

November 2023

By considering stories about possible futures, our investment teams are exploring climate change-related investment risks and opportunities. In her Disruption Week webinar, head of climate Caroline Cook explains the scenarios initiative and how it relates to a radical geoengineering idea.

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

Malcolm Borthwick (MB): Imagine a world in two decades' time when scorching heat waves, super storms and rising sea levels have led us to take radical action. A risky scheme is underway to inject huge amounts of sulphur into the atmosphere to reflect sunlight cooling the earth. The only problem is, is we don't know whether or not this will work and stopping it could bring catastrophic consequences of their own.

This is a plot in Neal Stephenson's book, Termination Shock, and as fantastical as the idea might seem, Stephenson wrote this novel to encourage policymakers, technologists and investors to consider how a geoengineering event like this might play out in real life. In today's Disruption Week, I'll be talking to Caroline Cook, Baillie Gifford's Head of Climate Change, about how we're using scenarios to test climate and energy transitions and what impact this might have on your investments.

A universe of opportunity

MB: Hello, and welcome to Disruption Week. I'm Malcolm Borthwick, Managing Editor at Baillie Gifford. And I'm joined by Caroline Cook. Caroline, great to have you with us.

Caroline Cook (CC): Thanks. Thanks very much, Malcolm. Thanks for having me.

MB: And just a reminder, this webinar will be about 40 minutes. Caroline and I will chat for 25 minutes, and then we'll open it up to questions from you, the audience, for the last 15 minutes. We'd love to hear from you. So if you do have questions, please use the Ask a Question button which is on the right of your screen. And we hope that our discussion prompts plenty of ideas, debate and questions from you, which we'll come to a little bit later on.

Caroline, if you could start by just giving an overview of your role and what your team does at Baillie Gifford, please.

CC: Yes, sure. So I suppose if you really boil it down, what I'd say it is at its most basic is it's just making things that we do, research things that we do, subconscious into the conscious. We're facing some fascinating stuff at the moment, where

in terms of what's happening around the climate and the energy transitions, it's really quite unparalleled.

We are trying to deal with changes in the physical climate which we've never experienced before. And at the same time as that, we're trying to change out the entire energy infrastructure of the global economy at pace in order to try and push back against climate change.

And the key issue for us as investors is, the complexity of that change, because it's so profound, is actually quite hard to think about. So what is material, who is material, how do we actually bring that into our investment processes, and how do we challenge ourselves to think differently?

So stepping back from that into the day job of what I do, what the Climate group does, I'd really divide it into three parts, I think. So I'll start with maybe the semi-boring bit, but the regulation is an aspect of it, because as an actor in the financial system, climate is almost a regulated activity, so making sure that we respond appropriately to what the regulator wants from us.

Then I'd say assurance is the second bit. So that's making sure that for all our clients in all our portfolios, we're able to tell them what's in there, those portfolios, from a climate and energy perspective, that we understand that. And then the third bit, the really core bit of the job, is actually helping to develop our research and engagement in this area. So that's with companies but also into governments and NGOs, policymakers and so on.

So it's trying to take that out across the investment teams to try and solve some of that complexity, help our idea generation, supporting engagement and really get to the core of it. And that's the bit that I love of the job.

MB: And you mentioned working with the investment teams.

CC: Yes.

MB: And your team sits with, amongst the investment teams. Tell me a little bit more about how you work with those investors.

CC: So I think it's again in several layers. So one thing that we've spent a lot of time on over the course of the last few years, I suppose you could call [it] education or sharing.

So, for example, we have what we call a climate exchange programme. So this is a webinar that we run every few weeks, and it could have an external speaker in. We had one of those this afternoon, for example. Simon Sharpe, who works for the UN Climate Champions team, talking about his work on policy and trying to accelerate change.

It could be an external speaker, it could be what we're doing in the Climate team around looking at the portfolios and frameworks, or it could be investors sharing good ideas or good engagement examples across the piece. So it's really trying to, again, just bring it out of the shadows and into the forefront and keep it front of mind as people try to figure out materiality, ideas and opportunities.

Then, as you know, many people know, a lot of the way that investment teams work at Baillie Gifford is through research frameworks, question frameworks. So it's putting, again, tools and thoughts around that. So different investment teams, depending on their approach, can figure out what sort of tools and ideas they want to embed into those pre-existing

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

question frameworks to bring out the materiality and help the ideas.

And then on top of that, then there are broad frameworks so we can give that insight into our portfolios, working on scenarios and helping with idea generation, supporting engagement and making sure that wherever we can be of help really, across the different teams, we lean in to do that.

MB: And we'll come onto those scenarios a little bit later on. But I wanted to chat about the idea we discussed at the top of the webinar, geoengineering and the idea of injecting large amounts of sulphur into the atmosphere. Could you explain that, please?

CC: Yes, okay. So it is a wacky idea, geoengineering, which is basically... It's what it says on the tin, we, as humanity, engineer the climate, the planet. And it's something that we decided to have a look at in a bit more detail actually as a result of some of the scenario work we started to do to think about possible futures.

