path dependencies and tipping points involved there as well.

So, Johan is absolutely right. I'm a real fan of economic modelling. My first job in the public sector was to run the Treasury model as head of economic forecasting. I've been working with economic models ever since. And they're wonderful tools. They enforce a discipline on the modeller to articulate their assumptions in a consistent manner.

What they don't cope very well with are conditions where you have multiple equilibria whereby the path you take determines where you end up on. So, let me give you an example. I mentioned that the cost of solar PV had fallen dramatically.

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One of the key proximate reasons why the cost of solar PV has fallen so dramatically is because they've been deployed at scale. When you deploy new technologies at scale, you learn from experience how to produce, distribute, install and maintain those technologies, and so the costs of doing so comes down.

You also get economies of scale from producing them in massive factories, in gigafactories for batteries and huge factories for solar PV in southern China. They reduce the unit cost of the technology. But of course, as the costs come down, people are much more inclined to buy them and deploy them.

So you see what's going on here. Falling costs generate deployment. Increased deployment generates falling cost. That's not the same in a fossil fuel or commodity-based system because they're not subject to increasing returns to scale as you will get with capital intensive knowledge-based sectors. Knowledge doesn't deplete as a commodity.

When you're dealing with resources, physical resources like fossil fuel, if you want more fossil fuels, you'll have to dig them out in an ever more remote location using exotic techniques. So you'll get decreasing returns, increasing costs to scale. So there's this uneven competition.

The problem with this kind of reinforcing feedback, costs come down, increases deployment, deployment increases cost, is, well, the clue's in the word feedback. Feedbacks are unstable. Think of putting a microphone next to a speaker. They're incredibly difficult to model because initial conditions, think of butterfly effects if you like, generate pathways that can get you to a very different place, dependent on the choices and decisions and investments you make.

But for investors, or firstly for policymakers, this matters a lot because it means that the choices you make have a real impact on what pathway you end up on. For investors, it means you have to really stay hyperalert to what pathway you're on and what are the key tipping points and the key events that might allow you to distinguish whether you're heading to hell in a handbasket or heading to an efficient, productive, innovative, cost-effective green future, or any number of horrible scenarios or more favourable scenarios in between.

**CC:** I think there's a real risk for investors, again, going back to that comment I made before about shorthand quantitative models. You get stuck in the weeds as a model, which is not necessarily accurately reflecting that feedback effect on the positive side, nor is it fully accurately reflecting the opposite feedback on the potential climate damages front.

So you get stuck in models which are not giving you the right answer on either side, and that's something that we've seen the IEA actually fess up to I think over the course of the last year or so. But you actually spend too much time on the detail rather than really exploring the big picture and those signals of how we're switching from one pathway to another.

**DZ:** You assume you have a tin opener.

**CC:** Yes. I'm going to move from that onto those three scenarios and just pick them through a little bit, try to bring them to life. Johan, maybe if I can start with you. So, orderly scenario, orderly transition, smooth glidepath to net zero 2050, and 1.5 degrees success. When you looked at it through your lens, what are some of the key characteristics of that world? What did you notice was missing from some of the regulatory language for that framework?

**JS:** Well, the first observation needs to be that orderly does not respond to the fact that there will be no shocks, because even if we get to the 1.5 degrees in time, it still means there will be major shocks, and also major repercussions in terms of

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who will have to bear the consequences of these shocks. So there will be a need for a just transition or for compensating people who will have to bear the costs.

The orderly refers to the path, how it is organised. So it would mean that we need a real good coordination across the public and private divide, for example, but also internationally. In order to get to orderly, we also really need to see a rapid scaling of innovation and we need to see blended funds, so a collaboration between public and private investors, in order to make it orderly.

If you look at the scenarios put forward, I think that it's very important to recognise that energy efficiency for example will be important in this scenario, and it's not just as an individual but it's a collective responsibility. So it needs to be taken up as a collective responsibility. There's food and agriculture that we do need to change the food system as well more than was assumed.

So it's not just about the energy system, is part of the message. It's about the connection between the energy system, the food system, the housing system, because we need to move to low emission buildings, retrofitting. And of course, we need to manage the need for minerals, also from a just transition perspective.

So these were some of the aspects we stressed in reaching this scenario.

