



HOUSE OF LORDS

Science and Technology Committee

Corrected oral evidence: Engineering biology

Tuesday 21 May 2024

10.15 am

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Members present: Baroness Brown of Cambridge (Chair); Lord Berkeley; Lord Borwick; Lord Drayson; Lord Lucas; Baroness Neuberger; Baroness Neville-Jones; Baroness Northover; Lord Rees of Ludlow; Viscount Stansgate; Baroness Willis of Summertown; Baroness Young of Old Scone.

Evidence Session No. 9

Heard in Public

Questions 182 - 198

Witnesses

I: Dr Peter Williams, Group Technology Director, INEOS; Dr Charles Hall, Head of Research, Peel Hunt; Greg Archer, Director of European Policy, LanzaTech UK.

USE OF THE TRANSCRIPT

1. This is a corrected transcript of evidence taken in public and webcast on www.parliamentlive.tv.

Examination of witnesses

Dr Peter Williams, Dr Charles Hall and Greg Archer.

Q182 The Chair: I welcome the witnesses to the committee's ninth session of its inquiry into engineering biology. Our witnesses today are: Greg Archer, the director of European policy at LanzaTech; Dr Charles Hall, head of research at Peel Hunt; and Dr Peter Williams, group technology director at INEOS.

The session is being broadcast live on parliamentlive.tv. You will be sent a transcript of the session shortly, and we would appreciate it if you could return it with any minor corrections needed. If you think of anything that you did not get a chance to say, or any data or any other information that would be useful to us, we would be delighted to receive it from you as formal evidence after this session.

We are interested in applications of engineering biology and the technologies that it enables in order to achieve goals such as decarbonisation and sustainable production, as well as economic benefit for the UK. So we would be really interested to hear about the applications of engineering biology in your companies or in the companies you invest in, those that you think will be most important, and how engineering biology is being used to innovate on existing products and processes. Again, there may be particular examples that you want to highlight.

We would also be interested in hearing about the major barriers to such engineering biology applications and projects. Are they barriers to investment or barriers of regulation, or indeed barriers of skills—things that we will want to pick up later in the session?

I will start with you, Charles, on the investment angle.

Dr Charles Hall: Thank you. I will start by telling you a bit about Peel Hunt. We are a leading UK investment bank focusing entirely on UK companies. As corporate advisers, we look after 150 companies, ranging from companies that are £10 billion market capitalisation down to £100 million. So we cover a broad spectrum of companies across all sectors. So I cannot say that this is my specialist subject, and I will leave it to the other gentlemen on the panel to talk through the applications.

We are interested in finding fund managers to invest in companies that are already listed, and to see the next generation of companies coming through and to enable them to secure finance. That is the crucial aspect; I am here today, because there is a dearth of capital to enable companies to grow in the UK. We may come back to that in another question.

We have a number of companies that play into this field. We have one in gene editing, Genus, which you may know, which is a champion of gene editing in the pig industry and the bovine industry and a very successful UK company; and there are others, whether it is ITM Power or Ceres Power, involved in energy transition.

So there are a number of companies involved in this space, but we need a lot more of them and a lot more finance going into these businesses. A key aspect and challenge is the time it takes to deliver on the projects and the risk appetite of some of the fund managers that invest in them. We may come back to that.

The Chair: Of the ones you mentioned, the one that presumably has some engineering biology applications is the gene editing for pigs and bovine pharmaceuticals. Is that correct?

Dr Charles Hall: This is in animal health. One company has a breakthrough technology that is involved in the treatment of a respiratory disease called PRRS. It is a UK company. It was founded in Oxford 60 or 70 years ago and is now a global market leader. So we should absolutely be championing them. The reality is that other countries, particularly the US, are championing them more than the UK is. Some of that is understandable, because the scale of the market is that much bigger. We are clearly looking to be a leader in gene editing and in a lot of applications across human as well as animal health, but at the moment we are a laggard compared to other countries. The company's particular technology has already been approved in Columbia and in Brazil and is going through the regulatory process in the States. Plenty more could be done in the UK to encourage that business and to support a national champion.

The Chair: Would you suggest that our regulatory processes are slow compared with these other countries?

Dr Charles Hall: Yes.

The Chair: We will come back to regulation and regulatory process later, but thank you. Peter?

Dr Peter Williams: I work with INEOS, and I am group technology director. I also head up investor relations and sit on the boards of three other companies, one of them developing a new bioproduct for the chemical industry.

From an INEOS perspective, we use engineering biology in the broadest sense, but remember that most of what INEOS does is making intermediates and polymers that end up in materials, so we

are well out of the gene editing side, for example, of engineering biology, and looking more for practical applications, developing bio feedstocks and bio approaches to new products. We are doing that today. We feed bio-based feedstocks, for example, in our processes, and we make modest quantities of bioproducts today. We look at all options for reducing the greenhouse gas and environmental footprint of the products that we make.

The single most important problem for us in trying to commercialise, to scale the approach is the availability of feedstock—bio feedstocks are in pretty short supply—as well as the economics, because any company has to make sure that it can achieve a return. Investment is needed if we are to achieve a sustainable future. To make those investments, return is needed to be able to afford them, so the economics are an issue. That may change over time. There is perhaps a UK perspective there, but there is obviously a global perspective.

The final thing to say from an INEOS perspective is that for a company like INEOS—I think it applies to others as well—we have an international view, so whatever we do in the UK has to be competitive with whatever we can do elsewhere. That starts to speak to some of the frameworks required in the UK for the application and development of this technology, at least in our field.

The Chair: When you say the availability of feedstocks, is that things like biogenic CO₂ or crops or—?