So there are many forms of geoengineering. Others which people may be more familiar with already [are] things like carbon capture. That is ultimately a form of geoengineering. But this idea of spraying sulphur into the atmosphere, what you're effectively talking about is... So what we're doing with the greenhouse gas effect is, because of our carbon dioxide emissions, our methane emissions, we're building up the greenhouse capabilities of the earth.

So by coming along and spraying sulphur in over the top of that, we're effectively turning the greenhouse earth into a greenhouse with shades on. And the sulphur particles do that by reflecting back out into space some of the sun's rays. So then you limit that effect of the greenhouse.

And we know that it works, because it's a natural process. Something that does it quite often is volcanic eruptions. Maybe we're going to see one in the next couple of weeks in terms of what's going on in Iceland. But one that scientists have given us quite a lot of information about, and its impact on the climate, was the explosion of Mount Pinatubo in the Philippines back in the early 90s.

So that volcanic eruption put about 10 million tons of sulphur into the upper atmosphere. And it's estimated, in the couple of years that followed that, globally that had a cooling effect of about a half a degree. So you've got 10 million tons, half a degree of global warming. Two years later, that effect dissipates. And there are other systems as well that we can see that working in. So it's just a matter of getting enough sulphur dioxide together, flying it up into the upper atmosphere, spraying it about and then potentially cooling the planet.

MB: Sounds simple.

CC: Yes.

MB: So Caroline has explained it, and there signs that it might work. So this is the topic of today's poll, because I'm intrigued about what your perspective is, those who are watching. So the subject of today's poll is, do you ever think that the idea of spraying sulphur into the atmosphere to reflect the sun in order to cool the earth could ever be a good idea? And the options you've got are yes, no or maybe. So if you could choose one of those options, that would be great, and we'll come back with your answers shortly. So it does sound like a wacky idea. Is it credible?

CC: It is credible. There hasn't been a huge amount of research done into it, but there is an increasing body of academic

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

word on it. The UN Environment Programme has also had a look at it. So as I was saying earlier on, what it would take is millions of tons of sulphur. So we're talking about probably somewhere between 10 million and 15 million tons of sulphur into the upper atmosphere to give us a cooling effect of about a degree.

How do you do that? You get sulphur dioxide. It could be other salts, but most of the work is around sulphur dioxide. You get that, you fly it up into the upper atmosphere using different sorts of aeroplanes. You'd be needing to fly at about twice the height of a conventional plane. You'd need, they estimate, about 75,000 flights a year to get this stuff up there. To put that in context, there's about 100,000 flights around the world at the moment to move us and our goods around the planet. You could use very high-level balloons as well. So you get it up into the upper atmosphere, you spray it around.

You could do it globally, so you could attempt to cool the whole planet, or you could just do it locally. Again, we've seen that work from the local effects of these volcanic eruptions. So you could choose, for example, to protect a certain city from... If you saw a heat bomb coming, as we've seen in places like India and Canada over the course of the last couple of years, these extreme heat events coming through. You forecast those, you intervene early to try and provide that shade.

You could, for example, put it over the poles. So trying to preserve global ice caps is also really important, because that whiteness also reflects the sun's heat back into space. So you could get a double positive from doing that.

And we know it works in this sort of local basis. One of the things that the climate scientists have been keenly watching and reporting on this year is something that's happened in global shipping. So back in 2015/2016, they decided that the global shipping industry should move from using high-sulphur fuel oil to low-sulphur fuel oil.

And as is the way of big industries, they put off doing that for as long as they possibly could, until the regulations actually came in, in 2019. So pretty much over the space of 12 months, the global shipping industry went from emitting 12 million tons of sulphur into the atmosphere as it steamed around the world to only two.

MB: Wow.

CC: So a 10 million ton fall-off. And sure enough, here we are, two or three years later, and scientists are pretty sure that they can see, around global shipping lanes, a rise in sea surface temperatures. So we know it has an impact. And whether it has bigger impacts, we can maybe come on to, but we know it does seem to produce a cooling effect, and it wouldn't be desperately expensive to do that.

MB: So why don't we hear more about it?

CC: I think because people are worried it's the wrong answer to a complex question. So there's all sorts of issues around unintended consequences. We know that every time we try and fiddle with nature... Carbon emissions themselves are a giant greenhouse gas experiment in many ways. If you go back to one of the seminal environmental works, 1960s, Rachel Carson writing *Silent Spring* about the knock-on effects from DDT, bird song literally disappearing from the fields.

There are so many examples of where we've interfered with the natural system and we haven't quite understood what all the unintended consequences of that are going to be. So regulators, I think, or policymakers are very concerned about that. Effectively, this is a form of moral hazard. So we've become used to thinking about that in the wake of the Global Financial Crisis. You give people an easy way out, they take way too much risk. So you give people an easy way out here, we just keep on burning fossil fuels. Why do we need to change behaviours if you can just fix it with a bit of cheap

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

sulphur? So...

MB: And this is a termination shock as well, isn't it?

CC: Yes, that's another problem. So there's isolated effects that putting this sulphur into the atmosphere might cause. For example, they're worried that it would reopen the ozone hole, so we'd all be a bit cooler, but we'd all have sunburn.