**CC:** And I think from our side, one thing that we took away, we took away much of what you've described, but particularly the importance of the just transition and the importance of greater social equality, of strong collaboration across communities, across countries, which is something which is very absent from what is quite a technocratic description of the orderly transition. So it has implications beyond the way we just think about energy transition stocks actually to the way we think about other elements of our portfolios as well, if you were to claim alignment with an orderly transition.

Maybe at the other end, Dimitri, the hothouse world. Can you maybe start with why this happens? It's not a happy place, so why do we do it? Why do we take on those damages to drive us to that conclusion?

**DZ:** Maybe I can tie my answer back to the just transition story, because as I think from both what I and from what Johan have said, you might be getting a sense that a lot of the real barriers to transitioning cost-effectively, allowing us to get to a cleaner, quieter, more secure and sustainable world that's also more efficient, more innovative and more productive, i.e., without a trade-off between clean and growth, the barriers preventing us from getting there tend not to be technological or economic, quite frankly.

A lot of this innovation story won't stop at cars, electric vehicles. It won't stop at electricity generation. People tell me all the time, they roll their eyes, you know that's the easy bit. Well, people weren't saying that ten years ago, and just as we now look at aviation, for example, and say, well, we're never going to decarbonise that, I'm not so sure. We see electric planes for short haul. We see all sorts of synthetic fuels available potentially for longer haul, composite materials, better air traffic control. Look, I don't know what mix of technologies may get us there, but I'm certainly not ruling out that we'll have zero-carbon aviation and much besides.

Johan talked about land use and agriculture. I suspect your children's children won't really be eating meat, partly because once enough people don't eat meat, you'll get really good chefs creating stuff without meat, as we've seen in the vegan revolution. If you've got good vegan food... The first vegan had a nasty, nasty set of choices, but with time the food gets better and more people will convert, and there'll be laboratory meat, there'll be plant-based, there'll be all sorts of options.

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I don't know what form they will take, but certainly the question of how we get from here to there and the degree of disruption, and I don't mean that in the sexy US west coast sense, disruption can be just that. It can be disruptive and people don't like it. They don't like change. There are coal miners out there. There are people whose jobs and livelihoods depend on fossil fuels. There are people who can't afford clean technologies, electric vehicles, heat pumps and all the rest of it.

They're going to need support, compensation or retooling and reskilling, so that they can take advantage of the opportunities of the new economy. So, this is a longwinded way to go back to your question about the hothouse world. Why we might end up with a hothouse world is because we don't handle the politics very well.

There are good reasons why people and vested interests want to prevent change, genuine reasons. And if we don't manage that change with an eye open to the just transition, bringing people onboard, then I think, as we're seeing, we're not getting the necessary policy signals and credibility to generate that private investment that will get us to the place we want to go, create those paths we want.

Don't forget, these are very policy and regulatory driven sectors. We're talking about energy. We're talking about transport. We're talking about buildings. These depend on policy, and you're only going to get good policy if there's the political will, and you're only going to get the political will if there's the public and social support behind it.

So I think that's the bit we need to focus on. This isn't a technological problem. This is a political and a cultural one. If we don't do that, then we go the route where you start to trigger these awful reinforcing feedbacks in the climate system, some of which I touched upon, and very quickly three degrees becomes a reality. And three degrees is a very, very nasty place for us to be at. It may not sound like a lot, but it starts to really compromise our ability to really exist comfortably on the planet. It's an existential risk that then starts to kick in.

Those risks aren't very well modelled either because, again, they are nonlinear and the risks are correlated. So you get these nonlinear risks on both sides of the equation, both the climate side and the economic transition side, and they get bigger and bigger and they are mutually correlated. The more we do the wrong thing, the more likely we're going to get a hostile climate. More likely you get a hostile climate, environmental issues will probably start falling down the list as people find that their jobs and livelihoods are threatened, so the more we're likely to do the wrong thing.

On the other hand, the more you do the right thing and you invest in clean technologies, the cheaper they're going to become. The cheaper they become, the more people are going to like them and push for policies that encourage clean technologies. And we can very quickly and quite comfortably end up in the right place.

So it's that understanding of these pathways and nonlinearities that I think is critical in the qualitative assessments of the otherwise more static and deterministic scenario stress tests.

**CC:** Yes. And I think it's a good moment then to try and shift from that inevitability you're describing, either around the orderly or around the hothouse world, to talk about the other scenario, the disorderly. And I think, as you both separately coined it, it's kind of the anti-scenario. It's characterised by the fact that it's clearly not orderly, but it doesn't entirely fail either really because somehow, some space emerges which pushes us back onto a positive pathway.