Dr Peter Williams: It is biomass-based feedstocks initially, because those are available in modest quantities today. If we look to the future, I think we will all be hopeful that you can convert biogenic CO₂ e.g. atmospheric CO₂, but that is some distance off, and that will not help us to address greenhouse gas emission growth, for example, in the next 10 or 20 years. However, it is important work to do for the future, and we recognise that as well.

Q183 **The Chair:** Are you closely engaged with the universities and the research sector in looking at what new things are coming through in the engineering and biology area that might change your processes, or accelerate them, or whatever?

Dr Peter Williams: We certainly do work with universities. I would not like to say that we are very broadly or intensively engaged, although we are engaged. We are also engaged with smaller companies that have started up recently, which are developing and trying to scale some of the technologies. That also applies to the recycling area, not just the bio—if I can call it that—area.

Greg Archer: LanzaTech is a carbon capture and transformation company. We capture the waste gases from industrial processes, and we can also gasify solid wastes from agriculture or municipal waste. We feed those gases to a biocatalyst—a bacteria, which produces ethanol on a commercial scale. Then we turn that ethanol through other processes into a whole range of products, including sustainable aviation fuel but also textiles, running shoes, fragrances, plastics, detergents—all manner of things in the chemical supply chain.

Our mission is to replace the fossil carbon that is currently going into sectors that cannot be decarbonised, such as jet fuel and chemicals, and replace that with above-ground carbon, recycled by using our biocatalyst. It is a commercially scaled technology now; we have six sites around the world, and we are at the moment developing a project in Port Talbot in Wales to produce sustainable aviation fuel from waste industrial gases.

We face three main challenges. The first is to have markets for our products. We are beginning to see mandates coming in for sustainable aviation fuels, creating markets in that sector, but there is no requirement on the chemicals industry, for example, to begin to phase out the use of virgin fossil fuels as a feedstock for their chemical processes. We have targets for the car industry to phase out and shift to electric vehicles, for electricity to shift to renewables, but at the moment there is no responsibility on the chemical industry to switch. We need markets created to scale.

The second issue that we face is one of feedstocks, which has been mentioned. In the short term, we will use industrial waste gases. In the medium term, we can use solid wastes. In the long term, we can take CO₂ from the air through direct air capture and we can recycle that, but that is a very expensive process at present and one that requires enormous amounts of renewable electricity, both for the direct air capture and for the hydrogen. So we have a technology that has longevity, but we need to get it started using waste fossil gases today.

The third issue that we face is investment. A lot of these are new technologies. They are not first of a kind—we have six facilities around the world—but they are ones where there is still uncertainty about investing in them, and the scale of the capital investment required is very considerable; you are looking at anything from between £500 million to £1 billion for each site.

The Chair: Where do you find it easiest to get investment?

Greg Archer: We have been very successful, fortunately, with a tie-up with Brookfield Asset Management, which has made a commitment to supply at least \$500 million to LanzaTech to roll out our gas fermentation technology, using the waste gases with the biocatalyst to produce the ethanol that we can then supply into markets. So it has been a very strong supporter of us, but we struggle more with other forms. We have been very successful with venture capital in the past—LanzaTech moved to the US from New Zealand originally to access those venture markets—but, in general, other forms of investment such as banks are still reluctant in this sector.

Q184 **Baroness Willis of Summertown:** My questions are really about the larger company uptake of engineering biology. We have been hearing a lot from the start-ups saying what novel processes they are following. I will appreciate hearing your thoughts on how much of your own strategic direction is looking at and bringing in novel technologies and R&D, and how much it is just building on business as usual.

Dr Peter Williams: We have a requirement to transition to a “net zero” economy. We have set targets for a 33% reduction by 2030, compared to 2019, and net zero by 2050. There are many different ways to achieve that: simple efficiency improvements; electrification; acquiring more renewable energy; carbon capture—we are doing carbon storage at the moment in the North Sea—and we have been capturing carbon for 15 years now off some of our assets. Bio feedstocks and bio approaches represent one element of those different approaches to achieving the targets. We need an investment in new assets, because we cannot run around in 30 year-old cars; we need to run around in modern equivalents. It is just the same in the chemical industry: you have to be able to afford the investment. So we are investing billions in projects that will transform some of the European chemical industry.

In that mix is biotechnology. We do not know which approaches will work better than other approaches, so there will always be a do-learn-do. But we are engaging in that with universities, and in our own facilities, and trying to understand how we can make bio approaches work. As I said, we are already doing that; we are marketing bio PVC today, and we have marketed some biophenol, and so on. So we are making some progress but, for the reasons we have just discussed, there are obstacles to that. As a large international company with about a euro 65 billion in turnover, we have to look at all avenues as we execute this transition.

Baroness Willis of Summertown: As you have described it, the drive to look at these different engineering biology aspects is more

about the requirements to get closer to net zero than anything else.

Dr Peter Williams: Absolutely. I understand the engineering biology field to some modest extent, and it is clearly a really exciting field, with gene editing work and so on. There are many good aspects of engineering biology, and I would recommend someone to follow it. But for the chemical industry, for making modern materials, our job is really to make sure that, in providing the emerging low carbon market with its requirement for low-carbon or zero-carbon materials, we have to use every approach we can to achieve that. These materials have been selected because of their low environmental footprint relative to other materials and their low cost. That is something that we have in mind.