But yes, termination shock is the big one, which is, we don't change behaviours, we shield ourselves with sulphur, and then for some reason, maybe there's a war, maybe we suddenly discover there is a lot of unintended consequence in the natural system, we suddenly stop it, and then you'd get very rapid warming, which is what we've just seen over these shipping lanes. So you could go from thinking you had the whole system under control into the space of, what we were talking about [earlier], this sulphur life of 18 months to two years, you could go to uncontrollable climate change very, very quickly.

MB: What, so you have to keep shooting sulphur up into the atmosphere?

CC: You have to keep doing it every year.

MB: Oh my goodness, okay.

CC: So 75,000 flights or whatever you're doing...

MB: Wow.

CC: Every year. It was interesting, one of the academic groups that we reached out to when we were trying to look at this is the great and very well named Cambridge Centre for Existential Risk, who look at all sorts of things, like AI, pandemics.

MB: That's Martin Rees's group. Yes.

CC: Yes, exactly, he's in that group. And they [ask], how could termination shock occur? It might occur because we have a nuclear war. So we could find [that] one minute, we have a nuclear war, we throw ourselves into nuclear winter, we stop injecting sulphur, and suddenly, two years later, there's a global furnace. So it really could compound the risks of other issues.

MB: So let's see what the audience's view was on the poll question, which was whether or not shooting sulphur into the atmosphere could ever be a good idea in order to reflect sunlight and cool the earth. So the results were, oh, a resounding no, actually just over 50 per cent, and then a bit of a split between the other two. So how would you have voted?

CC: Oh, absolutely, definitely not. No, I think we know too much that this is not the way out. After going away to look at this, I certainly wouldn't put it in my base case. Slightly more concerned that we might try to use it as a temporary intervention for those few isolated places. So from that perspective, I think it is worth keeping an eye on.

MB: And what could the investment implications be of something like this from a geoengineering perspective?

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

CC: So I think, on the one hand, you can say we don't have these special planes. But who knows if we're going to end up with 75,000 extra flights. I think that's a bit too far out there. But in terms of other things which we already know are going to be useful, and this could be another potential growth line, the absolutely key thing if we're going to start doing this in any kind of safe way is that we've got to be able to monitor it and intervene to try and control it. So monitoring systems become really important. They've got to be really smart.

So I think one stock that we hold commonly across quite a lot of the Baillie Gifford portfolios, a big holding, is NVIDIA. And the reason I pull that out is not just because of the AI chips and the more complex form of compute that we're now looking at, but NVIDIA themselves actually, for the last two or three years, have been working on a collaborative project with a number of universities to create a digital twin of the earth, which they call Earth-2, which is a project they've deliberately undertaken to try and improve the complexity and the performance of longer-range climate modelling. And it would be quite interesting if that sort of philanthropic endeavour, which they've obviously put a lot of time into already, actually becomes a business case for them. So that would be one.

Other areas, going to the monitoring piece, something like SpaceX, which we hold in some of the private company portfolios, satellites monitoring what we're doing from space. Bringing it right down to ground level, we have a couple of drone companies, so Zipline, AeroVironment, again private companies. Things like Global Discovery, our Smaller Companies portfolios, have exposure there. We're already looking at potential uses of earth monitoring for things like carbon capture, better agricultural practices. So again, that's already an interesting area for us, but geoengineering could be another business line for them.

MB: And there are other geoengineering ideas, I guess, that we haven't discussed, whether it's putting mirrors in the atmosphere to reflect the sun, whether it's cloud seeding to encourage the rain. But one interesting investment idea is in and around Climeworks, which is the brainchild of two engineers based in Switzerland. Tell me more about that.

CC: So, yes, Climeworks. So carbon capture, absolutely, is another form of geoengineering. And I think, again, one of the interesting things around that is that if we had been sitting here having this conversation ten years ago, it would have been in the same camp, almost, as geoengineering. It's just fantastical that we could actually be thinking about this as something that we would want to do and would be economic.

But because of the way particularly we've seen the cost of renewable energy come down, which is an absolutely critical ingredient to something like carbon capture, because you're having to filter out of the atmosphere a very, very, very low percentage, so you're talking about parts per million of carbon dioxide that you're trying to extract, it's a very, very energy intensive process, so it's become more plausible, because we might need it, because we're running late on the transition.

It's also become more plausible because renewable energy itself has got a lot cheaper, and therefore, you can begin to think about it as an actually economically viable scenario. I think, again, one of the weird things around it though is that the fossil fuel industry is often the industry that talks about carbon capture. We can keep going with fossil fuels, because we just need to capture the carbon, which misses the link that the point at which renewables are that cheap to make carbon capture viable, fossil fuels become very uneconomic. So that doesn't quite actually roll together when you look at it.

So yes, Climeworks is what we call a direct air capture company. We can think about carbon capture in two ways. There's a point source, which is where you put a gizmo on the top of a chimney and you literally capture it at source and then pipe it away and store it. So we have actually Aker Carbon Capture, which is an example of that, and we hold that in

Baillie Gifford™

International Alpha. Direct air capture, which is the Climeworks piece, could be deployed at a mega scale.

And one of the interesting things about, again, Climeworks is it enables us to use solar, well, particularly solar power, but it could be other forms of power, in areas of the world where people are not, because it doesn't really matter where you capture carbon. So you think about the potential of solar panels, for example, on the Sahara Desert. It could be huge, very high efficiency, so therefore, very low-cost solar power feeding into these giant direct air capture machines, which are helping pull some of the carbon that we've put into the atmosphere back and reduce that greenhouse gas effect.