And I think, again, Dimitri, we were chatting about this as we were going through the process. There's almost an infinite

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range of disorderly scenarios, but a limited range of forces or such shocks that could really shift us back to success. And Johan, maybe I can bring you again in here from your Deep Transitions perspective. How is that plausible? What sort of shocks could actually drive us back on track?

**JS:** Well, again, if you look at the history, I would argue that this scenario is plausible because if you look at the 20<sup>th</sup> century, we had a very bloody first part of the 20<sup>th</sup> century with two major wars, a big economic depression. Yet some of the change that happened after the Second World War was necessary, was already predicted before the First World War, but nobody was ready or prepared to act on it. Only after the Second World War people came together and acted in it.

So you could argue that this disorderly scenario happened in the 20<sup>th</sup> century and may happen again. The drawback is there will be high cost, major impacts. So, a lot of people will suffer, so anything we can do I feel to prevent this would be good.

But if this scenario would unravel, I think what you will see is more focus on top-down, also more focus on this technocratic decision-making necessary because of all the ecological and social costs that have occurred. So then we need rapid action which will lead to more investment in geoengineering, I guess, and carbon capture necessary, will also lead to very fast abandoning of fossil fuels in a disorderly way. Stranded assets will be a much bigger problem in this scenario.

But yes, I would say this is a plausible scenario, yet one that we should try to avoid. How? By investing early on in some of these solutions and not wait till it's too late.

**CC:** In about five minutes' time we're going to ask for questions, so just reminding everybody out there, if you've got some questions, put them in the Q&A and we'll get to them very shortly.

I think from us as an investor group, one of the other key elements, or a couple of key elements that came out of the work around the disorderly is twofold. One, the importance of timeframes here is that because we're not talking about a linear smooth pathway in either a good or a bad direction, investment choices and understanding your investment timeframe, the timeframe that matters to you, is really important as we pass through the volatility of disorder.

And the other key element is keeping an eye on the fact that we may just not be able to get back to it because the damages get too great. We become too poor effectively to reset to success. And it's really maybe from that that I can shift into what I'd like to ask as a last couple of my questions for this piece in terms of ideas for practical actions.

Dimitri, can I bring you in first? One of the things that you really pushed us on across the piece was hoping that we would use this, the scenario work, to become better at assessing our companies. And I think that's an important aspect for us, to be quite humble as investors. We're not running these companies, and we can't manage those risks for these companies, but we can get better at assessing those who may be able to navigate this for us.

**DZ:** Absolutely. The timeframes are critical here. Let's be honest with ourselves, it is really very unlikely that we will now make 1.5 degrees. We're within a decade of blowing that target. We may then find ways of either direct air capture and sucking, or investment of course in biological solutions, reforestation, seagrasses and so on, in reabsorbing greenhouse gases from the atmosphere or masking their effects through geoengineering, which opens up a whole set of risks of its own.

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But it's very unlikely we're going to meet the 1.5-degree target. If we were to do that, we'd have to halve emissions by 2030 and get them down to zero by 2050 or thereabouts.

That is not happening. So the longer it takes before that does happen, as Johan said, the faster we're then going to have to then bring emissions down to reach the safe target. And that means potentially scrapping capital, and certainly a lot of capital would be devalued.

And this is I think where the question from a perspective of investors and asset managers comes into play. It's about companies' balance sheets and whether they are future-proofed to a world where either there is a far more hostile policy environment or there might be new technologies that undercut the current technologies, or if neither of those things happen, then you're going to get significant disruption further down the line through climate damage.

But either way, judgement and decisions have to be made to invest in these kinds of future-proofed assets. And it doesn't matter whether you're a clean tech company or a steel maker or a cement maker who wants to be best in class in terms of efficiency and emissions, your investors will want to know whether you've got a risk management and hedging strategy that is resilient to the kinds of changes that we're going to see in the years ahead. And if you don't, they're going to want to know about it.

And by investing in the right assets, I don't just mean the physical assets. I also mean the human assets, the skills, the training, but also the intangible assets, the ideas, the institutions. Are you investing in institutions that are future-proofed, ideas and training that's not going to be devalued and redundant in the future?