Our market is changing, and we are having to work towards that market. We want to be there in 10, 20, 30, 40 years' time. We have always wanted that, but use of bio feeds one aspect of our approach. I assisted in a Royal Society study recently—in fact, I helped write some of it—on how to defossilise the chemical industry. If you read that study—it is now publicly available—you will see that there are several approaches proposed. But there is a recognition that this will take some time. It took us 10 years to switch from town gas to natural gas. These things take time.

Q185 **Baroness Willis of Summertown:** Greg, clearly you are dealing with very different organisms and different approaches. How much of your work is R&D and focused on the engineering biology side of things?

Greg Archer: LanzaTech is not a big company. It has only about 400 staff globally, but a very big part of our company's ethos is in engineering biology. Our bacteria—we use *Clostridium*—is naturally occurring, and we have selectively bred it to improve the yields of ethanol that it creates. But we also have an extensive gene-editing programme, in which we exchange certain genes within that bacteria for genes in other bacteria. If we do that, the bacteria no longer produces ethanol—it produces other chemical species. It will produce acetone or monoethylene glycol, one of the key building blocks to produce polyester fibres. We have synthesised well over 100 different chemical species.

Our intention is that we use our existing hardware—the bioreactors in which we feed the gases into the solution of bacteria to produce the ethanol—but simply change the bacteria like changing software. That system, that plant, would then produce a different chemical species. We have done this on a demonstration scale now, but our

intention would be to start to supply this as bulk chemicals into a whole range of the chemical industry.

In this way, you start to shorten the transition pathways in the chemical industry, so rather than going from ethanol to ethylene to ethylene oxide to monoethylene glycol, you could just produce monoethylene glycol directly, which is a much more energy-efficient process. In this way, we are starting to decarbonise the chemical industry by producing specific projects using biology—something that simply cannot be done in a single step through thermochemical processes.

Q186 Baroness Willis of Summertown: We have also heard about lots of start-ups doing really innovative new work. How easy is it for larger companies like you to partner with those smaller start-ups? Are there barriers to being able to do that?

Dr Peter Williams: I do not perceive any barriers. We are doing that today; we are partnering with a number of companies. I do not perceive any real barriers to that. I think the barriers to getting to the right scale lie elsewhere.

Baroness Willis of Summertown: So it is a scaling issue.

Dr Peter Williams: The world requires huge volumes of materials at the moment, and that demand is growing. With polymers and materials alone it comes to 450 million tonnes a year. To make inroads into that, we have to be able to scale, and that is where the obstacles lie.

Baroness Willis of Summertown: Are there particular examples where we do that well? We hear what the problems are, but is there a particular ecosystem where we are able to scale up well in this country?

Dr Peter Williams: To a certain scale, yes. Another thing I am involved with is a smart sustainable plastic packaging initiative, which is run by UKRI. There are a couple of successes coming out of that in terms of getting to a certain scale, but implanting that scale, and growing from it, is quite difficult in the UK. That is not because the technology does or does not work; it is just quite difficult. There needs to be an holistic framework for the development of that sort of approach.

The Chair: That is the perfect point to hand over to Lord Drayson, who I am sure will want to follow up on that comment.

Q187 Lord Drayson: For the record, I should note that Peel Hunt was the investment bank that IPO-ed Sensyne Health in 2018, the

company that I founded.

As mentioned, I want to focus on the investment environment for companies in engineering biology and for the wider ecosystem of start-up technology companies. We have already heard extensively from witnesses to the inquiry that innovative companies are finding it very difficult to raise investment and to scale in the UK. It is hard to obtain funding and, as a result, companies are increasingly listing and moving overseas, especially to the US. We are acutely aware of the problem. What do you think the next Government could do to help to solve it?

Dr Charles Hall: You are absolutely right that there is a problem. It has been like boiling a frog, in that this problem has been coming for years and the temperature is getting pretty hot. We are seeing a large number of our companies being acquired by overseas businesses. That normal cut and thrust of M&A is not necessarily a bad thing, but you have to look at the root cause of it, which is the valuation of UK companies in comparison to our overseas counterparts. What is causing that undervaluation is the fact that we are world experts in exporting our capital and not keeping it in the UK.

If you look at all the different pockets of investment, that is happening across the board. Pensions are going global, wealth managers are going global, and retail investors are increasingly going global. We are given tax incentives to enable people to globalise their portfolios. As an individual or an individual pension fund, that is no problem at all, and all the consultants will say that you are doing absolutely the right thing, but for a country it is a disaster, because we are not retaining capital in the UK.

We are seeing that the equity capital markets in the UK are reducing considerably as a proportion of the overall market. Just in the last 10 years, our overall proportion of the UK compared to the global indices has halved. That is a really significant reduction in just 10 years. That means that the capital is increasingly going to the US. We cannot complain about that, because the US has a great economy and a great system, and it has loads of investors and deep pockets. We have to enable people to invest in the UK and think that that is a good thing.

There are a number of things that we can do to reverse this issue really quickly. Within a year, we could enable the UK to become what it used to be as the finance hub not only of UK companies but of overseas companies. There are some relatively simple things to do on pension reform and ISAs, so encouraging people to invest in the UK, as well as on stamp duty, and encouraging entrepreneurs

to grow their companies and scale in the UK. More than 40% of our stock market was owned by pensions only 25 years ago. That is now down to 4%. We have globalised and diversified and moved into passive investments, and that really matters because it is active fund managers that invest in technology and projects. Passive investors never do so. You also have the fact that consultants will be saying that it is a great thing to be diversified. Again, that is great for the individual pension and disastrous for us.