MB: Yes. And that's really important. It's often about the energy supply in the first place, isn't it? And at Climeworks' Orca plant in Iceland, that's powered by geothermal.

CC: Geothermal, yes. And again, somewhere where people are not, so it's a useful use of energy where people are not located. So that's a real shift from the way we've used energy historically.

MB: So more broadly, as investors, why is it helpful for us to look at scenarios?

CC: Well, we all use scenarios in our own lives every day. So shall I take this job? Shall I participate in this webinar? What shall I buy my husband for Christmas? What's the quid pro quo in that? So if we use them in our own lives, in this line of work, they should genuinely be useful. And I think particularly as long-term growth investors trying to find those future trends, hopefully in a very successful world, but really testing our assumptions even if the world doesn't turn out to be the great place that we'd all like it to be.

And we could look for scenarios around AI. We could look for them around politics. But it's particularly important, I think, around climate and energy, because the depth of changes that we're talking about could be so profound and so complex and so linked into the sorts of behaviours that we have as a society.

MB: And it's also a regulatory requirement, isn't it? I think what's interesting is we've seen responses from various financial institutions about this, and often, firms look at it in a quantitative, numbers, data, metrics fashion. But your view seems to be to look at it in more a qualitative scenario fashion. Why is that?

CC: Yes. So I think the qualitative approach captures the complexity a lot better. I'm really pleased that the regulators are absolutely pushing and requiring us to do scenario work. I think it's a good idea. But their first response for our sector, as a financial sector, has been to look around and say, where do we already do scenario analysis? We do it for quantitative stress tests for commercial banks, so let's just take that and ask everybody else to do it.

The problem with it is that those quant stress tests have really been designed for those fixed, quite restricted cash flows that usually sit around the kinds of loans and debts that commercial banks have, so there's a limited number of moving parts. Whereas, we're investors in companies, as equity investors, and those companies are not static. They're not defined in the way a credit cash flow is. So they can change. They can adapt. They can grow new business lines. The world around them is very complex and changes the values and the prices and the margins that the society is willing to contribute back.

So it's really only by taking that more real-world, complex view that we can really figure out whether our companies are going to succeed or not, and how they're geared. And I think it's interesting, actually, when you look at that regulatory guidance for real companies in the real economy. They're told to look at things qualitatively. They say to managers, okay,

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

think about different scenarios for your business. How do you think your strategies might evolve over time? And we think that's a much better approach for us, our particular subset of the financial sector as well.

MB: So let's look at the scenarios that we've been working on with Independent Economics, a macro consultant, also the Deep Transitions project, a combination of work from Utrecht University in the Netherlands and also Sussex University here in England. They've devised three scenarios. Could you talk me through those scenarios?

CC: Yes. So we started this project with those two guys, Independent Economics and Deep Transitions. And we started it using the three scenarios that the regulator wants us to start with. But what the regulator does, and some people don't expand them beyond this, they just give us three skeletons to work with. So at one end, there's an idealistic... everything in society, technology, policy, gets in behind the drive to net-zero emissions by 2050 at pace to try and hold the overall increase in temperatures to 1.5 degrees. So it gives us quite a linear, orderly progression towards climate success.

At the other end, you've got the opposite to that. You've got climate failure. Emissions don't fall, we don't get behind the transition [and] it stays a very fossil-based society, so temperatures continue to rise. So we're about plus-2 degrees by 2050. We're heading towards plus-3 degrees, so twice the amount of temperature increase we've seen so far, by 2100. So a much more physically challenged world. So that you've got those two endpoints, climate idealism and climate failure.

And then they prescribe a sort of messy middle, a disorderly transition, as it's called, which could happen because we just run late or the transition moves at a different pace in different regions. But ultimately, within that storyline, there's some kind of shock, an intervention, which forces us back towards success again.

And that shock could come from maybe an accumulation of bad climate events which creates a policy space for policymakers to really intervene and push the system. So similar to that would be the second world war creating the policy space for the creation of the welfare state. A lot of discussion about that before the second world war, but we needed the war to make the change. Or instead of a policy space, it could be a technology shock. So, suddenly, we discover some much better technology than we have available to us right now, which enables us to make that transition at pace. So you've got those three basic outlines.

And then what we asked our scenario partners to do was really build those out so they're not just about wind and solar or energy efficiency, they're a full view into society. And really pick out both all of the aspects of physical change that are going to unfold over time, because time is another important element for us as investors. We've got this year, we've got three years out, we've got ten years out. So we've got to be able to think about it over time, and then bring in all the non-linearities around cost reduction, around uptake in new technologies, around what we value actually as a society and what we're willing to pay for.

MB: So I guess the important thing when we're thinking about how this might play out over time is to use narratives to test these scenarios, which you're also using. Give an example of one of these narratives that you've employed.

CC: Yes. So the Deep Transitions Team are particularly good at this, because again, a lot of the scenario work that you see out there, it's [on a] very global scale. But the world doesn't work on a global average basis. We've got lots of different regions, lots of different sectors that are going to come together and respond to these complexities in different ways. So they came up with the idea of taking, to start with again, three regional deep dives, using the different scenarios.