And so you need to look at companies. It's not just about backward-looking disclosure. It really is about taking a forward look, which is slightly more qualitative again and slightly more subjective. Are these companies serious? Do they have a plan? If they have a plan, what mechanisms are they using to implement those plans? Is management well informed about these plans? Does it feature regularly at board level? Are there metrics and processes implemented to hold companies' strategies accountable to the delivery of that plan, and so on, because there will be barriers within your organisation.

There will be resistance to change. There will be people who, unless really they are incentivised and it's written into their job plan and it comes up in their quarterly or annual reviews, they will not want to implement changes which they haven't had to make in the past. So you've really got to look at whether a company is serious in order to be able to assess how exposed it is to the kinds of risks that we are looking at, because one thing is for certain. The rate of change and the magnitude of change is not only going to pick up, but it will be correlated.

We get a breakthrough in technology. That's going to make the politics more favourable, which will mean more breakthroughs in technologies, or the other way around, if things go nasty and we don't do enough and we start getting conflict and migration. Then the focus might be on militarisation, war and nativism, rather than addressing environmental concerns. And of course, that only makes the problem worse.

**CC:** And again, for us, having these discussions at team level around these different qualitative scenarios just helps us in terms of informing those debates with companies. Johan, coming to you, some of our clients do want to set their portfolios up to positively reinforce the chances of a successful, preferably orderly, transition. And I know you've been working with a range of investors on this idea. A little bit of a highlight maybe on your emerging Deep Transitions

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investment philosophy.

**JS:** Yes, one of the questions we asked is whether a company is contributing to system change or system optimisation. For example, precision agriculture is a solution for a certain type of problems, use of pesticides for example, but in the long term it's not providing system change. So, one thing to ask is whether the companies in your portfolio are leading to system change, and it's not just about individual companies, because investors are used to looking at individual companies, but we try to look at portfolios of companies.

So, if you have investments in five companies in the food space, how do these companies, the work they do, how do they help each other, in fact? And can you identify missing companies, so to speak, or missing activities that would really strengthen the portfolio from a system change perspective?

We extend that to public action, so we also look at the opportunities for blended finance, building the capital chain, and then we look at desirable futures, because what we have been doing is looking at plausibility, but I think it's also important to think about the systems that need to be in place let's say in 2050. So we have been building free scenarios as well of futures, I have to say, with different ways these systems could look like. For example, the energy system could be very centralised with a grid, or could be very decentralised. And this may also differ in geographies.

So we have been looking at the ways these systems could look like in 2050 in very different ways. So investors need to be world builders through that investment. So, that's one of the ways they can look at the companies.

**CC:** And I think that's a really good aspiration for clients, for asset owners, thinking about net zero aligned portfolios and really trying to think about it at that system change level rather than in terms of simple metrics.

Just finally from our side before we go to questions, what are we doing at the moment? Well, with the work that Dimitri and Johan's teams have done for us, we're taking those narratives which we're happy to share, and do contact us if you'd like a copy of the work that's been done, taking that to the teams, using it for debate, exploring what we do and we don't know, looking at baked-in assumptions that we have in our stock choices, looking at maybe the tilts that are incumbent in our portfolios at the moment, new ideas, and also engaging with the regulators on our experiences around scenario work, which I think is particularly important, given some of the quantitative scenario metrics that have come out this year.

And we'd really like to see I think you, our clients, asset owners, thinking about how you want to sit versus the scenarios and not being shy at asking people like us, like your asset managers, to provide insight against those scenario backgrounds to the setup of the existing portfolios.

Now, we have Dimitri and Johan for a bit longer and very, very happy to take questions. Oliver, do you want to jump in with a couple of questions before we bring it to a close?

**Oliver Carr (OC):** Yes. We've had quite a few submitted beforehand. Continue to send them in if you have anything you want answered. So I guess to start with an optimistic point and then we can spiral down from there. Neither of you seem completely pessimistic or despondent. And given the size of the challenge and we're potentially seeing signs of fracturing, are you optimistic about the transition, and if so, what is it exactly about the nature of the transition or previous ones that makes you optimistic?

**DZ:** Could I have a crack at that one? I think that's really important. So, people often hear me talk about these cost

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declines and reinforcing feedbacks that allow us to transition ourselves cost-effectively without threatening growth, and they say, well, this guy, what planet's he on? Is he a sort of clean economy evangelist that's overly optimistic?