We can learn from other countries. Australia was in a similar position to us 25 years ago, and it now has one of the best pension markets in the world. Its people are putting enough money into their pensions, unlike us: we will have a nation of very poor pensioners in 20, 30, 40 years' time, because we just do not put enough into our pensions. But they also invest significantly in Australia. The AustralianSuper fund is the poster child here; it invests 23% of the Australian contributors into the scheme into Australia.

Compare similar UK funds to that and it is more like 5%. That is a dramatic difference, not a slight one. The Australian equity market has much more capital involved in it, and the Australian economy is growing faster. With Sweden it is exactly the same; they are investing actively in their pensions, the pensions invest actively in Sweden, and as a result they create national champions. The Swedish stock market is doing really well. For a relatively small economy, it is batting considerably above the normal average.

With pensions, we are starting to move on that—we will come back to the Mansion House compact—but we need to move faster and further to make this a situation where we are enabling pensioners' money to grow the UK economy. It is to everyone's benefit—and it is to the pensioners' benefit, because the reality is that the vast majority of those pensioners are going to live in the UK, and if we do not generate economic growth we are not generating tax revenues to invest in the NHS, defence and all the other things that we want. Why have we underperformed for the last 25 years? A huge amount of it can be put down to pensions alone. There are so many issues with our pensions system that one could go into that we could be here all day.

Q188 Lord Drayson: Before going a bit deeper into the Mansion House reforms, you said something interesting earlier about how government should encourage entrepreneurs to scale and grow in the UK. Do you and the rest of the panel have any specific thoughts on what government should do to do that?

Dr Charles Hall: People have forgotten the value of equity. Equity is permanent capital: once you have raised it, you never have to refinance it, you never have a coupon that you have to pay on it, so it is there permanently. When we are enabling companies to grow, equity capital is the best way for a small growth company that needs funds to enable it to have a long-term future. Trying to do that out of asset finance or banking finance is incredibly challenging.

We need to encourage our equity market. Over the last few years, all the reasons for investing in the UK have become worse because of our dividend tax, capital gains tax, stamp duty. Effectively, everyone is being encouraged to invest overseas, because we have the second highest stamp duty tax in the world. It is no wonder that people are investing in the States rather than in the UK.

Lord Drayson: So effectively it is about tax reform, you think.

Dr Charles Hall: A lot of it is taxation. Some of it is cultural; entrepreneurs in the UK do not get the respect they deserve. Also, there is no desire to grow and scale their businesses. I think INEOS will be very different, but the culture generally does not enable companies to grow in the UK. There are also tax incentives effectively to sell out far too early. Typically, we have quite good seed money but very poor scale-up money, and the reality is that when you get to a certain size, floating in the US or selling out to an overseas company becomes more and more attractive. That is what we see a huge amount of the time.

If you do not create the ecosystem in the UK, it is no surprise that people try to get funding from the US. That is where all the deep pockets are. We have to ensure that capital stays in the UK. We have the expertise in the UK. Inevitably, if you are a company that has some good technology, you are growing quickly and all your capital comes from the States, the first thing those funders want you to do is to grow in the US, to create jobs in the US, to generate government financing from the US. Effectively, all that happens is that your business rapidly tilts towards US growth. Then, of course, they have some large companies that will snap up quite a lot of our growing technology businesses.

Q189 **Lord Drayson:** Dr Williams, part of the remit of the inquiry is to understand the likelihood of the present Government's policy identifying engineering biology as a driver of economic growth for the UK. INEOS is a rare example of a company that has massive scale. What would you like to say on the issue of the culture and the investment environment? How can we create more INEOS-es out of the science base that we have?

Dr Peter Williams: Bear in mind that INEOS has many more assets outside the UK than in it. The whole ecosystem has to include the end use, because if it is going to be a benefit for the UK, it probably means that you are going to manufacture something in the UK. Manufacturing in the UK as a contribution to UK GDP has fallen from 16% or 17% to 8% or 9%. It has halved over the last couple of decades. With that halving goes the ecosystem that you need in the manufacturing base. If I were looking at developing and applying a new technology, I would want not only the finance—Charles has given a sense of that very well—but to know that I had the ecosystem there beyond the finance in the application and the markets to achieve that in the UK as opposed to somewhere else.

One recent discontinuity in these sorts of areas has been the Inflation Reduction Act. For good or bad—one can comment on how that is operating—it has channelled a lot of investment thinking to the US. For our sort of industry, those incentives do not really exist in the UK. In fuels, perhaps, they do. Biomass in the UK will probably be snapped up by fuels because of the incentives there, but to my knowledge—I may be wrong—there are no incentives for materials and chemicals. There is that imbalance and a lack of a manufacturing base. If I were a young person coming in now and someone said chemical industry UK, I would say maybe, but maybe I will go elsewhere.

Lord Drayson: Maybe engineering biology UK, if we can find a way of solving those problems.

Dr Peter Williams: If it can be applied, I totally agree. There is obviously fantastic stuff going on, so I am only talking about my narrow chemicals perspective.

Q190 **Lord Drayson:** Charles, going back to the pension reforms, do you think that the Mansion House reforms go far enough? Do you think they are going to work?

Dr Charles Hall: I am hopeful that they will, but they do not go far enough and they are too slow. There is obviously talk of 5% by 2030, which gives a lot of opportunity to drag heels. Having talked to a number of pension funds, I know that one or two are going to move more rapidly, which is really encouraging. One or two want to set an example and say that they are doing this because it is the right thing to do and because they will get a good return.

We want our pension funds to earn a good return. There are a lot of question marks over whether investment in the UK means you will get a poor return. The reality is that for the last 25 years there

has been a poor return compared to the States, but that is largely because pension funds have been selling out of the UK. If they were actually investing in the UK, we might see a better return.