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

And one area that they looked at was the southern part of Southern America, so Argentina, Bolivia, Uruguay and so on. And they tried to look through the eyes of some people actually living in that region. So it's a strong farming community, strong on conventional farming, also a lot of opportunity around mining, particularly the mining [of] metals and minerals that we need to support a lot of the transition technologies, so things like lithium and copper and so on.

So when they ran this scenario or created the narrative around the scenario, what you see is a farming region that comes under increasing stress, perhaps less stress than some other regions in the world, but it is under genuine physical stress. And also, you can work through the dynamic of how mining needs to become more sustainable, more responsible in the way that it interacts with local stakeholders. If it's going to move at pace and if it's not going to get shut down and if it's actually going to find customers amongst the big manufacturers that want to buy responsibly mined products. So it was a really good way for us actually to think through our engagement with mining companies.

I'd say the other element that it really brought out was actually the issues around farming. So again, food and land, because they're underrepresented really in global equity markets, don't really come out in the regulatory prescribed scenarios, but they're absolutely foundational obviously to the entire economy.

And what we saw in this scenario made us think again about some of the agricultural opportunities available to us as equity investors. I think we looked at these a couple of years ago as possible solutions to emissions. If we move from all eating beef burgers to eating alternative burgers, then perhaps that reduces emissions. So that's a climate solution.

But actually, maybe the opportunity, the real niche for things like precision agriculture, for things like alternative proteins, for GM foods and for all the synthetic biology options that we might have in the food chain, maybe that's really driven because the food system comes under stress, it starts to fail, it gets too expensive, and that's what opens up really the opportunity for those companies.

MB: And how do you work with the investment managers on these narratives and scenarios?

CC: So that's a good question. We started this project very much working in partnership with International Growth, one of our larger International Growth strategies. And they worked alongside the guys who wrote the scenarios so they could understand us better and we could contribute a little bit back to the process.

What we're now doing is taking that and rolling it out more broadly across the piece. So for example, just yesterday exactly, we had the Deep Transitions team up here with us in Edinburgh. So we had a morning with Sustainable Growth, talking through some of the different scenario approaches. Then we had a really interesting brainstorm on India, where we'd like to develop another of these regional deep dives.

And the good thing there was we had representatives from all sorts of different strategies actually, our EM/Emerging Markets Group, Global Discovery, our Smaller Companies Team, our Emerging Market Sovereign Debt Team, so really lots of different perspectives coming together to start the foundation of what we know and what we want to explore better about the scenario.

And then we finished off the day with Long Term Global Growth, and we were going through their portfolio and how that might look in a climate failure scenario. Because I think that, again, for us is an important learning, is that we can't assume that the world is going to drift towards or drive itself towards optimism, and therefore, we have to think about how resilient could we be, what do our companies look like, what opportunities are there actually if we end up in a climate

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

failure case.

MB: I've got loads more questions, but I'm going to have to restrain myself, because I want to go to the audience questions now.

Your questions answered

MB: So we've got loads of questions that have come in, Caroline. So I'm going to start with one. Oil has historically been a major raw material for plastics, for which alternatives are sometimes difficult to find. Is there a scenario, if waste plastic can be controlled, in which we must reduce oil consumption in order to enable us to have plastic?

CC: So in terms of can we move from petroleum-based plastics to bio-based plastics?

MB: Yes.

CC: So I think there's a number of things in there. It is a really good option for us to use our waste materials to actually be that raw material for new plastics. And I was just in India the week before last, and this is a particular area that they are focused on. They have a huge amount of biowaste. So you have a giant agricultural system, because India absolutely is determined to be food self-sufficient. That's one of the basic tenets of the Indian economy. But you have a very diverse, very smallholder-based agricultural system which creates a large amount of agricultural waste.

If you can aggregate that and actually use that as a raw material, into what is quite a complex refining system in India, to create the plastics that they then want to actually extend the lives of, say foods, for example, to stop food waste, then that becomes a positively reinforcing cycle.

And we discussed this when we went to see the energy advisor to the prime minister. And we said, what's the interest here? And he said one of the critical elements is again around self-sufficiency as a nation, but it's a way of getting value, getting cash, effectively, from the industrial system back into the agricultural system again. So you can see an incentive system that would actually want this to succeed.

So, yes, it's plausible. And again, if we think about it from our perspective, where are we likely to find investment opportunities, most likely through some of the synthetic biology, synthetic refining companies, who are really bringing very advanced tech to enable that system to go from waste products to genuinely high-performing plastics.

MB: Yes, and one of the companies we invest in is Solugen.

CC: Solugen.

MB: Which uses sugars, doesn't it, in the process?

CC: Yes. Ginkgo is another example. And we've got some others that we're looking at as well. So these new opportunities are genuinely coming through as the system itself starts to show that this is a niche which is going to be remunerative.

MB: Yes, these are very exciting companies. So another question. Given the lack of infrastructure and the supply chain issues, what are your thoughts on green hydrogen in the near term, so one to five years, and the long term, so ten years-

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

plus?