And at this point, I tend to invoke Paul Romer, who's one of my favourite economists. He won the Nobel Prize in 2018 for spearheading a movement called endogenous growth theory. And all this said is that if you want to increase productivity and you want the economy to grow, you need to invest in stuff, whether it's capital or people or ideas and R&D, otherwise you won't get that productivity growth. It won't just happen as manna from heaven. You need to innovate.

And he applies the notion of conditional optimism and compares it with complacent optimism. And my response to that question is I am conditionally optimistic and not complacently optimistic. What do I mean by that? Well, he gives the example of complacent optimism as a child which just waits for presents. He then juxtaposes that against the notion of conditional optimism, which is a child that says, you know what, why don't we get some wood and some nails and get together and build a treehouse, and we'll end up with something really cool and we'll have some fun in the process.

Note, the treehouse doesn't invent itself. You have to actually make the decision and choices and investment to get to that point. And he argues, rightly, that the economy's very much like that, and from the perspective of policy, it means that policy choices matter ever more because the world is now path dependent and those choices and investments that you make can deliver the outcomes that you want.

So I'm conditionally optimistic, but that is slightly double-edged because it points to the tragedy that we really could transition to a better world on many counts that is net zero, but the chances are, and they're quite significant chances, that we won't. The reality is we are taking too long, and the longer we wait, the harder it will be to attain those same ends and prevent some of those climate risks.

So, that conditional optimism comes with quite a depressing understanding that despite what we could have, we may still manage to go to hell in a handbasket. Is that optimistic? I don't know. But I do know what needs to be done.

**OC:** Yes. Anything, Johan?

**JS:** Yes. Well, I call myself a moderate pessimist. First of all, history shows that major change happens. Think about the fall of the Berlin Wall as you think about history. Who could predict? For example, the example mentioned about solar, the fall in price. So, changes are happening at many, many levels.

You can say, okay, we can rely on that. The question is who will pay for it, because the distribution aspect is also very important to consider. And this will have major implications, also for the people who win. They will also have to deal with some of the consequences. For example, if the consequences are in Africa, and many people become very mobile and migrate, that will have consequences for the Global North as well.

So, whether you are a pessimist or an optimist, it's important to look at this side of the story as well, what is now called the just transition part. But yes, I agree that it does depend on conditions, as Dimitri was saying, and investors are a good place to start to think about putting these conditions in place.

**OC:** Yes. And as your examples point to, many of those conditions are related to geopolitics. We've got quite a few questions on here, both from the positive and negative side. So, what role can the geopolitical environment have in supporting a successful transition? And then to Becca's question, if we're pulling away from free markets and towards

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protectionist policies, and increasingly seeing conflict, what's the impact of that, whether physical or rhetorical?

**DZ:** Sorry, am I jumping in, Johan? The answer is, geopolitical conditions, as I've already hinted, are absolutely critical. This is going to be policy-led. These technologies, they didn't become cost-effective without intervention. The private sector wouldn't have taken on solar PV and wind without a lot of public money going into both R&D and deployment at the time when it wasn't commercially viable, because it was too expensive.

So you need policy action to get you over that hump. Clearly, the conditions at the moment, the reversal of globalisation, the reversal of freer trade and investment flows, are going to gum up the system and add to inefficiency. However, there is a potential silver lining to this, and in this respect, I disagree with the Economist and have always disagreed with the Economist. The Economist, I think rightly, in many cases falls back on its libertarian economic principles, but it got it wrong in 2014 when it said solar PV is the most expensive way to decarbonise.

And I think what it's getting wrong now is not understanding, and there's actually a line in that article, it still champions carbon prices as being the efficient non-discriminatory way of bringing down emissions.

Well, it is true. I'm an economist. Of course I favour carbon pricing. But it's very clear that a uniform carbon price ramping up with time as you pick off the most options is not a good characterisation of an economy that requires you to invest quite heavily in things that are currently expensive that a carbon price would not reach. If I've made any sense in what I've said already, that should be pretty clear. You need to undertake what economists Daron Acemoglu and Philippe Aghion have described as kickstarting the green innovation system.

That means you intervene with a strong message, credible policies, and then you can allow the clean economy to take care of itself in many cases, just because it is more innovative and productive than what it replaces. But you need that policy intervention to begin with, and it also means that you need to make choices. Remember the Romer example. Choices and decisions matter. The market cannot be left alone to make those choices at a time when there need to be quite substantial strategic decisions made.