There is a growing will, but it needs to move a lot faster and have more energy and commitment. There are definitely some early signs of improvement, but we have a long way to go. A lot of the issue in the UK is a concern about risk. We have an incredibly risk-averse society, which we will come back to in relation to regulation. So many of our products and so much of our attitude towards investment is that we have to avoid risk. In this area, the reality is that you have to invest in risk and be prepared to invest for quite some time.

Lord Drayson: To do that, you have to reasonably understand risk. One of the points made by previous witnesses is that there is a difference in expertise in the UK compared to other markets, particularly the US, in the sophistication of the understanding of investors in technology. There has been a decline in this expertise. First, is it true that there really is a difference? Secondly, if so, what could the Government do to fix it? We really need to make a change to this and to understand which levers are likely to work.

Dr Charles Hall: It is true, and it is likely to get worse because of the reduction in the UK equity market and the large number of our companies being sold. Effectively the ecosystem goes with that. We absolutely need to encourage greater expertise in the UK. You cannot do that overnight, but you can have a number of UK champions and then the expertise builds around it. France does this much more successfully than we do. They have a number of organisations that aim to scale and grow companies and then to enable them to IPO. Then, they will be cornerstone investors. Caisse des dépôts is a really good example.

Their attitude is to build a whole ecosystem around that, particularly of asset managers, to make sure that you have experts in particularly precise areas. It is no good being a generalist, because, as you say, the US has expertise across so many different areas, and we have to compete against that. We cannot just assume that we will be fine and that the US will let us grow our economy. We have to enable it to happen ourselves.

Q191 **Lord Drayson:** Mr Archer, we have heard that UK investors tend to focus on financials, while US investors focus on science and technology. Has that been your experience?

Greg Archer: No. I think US investors are very focused on the bottom line as well. They are certainly interested in technology, but

they still expect technology companies like ours to deliver significant revenues and returns for them. Sometimes we get the false impression that the appetite of US investors is just for technology. They are looking for a return too.

Dr Peter Williams: I agree. The financial questions from investors are much more perceptive, frankly, than the ones we receive in our London day. We did this just last week. I held a day in New York and a day in London, and the New York one was much more focused on the financials.

Q192 **Lord Drayson:** What can a Government do to improve UK investors' ability to assess risk and make more investments?

Dr Peter Williams: I am afraid I am not sure that I have a clear answer to that one.

Greg Archer: There are some good examples. The Government have been very keen to develop a market or production of sustainable aviation fuels, as well as to create a market for the airlines. To encourage investment in the sector for what are very high capital-intensive plant, they are developing a revenue certainty mechanism—a contract for difference type of scheme—that will guarantee revenues for investors if the price of sustainable aviation fuel drops very low, for example.

That scheme is being developed far too slowly. We are looking for investment now and it will not be in place until the end of 2026 or beginning of 2027. So when we talk to investors, they say to us, "Come back in two years' time", which is not very helpful for us, but the fact that the Government are putting that scheme in place will benefit future companies that are looking to secure investment. Our problem is that we need an interim solution now, which the Government are not moving forward with at the moment, but that is an example.

Another example is the reason why we are planning to build our facility in the UK, as well as elsewhere. It is because the Government put up £25 million through their advanced fuels fund to help us take the project to a final investment decision. We have been supported with the front-end engineering design, the costs of the planning and permitting, by securing the offtake agreements and so forth to get us to a final investment decision with public money. That is why we are developing that project in Port Talbot rather than in Ghent or some other place in Europe or the rest of the world. There are at least five very well-developed projects—first-of-a-kind SAF production facilities—that have benefited from that scheme. They are all at a similar stage to us and could make

the UK a real leader in producing advanced sustainable aviation fuels, so there are good examples out there.

Dr Charles Hall: I have another example on the pensions front. If you have greater scale in pensions, you can have a greater risk appetite, because you can diversify your risk more effectively. One of the problems we have had in the UK is a very disparate pensions market. I know that some action is being taken to move to a more consolidated pension market. We have one of the largest pension assets in the world—£2.5 trillion—so there is huge firepower there, but at the moment we are not using it to grow the UK economy, and the structure is not right to enable that to happen.

Dr Peter Williams: I will just add one more thing, which is not specific to engineering biology but is similar to the line that Greg was just describing, and it is carbon capture and storage in the UK. It is an example that, if translated into the engineering biology area, would have the same effect, but it is very slow to develop. All the right ideas are there, but the funding just has not arrived for the infrastructure side from government, and speed is important. People are probably having to re-engineer projects in some areas. This is not engineering biology, but it is symptomatic, as the UK could be quite a substantial leader in this area.

The Chair: I would like to follow up on a comment. As you were answering the last question, Peter, you said that the UK is a good place to build a company to a certain size.

Dr Peter Williams: I am not sure I said that it is a good place. It is a reasonable place to do that. You can achieve a certain size, but going beyond that scale requires a base of manufacturing, probably, of feedstock, skills et cetera, plus reliable energy pricing looking forward. The UK is quite a volatile place for energy prices, which also creates uncertainty. It is critical that the UK focuses on a really coherent, long-lasting energy policy, beyond one term of Parliament.

The Chair: That also implies an industrial strategy.

Dr Peter Williams: Yes, it does. I was more reluctant to say that, but it requires an industrial strategy. We need that honest conversation about where our energy comes from and where it needs to come from, where our materials come from and where they need to come from in the future, and what new materials are required. My perception is that we do not have that honest conversation, so, frankly, we end up with one-liners, soundbites and so on, instead of a coherent thought process that leads to

actions that last beyond one Parliament. That is an important thing for the Government to try to achieve.