CC: So green hydrogen, it's an immediate solution for some areas. So again, if I go back to my India experience, [there's] a lot of fertiliser, a lot of low-cost energy potential, particularly through solar. [It has] a decent emerging manufacturing base. Electrolysers, they're a complex bit of kit, [but] they're not a super complex bit of kit. So you can see how, in a country like that, those three elements are coming together to actually be able to substitute out ammonia use into fertiliser and that becoming potentially competitive at quite an early stage.

So I think another area is the use of green hydrogen within the steel industry in Europe. Again, you've got potential because you've got some low-cost renewable energy, particularly in Scandinavia. Whether that's coming from [what] you would call nuclear renewable or whether it comes from hydro, for example, in Norway. You've got a hydrogen electrolyser manufacturer, you've got a lot of policy support for it, you've got a steel industry that wants it. So again, it fits. All those enabling bits of the ecosystem come together.

So I think when you've got some examples like that, hydrogen works. [In the] US, the IRA is coming actually in behind, not so much that, but behind hydrogen into trucking. And the reason that works is because they've spent some time supporting natural gas as a fuel for big, long-distance trucks. So hydrogen can just come and slot into that bit of the ecosystem. So, short term, I don't think the volumes are huge... way bigger than they are right now. But it's finding those niche solutions where all the bits of the ecosystem come together.

Very long term, that's really a battle still between what's cheaper. When you've got really cheap renewables, do you put it into hydrogen to balance the system, or do you just find a way of making the electrical system itself much more resilient and much more variable over time? In which case, just straight electrification might be better. But whatever way, it's going to be bigger than it is now.

MB: Yes. We're invested in ITM Power, for example, which is a hydrogen company, among others. So are the current pledges to decarbonise achievable? What is the role of emerging markets, given their own development goals? Who is going to pay for their transaction capital requirements?

CC: All very, very valid questions. And obviously, we are not at pace on decarbonisation. Emissions are still not falling. Against that, you have to flip to the other side, which is to say that the deployment rates - given [that there's] not huge amounts of policy support so far - are actually extremely impressive. So if you take that to bits, for example, last year, straight subsidies to the fossil fuel sector [were] over \$1bn, \$1.3bn, the IMF estimated. Subsidies into the renewable system, about \$150bn. Almost an order of magnitude different.

Yet... Given the way that the playing field is actually still tilted towards fossil, the fact that a decade ago, renewables were basically nowhere in the system, by 2016 they went through 5 per cent of electricity, through 12 per cent last year. Probably we can easily imagine 30 per cent by 2030. So non-linear deployment may really be starting to move. And the optimists have got to hope it's that non-linear reduction in costs and deployment that really start to pick up and push us over the edge.

But a critical element there for us as investors, which takes me to the EM point, is that that uptake won't be linear. So what we mustn't do is say, well, emissions are not down, so we need to start defunding things today. What we need to accept is the big shifts in emissions will come later. So let's be patient, keep funding those companies, particularly in emerging markets.

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

So again, going back to the India example, a company like Reliance, it's got a high carbon intensity, very ambitious plans though to roll out into green energies, which will really start to deliver towards the end of this decade and the beginning of next. So we can do our bit, but absolutely, we need policy mechanisms and international finance, World Bank, etc to come in and help catalyse that.

MB: And this is another great question. I was chatting about this to Kirsty actually on Disruption Week on Monday, with Rivian, the electric truck company, and also Aurora. So which companies are best placed to benefit from electrification? It doesn't seem obvious at the moment.

CC: Yes, that's a good question. So I think the key issues would be uptake within the electricity system within the transportation system. But also, one area that we're waiting for, [where] we're constantly looking at trying to find the opportunities, is the smart grid itself, because in many ways, the cheapest form of additional capacity into an electrified system is the ability for us to consume electricity more smartly, more cleverly.

So if you think about renewables and their oscillations: the sun is not shining, the sun is shining; it's windy, it's not windy; maybe we need to use some batteries... If we want to reduce the amount of hard CapEx that we put into hard capacity generation, then the way to do that is to adjust our consumption, so to try and match our consumption in terms of location and also time of day, type of need, to best match the capabilities of renewables themselves.

And so that takes us back to AI again. It takes us back to smart systems, smart meters, prediction, so that we know when electricity is going to be needed or not needed. So we may well find that the real value, that where value really attributes is where we can expand the use of renewables, expand the use of electrification, but by not adding actual hard capacity. So it's not free, but it's almost that the cheapest form of energy saving is not using it at all. And so it's looking at those compute companies and those electrification companies to find those.

MB: So there's time for one more question. Can you give us an example where your engagement with a company has changed their position or strategy?

CC: Yes, maybe I'll go back to my mining example that we talked about earlier on. But if I've got time, I'll give you two. So one, Albemarle. So this is a company that we hold across a range of our funds, and it's a company that my colleagues in Global Income Growth, particularly, have led the engagement on over the last four years. So we've talked to Albemarle, who is a big lithium miner mainly in South America, about mining practices, about water use, about emissions.

And we've really been with them on a journey, supporting them about disclosure, about targets to manage that, about more academic work to understand their own position in the system, understand around water use, and supporting them in terms of driving forward their accreditation of their mining practices with IRMA, which is the Initiative for Responsible Mining [Assurance] globally.