And for investors, that means that the Markowitz dispersion diversification story becomes quite nuanced, because you actually also have to understand that some sectors are more heavily exposed to change than others, and you too have to make choices about your investment basket. The only question for you as investors is that you get the timing roughly right, because if you move in way too soon, you might not make money. If you move in too late, then clearly, you'll have missed an opportunity.

That's where the tipping points and looking out and having a list of watch-fors that allow you to stay ahead of events I think is so critical from an investment and asset management standpoint.

**OC:** Thank you. And Johan, are you able to speak to the impact of conflict in a more divided world?

**JS:** Yes. So, again, historically of course conflicts have been very destructive. So we should not ignore that, and investors may want to move out of certain areas because of that, certainly in certain geographies. At the same time, conflicts can also on the one hand provide windows of opportunity, open up windows of opportunity that did not exist before, and they lead to choices. Our historical research shows that they really are a moment when actors align, coordinate and come together in ways that didn't happen before.

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Another impact of conflicts and violence is trauma, or what we call imprinting. So, trauma can have an impact on people in a way that they now are prepared to do things they were never prepared before, because it provides a kind of direct impact on the way they see the world. So it's not about rational choice, because the language of windows of opportunity assumes making choices, while the language of imprinting and trauma assumes a bodily response. And this is part of it.

So, when we consider wars and conflicts, you need to look at the destructive sides, yes, but you also need to look at the other side, how it will shift the decision space.

**OC:** I think one more practical one before I move off, perhaps for you, Dimitri. You've analysed the limits of the quant. Given a lot of people here will be working with the numbers on a day-to-day, do you have any guidance for exactly how and when the quantitative side is useful?

**DZ:** Yes. Look, I've said already that you want a framework for consistency and you want a framework for transparency. Models are very good with that. So I would still advocate the use of models. However, you'd want to inform some of the structural elements in your model. You could do it in model, but perhaps best to do it off model.

Some of these key parameters in a model, these behavioural characteristics to do with consumer choices, to do with technology costs, they vary. And they vary as a function of history. In other words, choices, decisions, paths are undertaken. And you need to understand the process by which they vary.

So the name of the game is not to predict what the future will look like. We frankly don't know. We know that there'll be many pathways and we know that those pathways, if you like, they fan out because the risks and the impulses they generate create new pathways. But we want to know what the processes are that generate those pathways so we can say something about the risks associated, how those risks are likely to play out, and where we are on that path.

Now, you never know with any precision where you are on that path, and you also never know exactly where you'll end up because that path can still take many, many different directions. But you can begin to see pathways closed off, good ones and bad ones, and that I think is informative.

So I think there's got to be a quantitative story around the macro key indicators, but there also needs to be a dynamic quantitative story, one that allows you to understand the process of innovation and social change so that you can then inform the parameterisation and the coefficients in your model to allow it to be updated in light of new information. And when I talk about static optimisation, the term I used right at the beginning, it's the term static that is inappropriate when you're looking, by definition, at major dynamic structural change through time.

It's getting over the static bit, which I think is the reason why the IEA and everybody else failed to predict the cost reductions firstly in key renewable technologies and then in electric vehicles. It's because they failed to understand that dynamic relationship between costs and deployment, back to costs, and then back to deployment.

**CC:** Good. I think we'd better bring it to an end there. Thanks very much to everybody who's stayed with us, and huge thanks to Dimitri and Johan for sharing their expertise with us. I hope everybody's found today's brief introduction to our qualitative scenarios work useful. It is complicated. Well, it sounds complicated, but working your way through narrative stories is much simpler in many ways than some of the models, the computer models that attempt to encapsulate this.

And it's much more participatory. We can all get involved in a discussion and a debate around these different scenarios

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and the messiness in the middle in a way that we find really difficult to do with the numbers. Certainly, when we've been having these debates with our investment teams, we've really found them very animating and they've really brought things to life, and really enabled the investors to see maybe impacts and dependencies they hadn't spotted before those discussions.

And we'd be really happy to take up these conversations directly with folks, so please do get in touch with us directly, and also very happy to share the papers that Johan and Dimitri's team have created for us. So please do keep in touch, and thanks very much indeed again to Dimitri and Johan and for all of you out there taking the time with us today. Thank you very much.

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