The Chair: That is just the sort of issue that Lord Lucas is going to explore.

Q193 **Lord Lucas:** If we are going to decarbonise chemistry and jet fuels, we will need a lot of carbon. Do we know where that will come from? Can you sketch where you think it is coming from? Are we yet at a stage where using these feedstocks, which tend to be quite dispersed, is economic, or do we have to wait until we are not allowed to use fossil fuels anymore?

Greg Archer: There is undoubtedly a shortage of feedstock available, but that is largely because we are wasting a lot of the waste that is available. We are still incinerating large amounts of our municipal and other wastes. We are producing very high carbon-intensity electricity in some cases, but in some cases without any energy recovery at all. These are valuable resources. Instead of incinerating these waste products, we could be gasifying, capturing the carbon and reusing it to make new chemical products. In that way, we would create a circular carbon system in which, rather than continually relying on more fossil carbon from below the ground, we recycle the above-ground carbon that we have and reuse it.

But that requires a change in policy. It requires us to stop incinerating huge quantities of waste, as we are today, and to recognise that carbon is a valuable product, not just a pollutant, to transform the way we look at it. If we did that and made use of the industrial waste gases that exist today—for example, things from steelworks or non-ferrous metal processes—we would begin to capture and reuse that carbon. That becomes an intermediate technology until we have brought down the costs of renewable electricity and have cheaper hydrogen, so we can start to make use of the long-term source of carbon, which is taking it out of the air for direct air capture.

So there is plenty of carbon available. We have to develop a plan that will transition us to the point where we have entirely sustainable feedstocks. Sometimes we are looking to reach the ultimate goal today, but we should recognise that these technologies are still maturing and that it will be an energy and feedstock transition, not the instant solution that we want today. That is part of our challenge: we sometimes allow the best to become the enemy of the good, and we put barriers in the way of good technology today, preventing it from scaling and its costs

coming down and therefore preventing it from becoming the excellent technology of the future.

Dr Peter Williams: I agree (on the barriers point). It is a transition: you cannot go from A to Z straightaway. The investment cycles and so on do not permit it.

Recycling carbon, whether it is plastics recycling, CO₂ recycling—that is, using waste CO₂ and so on—or ultimately doing what plant matter does and using CO₂ directly from the atmosphere in the more efficient way, it can be done eventually, but it is a transition. It is do-learn-do.

If you look at the analyses in this area, a professor at Oxford, Myles Allen, puts it very well. He says that we need to wean ourselves off CO₂ emissions before we wean ourselves off hydrocarbons. That is simply a function of time and effort. It will take us a while to get there, but if we have that in mind and start to use technologies that can mitigate against any hydrocarbons we use—plus developing recycling infrastructure—there are opportunities there, I think.

Ultimately, sustainability is also about economics. Different companies, whoever they are—INEOS, LanzaTech or whoever—have to be able to make some return on the investment to afford the investment in the first place. That is critical. We need to reinvest.

Lord Lucas: So what do the Government need to do to take you and other big companies, such as BP and Shell, down this economic road successfully?

Greg Archer: One thing they need to do is stop overcomplicating regulation. That is not just a problem in the UK; it is an even bigger problem in Europe, with the European Commission. Let me give you an example. We were based in Port Talbot, because we planned to use the blast furnace gases from the Tata steelworks. Those blast furnaces are closing, but we can still use the CO₂ that comes from an electric arc furnace—or we can use another source of CO₂ in the area, combine that with green hydrogen and feed it to our biocatalyst, which will produce ethanol—but we cannot get benefit from the Government's hydrogen production business model and use that hydrogen to make a sustainable aviation fuel that we can sell toward the SAF mandate in the UK. The Government do not allow you to get benefit from the hydrogen production business model and the SAF mandate. We could be a really great offtake for a large electrolyser of 300 megawatts, buying most of its hydrogen and turning it into sustainable aviation

fuel that we sell into the UK market, but the rules do not let us do that at the present time. It is just putting barriers in the way.

There are also enormously onerous additional requirements on the hydrogen we produce as to where the electricity comes from. Yet we know that the UK electricity grids will be decarbonised in the next 10 years anyway. So we are loading additional complexity on to project developers while the electricity grids are decarbonising anyway. We just need to start joining the dots a bit more. Policy will then enable the kinds of investments that we want to make.

Dr Peter Williams: This comes back to my point that we need an honest conversation about where our materials and energy come from. That is really important. For example, if we want to run electric vehicles and increase those, and we want to make electrically generated hydrogen, there will be loads on the grid. I am sure some of your witnesses must have talked about loads on the grid and the reinvestment required there.

It is about the holistic picture that needs to be created. What is required holistically to deliver that transition? That is really important, and it includes the Treasury. For example, we are investing in the UK in advanced recycling for certain materials today, but it does not exempt taxes on packaging. So we are investing in recycling, and through some government investment, but the Treasury does not recognise that as recycled material when it comes to taxes. That is changing at the moment, I think—I do not think it has already changed—but that is all delay, at the end of the day. Once we have decided to recycle, the picture should be: how do we make sure that all government departments are on board with the recycling approach? That will apply to biomass as well.

Lord Lucas: So what should our approach be to the waste that we are currently burning and, indeed, to all the agricultural waste that we are currently not using or are tipping into rivers? How should we be moving from where we are now to where we would like to be?