So they now have a number of mines that are working towards or have that accreditation. And that's absolutely been critical to them signing up some of the big auto manufacturers to supply lithium from those specific mining projects. So it's worked through to give them a competitive advantage.

And the other one is a slightly esoteric one, which is actually to show that it's influences that matter as well as the picks and shovels... and that's Wayfair, which is a retailer of global furniture to the likes of you and I. So in the West, by

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

aggregating lots of suppliers across Asia. So they're a critical company, because they can help suppliers think about how they become more sustainable, use more sustainable materials. They can aggregate logistics to shift logistics towards green fuels, and they can inform us, as buyers, about durability and origin and so on.

So they're really important, actually, in sending out those messages across the piece. And again, we've worked with them over the last three or four years to improve their disclosure and their targets and plans for messaging.

MB: So I appreciate this is a vast topic, and it's been wide-ranging, but if you wanted to leave the audience with one thought in no more than a minute, what would it be?

CC: Okay, so all this scenario stuff, it sounds really complicated, and it's time-consuming, and that's our job. We should do it. So I think my one thing as to clients out there is, ask your asset manager, just in simple, plain English to say, here's a few views of the world, from the great to the not so great to the messy middle. How does my portfolio stack up against that? Have you got stuff in there which is betting on climate failure, really driving for climate success? How does it sit around the volatility? Don't give it to me in decimal points, but just explain it to me and how my portfolio sits up against these plausible futures.

MB: I've really enjoyed our conversation, the last in this series of Disruption Week. I hope you, the audience, have enjoyed it as much as Caroline and myself. And if you'd like to find out more about what else we've been discussing this week in Disruption Week, such as how physical and digital assets are merging together in a new wave of disruption, such as nuclear innovation, artificial intelligence, then check out our website at BaillieGifford.com/DisruptionWeek, where you'll find articles and recordings of the webinars.

And if you've got any questions or anything you'd like to raise, please get in touch with your client contact or email us at DisruptionWeek.com. Maybe you've got an idea of what you'd like us to discuss next year, and I hope you'll join us then. In the meantime, thanks for investing your time in Disruption Week.

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

Risk Factors

The views expressed should not be considered as advice or a recommendation to buy, sell or hold a particular investment. They reflect opinion and should not be taken as statements of fact nor should any reliance be placed on them when making investment decisions.

This communication was produced and approved in November 2023 and has not been updated subsequently. It represents views held at the time of writing and may not reflect current thinking.

Potential for Profit and Loss

All investment strategies have the potential for profit and loss, your or your clients' capital may be at risk. Past performance is not a guide to future returns.

This communication contains information on investments which does not constitute independent research. Accordingly, it is not subject to the protections afforded to independent research, but is classified as advertising under Art 68 of the Financial Services Act ('FinSA') and Baillie Gifford and its staff may have dealt in the investments concerned.

All information is sourced from Baillie Gifford & Co and is current unless otherwise stated.

The images used in this communication are for illustrative purposes only.

Important Information

Baillie Gifford & Co and Baillie Gifford & Co Limited are authorised and regulated by the Financial Conduct Authority (FCA). Baillie Gifford & Co Limited is an Authorised Corporate Director of OEICs.

Baillie Gifford Overseas Limited provides investment management and advisory services to non-UK Professional/Institutional clients only. Baillie Gifford Overseas Limited is wholly owned by Baillie Gifford & Co. Baillie Gifford & Co and Baillie Gifford Overseas Limited are authorised and regulated by the FCA in the UK.

Persons resident or domiciled outside the UK should consult with their professional advisers as to whether they require any governmental or other consents in order to enable them to invest, and with their tax advisers for advice relevant to their own particular circumstances.

Financial Intermediaries

This communication is suitable for use of financial intermediaries. Financial intermediaries are solely responsible for any further distribution and Baillie Gifford takes no responsibility for the reliance on this document by any other person who did not receive this document directly from Baillie Gifford.

Europe

Baillie Gifford Investment Management (Europe) Limited provides investment management and advisory services to European (excluding UK) clients. It was incorporated in Ireland in May 2018. Baillie Gifford Investment Management (Europe) Limited is authorised by the Central Bank of Ireland as an AIFM under the AIFM Regulations and as a UCITS management company under the UCITS Regulation. Baillie Gifford Investment Management (Europe) Limited is also authorised in accordance with Regulation 7 of the AIFM Regulations, to provide management of portfolios of investments, including Individual Portfolio Management ('IPM') and Non-Core Services. Baillie Gifford Investment

Baillie Gifford™

Management (Europe) Limited has been appointed as UCITS management company to the following UCITS umbrella company; Baillie Gifford Worldwide Funds plc. Through passporting it has established Baillie Gifford Investment Management (Europe) Limited (Frankfurt Branch) to market its investment management and advisory services and distribute Baillie Gifford Worldwide Funds plc in Germany. Similarly, it has established Baillie Gifford Investment Management (Europe) Limited (Amsterdam Branch) to market its investment management and advisory services and distribute Baillie Gifford Worldwide Funds plc in The Netherlands. Baillie Gifford Investment Management (Europe) Limited also has a representative office in Zurich, Switzerland pursuant to Art. 58 of the Federal Act on Financial Institutions ("FinIA"). The representative office is authorised by the Swiss Financial Market Supervisory Authority (FINMA). The representative office does not constitute a branch and therefore does not have authority to commit Baillie Gifford Investment Management (Europe) Limited. Baillie Gifford Investment Management (Europe) Limited is a wholly owned subsidiary of Baillie Gifford Overseas Limited, which is wholly owned by Baillie Gifford & Co. Baillie Gifford Overseas Limited and Baillie Gifford & Co are authorised and regulated in the UK by the Financial Conduct Authority.

China

Baillie Gifford Investment Management (Shanghai) Limited 柏基投资管理(上海)有限公司 ('BGIMS') is wholly owned by Baillie Gifford Overseas Limited and may provide investment research to the Baillie Gifford Group pursuant to applicable laws. BGIMS is incorporated in Shanghai in the People's Republic of China ('PRC') as a wholly foreign-owned limited liability company with a unified social credit code of 91310000MA1FL6KQ30. BGIMS is a registered Private Fund Manager with the Asset Management Association of China ('AMAC') and manages private security investment fund in the PRC, with a registration code of P1071226.

Baillie Gifford Overseas Investment Fund Management (Shanghai) Limited 柏基海外投资基金管理(上海)有限公司 ('BGQS') is a wholly owned subsidiary of BGIMS incorporated in Shanghai as a limited liability company with its unified social credit code of 91310000MA1FL7JFXQ. BGQS is a registered Private Fund Manager with AMAC with a registration code of P1071708. BGQS has been approved by Shanghai Municipal Financial Regulatory Bureau for the Qualified Domestic Limited Partners (QDLP) Pilot Program, under which it may raise funds from PRC investors for making overseas investments.

Hong Kong

Baillie Gifford Asia (Hong Kong) Limited 柏基亞洲(香港)有限公司 is wholly owned by Baillie Gifford Overseas Limited and holds a Type 1 and a Type 2 license from the Securities & Futures Commission of Hong Kong to market and distribute Baillie Gifford's range of collective investment schemes to professional investors in Hong Kong. Baillie Gifford Asia (Hong Kong) Limited 柏基亞洲(香港)有限公司 can be contacted at Suites 2713-2715, Two International Finance Centre, 8 Finance Street, Central, Hong Kong. Telephone +852 3756 5700.

South Korea

Baillie Gifford Overseas Limited is licensed with the Financial Services Commission in South Korea as a cross border Discretionary Investment Manager and Non-discretionary Investment Adviser.

Japan

Mitsubishi UFJ Baillie Gifford Asset Management Limited ('MUBGAM') is a joint venture company between Mitsubishi UFJ Trust & Banking Corporation and Baillie Gifford Overseas Limited. MUBGAM is authorised and regulated by the Financial Conduct Authority.

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.

Australia

Baillie Gifford Overseas Limited (ARBN 118 567 178) is registered as a foreign company under the Corporations Act 2001 (Cth) and holds Foreign Australian Financial Services Licence No 528911. This material is provided to you on the basis that you are a “wholesale client” within the meaning of section 761G of the Corporations Act 2001 (Cth) (“Corporations Act”). Please advise Baillie Gifford Overseas Limited immediately if you are not a wholesale client. In no circumstances may this material be made available to a “retail client” within the meaning of section 761G of the Corporations Act.

This material contains general information only. It does not take into account any person’s objectives, financial situation or needs.

South Africa

Baillie Gifford Overseas Limited is registered as a Foreign Financial Services Provider with the Financial Sector Conduct Authority in South Africa.

North America

Baillie Gifford International LLC is wholly owned by Baillie Gifford Overseas Limited; it was formed in Delaware in 2005 and is registered with the SEC. It is the legal entity through which Baillie Gifford Overseas Limited provides client service and marketing functions in North America. Baillie Gifford Overseas Limited is registered with the SEC in the United States of America.

The Manager is not resident in Canada, its head office and principal place of business is in Edinburgh, Scotland. Baillie Gifford Overseas Limited is regulated in Canada as a portfolio manager and exempt market dealer with the Ontario Securities Commission (‘OSC’). Its portfolio manager licence is currently passported into Alberta, Quebec, Saskatchewan, Manitoba and Newfoundland & Labrador whereas the exempt market dealer licence is passported across all Canadian provinces and territories. Baillie Gifford International LLC is regulated by the OSC as an exempt market and its licence is passported across all Canadian provinces and territories. Baillie Gifford Investment Management (Europe) Limited (‘BGE’) relies on the International Investment Fund Manager Exemption in the provinces of Ontario and Quebec.

Israel

Baillie Gifford Overseas Limited is not licensed under Israel’s Regulation of Investment Advising, Investment Marketing and Portfolio Management Law, 5755-1995 (the Advice Law) and does not carry insurance pursuant to the Advice Law. This material is only intended for those categories of Israeli residents who are qualified clients listed on the First Addendum to the Advice Law.

Baillie Gifford™

Calton Square, 1 Greenside Row, Edinburgh EH1 3AN
Telephone +44 (0)131 275 2000 / bailliegifford.com

Copyright © Baillie Gifford & Co 2023.