Dr Peter Williams: I come back to what, for me, is the starting place. There has to be a clear understanding of what we use today, why we use it, what energy we require today, and how those materials and energy pictures need to change in the future. Unless we define the problem, I honestly do not see how we solve it in an efficient and effective way. I do not think that is there at the moment. All the right ideas are there; I just do not think they are grouped in the right sort of way at the moment.

Greg Archer: We need to recognise that some sectors, such as electricity and electric vehicles, can decarbonise very effectively, while some sectors, such as the chemical industry and sustainable jet fuels, will always rely on carbon in some form. We need to begin to direct the important carbon resources that we have in our wastes towards the sectors that will need them, rather than just allowing them to be incinerated, with the carbon lost into the air and creating a continuation of the environmental crisis. We have to redirect those carbon resources to where they are most needed. That policy is not happening at the moment.

Dr Peter Williams: That conversation is not happening at all.

Lord Lucas: It is not a conversation?

Dr Peter Williams: I do not think so, no. I do not see it, anyway.

Lord Lucas: I have hit a brick wall with Defra on agricultural waste, so I am not surprised to hear that.

Dr Peter Williams: We are importing biomass into the largest single emitter of CO₂ in the country at the moment from North America. That is an example. When you are dealing with biomass, you have to be very careful that that biomass is regenerated, because it creates a debt that needs repaying when you use biomass for that sort of purpose. This is the sort of thinking that is required.

The Chair: We should move on to Lord Borwick and explore that regulation area a bit further, if that is okay.

Q194 **Lord Borwick:** Obviously, it is easier to regulate something that is stable and not changing, but it is the essence of engineering biology that it changes almost daily. It must be very hard for the regulators to regulate something that they have never seen or even conceived of before that time. Do they have the skills to cope with this rapidly changing market, and do they have the resources to gain those skills?

Dr Peter Williams: I do not know. Perhaps my colleagues do.

Greg Archer: We are in quite a fortunate position with the Clostridium bacteria that we use, in that it is naturally occurring and is classed in the safest category of bacteria by the World Health Organization. Our bacteria is classed at the same level as yeast, so from a regulatory perspective we do not have too many problems convincing people of the safety of our products. The bacteria is also anoxic. As soon as it comes into contact with air, it dies, so it cannot escape either. From our point of view, we have

been quite fortunate in not having onerous requirements imposed on us.

Lord Borwick: Did you choose that particular bacteria because of its ability to cope with the regulations?

Greg Archer: No. We chose it because it produced ethanol; it is very unusual in that. It is a fortunate coincidence that it cannot escape and is perfectly safe.

Lord Borwick: But we need to set up a regulatory system that will cope with everything, rather than just the most fortunate stuff.

Dr Peter Williams: Does it not need to cope with things as they arise, rather than with everything that we cannot imagine yet?

Lord Borwick: Absolutely. Do you think it does?

Dr Peter Williams: In terms of resources, I honestly do not know. From the couple of examples that I am aware of, I think it can cope in principle, but it is how the regulation is then formulated that is really quite important. It is not necessarily a resource issue; it may be how the regulation is formulated.

Q195 **Lord Borwick:** Do you think that the formulation of the regulation is more important than the regulator?

Dr Peter Williams: Regulation is clearly a driver for change and innovation, so it needs to be thoughtful. That is rather important.

Baroness Neville-Jones: It can also be an obstacle.

The Chair: An issue we have found with regulation is that, partly because engineering biology can produce products for human and animal health, products for potentially fuelling aircraft and products that we might eat, is that there is quite a wide range of regulators involved. We have been trying to explore whether it is easy to find out, if you are in different parts of this field, which regulator is relevant or how many of them you need to engage with. Have you had any experience of it not being clear which regulators are relevant or can make the decisions?

Greg Archer: Before I came here, I tried to check which regulator we would need to use, but I was not able to find out. It was not an exhaustive search, but it is still an illustration of the fact that there is a degree of confusion. I am sorry that I cannot answer the question in more detail, because I do not have that experience.

Lord Borwick: Mr Hall, do you value companies and sectors with a better regulator?

Dr Charles Hall: When I am speaking to global investors and they are thinking about the UK, regulation is one of the aspects that they ask about, because their perception is that we overregulate and then change our minds, and that we have backwards-looking regulations that have negative connotations for investment. Our regulatory system is definitely seen as a negative for an investment flow into the UK.

My viewpoint from the financial world is that there is generally a view that we have to protect everyone, and we move to the lowest common denominator. A good example of that is calling investors “consumers” as though they need to be protected from themselves. That is extraordinary when you can invest in cryptocurrency with no trouble, but if you invest in Shell you need protecting. That is often the wrong way around.

We see the best regulation when practitioners are brought in from the industry who have real-life experience of the difficulties of funding and coping with regulation, and of the huge burden of reporting that we have, which is a massive issue. Some regulation is definitely good, do not get me wrong; I am very supportive of a lot of the ESG criteria that have been put together, which has a proper drag effect. We were talking earlier about needing the demand side to come through in the UK, and a lot of the investors are putting pressure on companies to help to drive the demand side. However, the scale of the burden is enormous. It is really challenging for a lot of smaller companies in particular to run their businesses and manage the regulatory side. If there was one thing I would change, it would be to make every regulator bring experts on secondment so that they understood how running a business worked.

Lord Borwick: That is asking quite a lot.

Dr Charles Hall: I do not think so at all. It is relatively straightforward when you think of the budgets that a lot of regulators have. We are already doing it; the FCA is now bringing people in from industry, and that is just starting. It is incredibly healthy to understand the real-life impact.

Lord Borwick: Oh, I entirely agree.

Dr Charles Hall: We see all the time that the unintended consequences of regulation are endless.

Dr Peter Williams: So they should recruit from industry.

Lord Borwick: In many cases they would rather recruit from other parts of the Civil Service. Is that not right?

Dr Charles Hall: Yes. They are very bright people, so there is plenty of skill, but generally, and particularly in this area, you have to educate yourself in the industry you are trying to regulate before you even regulate, which is partly why it took so long. A lot of our regulation takes far too long. The CMA is a classic example of that; inquiries can last three years. That is just crazy. Who can run a business when you do not know what you are doing for three years?

Q196 **Baroness Young of Old Scone:** That is quite a good point to come in on, because my experience at the Environment Agency was that our best regulation was done when we had people in from the businesses we were regulating, partly because they knew where the bodies were buried.

My question is different. It is about the reverse side of regulation, which is voluntary approaches, assurance schemes and those sorts of things. I will direct this to Peter and Greg. How far do you think that environment of assurance schemes is developing, and how effective do you think it might be? Is it sporadic and patchy?

Dr Peter Williams: Sorry, which sort of assurance schemes do you mean?

Baroness Young of Old Scone: Things like the round table on sustainable biomaterials—that kind of supply chain assurance.

Dr Peter Williams: We are being required in Europe as of financial year 2025, and already in the UK, to provide verifiable assurances over supply chains. To be quite honest, I do not have any direct experience that can be helpful to you there. I am probably not the right person from INEOS for that, and I do not want to talk about things that I cannot make a proper contribution on.

Baroness Young of Old Scone: So there would be no overarching commitment from INEOS to involve yourselves in voluntary assurance schemes that to some extent would be a substitution for regulation.

Dr Peter Williams: I am aware that we do so in some areas. Animal testing, for example, is an issue. We are lobbying to make sure that animal testing is no longer required and is replaced by other methods. That is the sort of approach we would take, but I cannot give you a firm example today.

Greg Archer: I can help you. LanzaTech relies extensively on voluntary assurance schemes of different types to demonstrate the validity of the feedstocks that we are using and our processes, to demonstrate that we comply with EU regulations or UK regulations,

where we are sourcing feedstock from and so forth. I was extensively involved in this when I originally set up the regulations on biofuels 10 or 15 years ago.

I think the answer is that there is no real alternative to these types of supply chain assurance schemes. The big question is who audits the auditors. There has to be proper scrutiny of the way in which schemes are operating, particularly when they are pseudo-regulatory, because a lot of the assurance schemes are being used to demonstrate that regulations of one form or another are being met. If there is proper scrutiny of the way those assurance schemes are operating by the European Commission, the Department for Transport, Defra or the Environment Agency, they can be very successful, but there are too many examples coming to light of inadequate practice.

I could give the example of the recent scandal about used cooking oil coming from Malaysia and Indonesia into the UK, where more used cooking oil was coming into the UK than was actually being collected in Indonesia. The question is therefore, "How used is some of that oil that is coming in?" There have been some big fraud cases involving used cooking oil in the Netherlands and in other places.

There needs to be really close scrutiny of the way the assurance schemes are actually operating to make sure that the audits they are undertaking are robust. However, with long and complex international supply chains I can see no other way in which we can do this and check the validity of the feedstocks that are being used.

Dr Peter Williams: From our perspective, if by "assurance schemes" you mean for example certifying recycle quantities and the origin of bio feedstocks, getting ISCC certifications and so on, clearly we do that. Those schemes are audited, and the auditor ought to be separate from the scheme that you are actually using. Those are clearly developing in biofuels, biosource chemicals, recycled chemicals and so on, and they are necessary. Of course we participate in those. At the end of the day, those are value-chain and customer driven. They are sometimes subject to fraud; some people will game the scheme.

For assurance beyond that, I am not the right person to comment, but we certainly use those sorts of approaches. Verifying the origin of our materials is important to us. We go into a detailed conversation on that with all our suppliers, regardless of the supply. That is part of regulation today.

The Chair: Thank you.

Q197 **Baroness Northover:** This question probes further areas that you have referred to: the global comparisons and how the United Kingdom sits here. Given your involvement in companies that have global footprints, could you tell us more about how you feel the United Kingdom compares with other countries when it comes to supporting an area like this in innovative technologies like engineering biology? Do you have further thoughts about the optimal role for the UK in global supply chains moving forward, and what do the Government need to do to ensure, as we have discussed, that more of the value of engineering biology technologies developed in the UK is captured here? Maybe I could start with Mr Hall, given that you expanded on this earlier to some extent.

Dr Charles Hall: From a finance point of view, there is an enormous amount that we can do to encourage investment in the UK, and we touched on it earlier. It is all about coming up with policies that enable and encourage all the investor base to back UK companies to the benefit of everyone and long-term growth in GDP. Having the ability to have a long-term vision is important.

Earlier we heard that this is not about speculative investment but has to be about projects put in place for a decade or more, and having a certain planning and regulatory environment is a crucial part of that. Having a long-term vision and taking some of this away from party politics is incredibly important. This is more important than a five-year cycle. One of my bugbears in having a five-year cycle for the OBR is that you create a whole load of tax rules that are purely based on that five-year cycle, rather than the 10 or 20 years that we will need for a lot of these projects to come to fruition.

To go back to the regulatory point, I recently welcomed bringing in the concept of competitiveness and growth, which is really important. We are now working in a global environment. We have global talent and companies. If we do not nurture them and help them to grow here, it is totally understandable when they go elsewhere. Having that lens on competition globally and having the ability to grow is really important.

I am sure you have seen that the FCA recently adopted that as a secondary objective. Another Lords committee, the Finance Committee, is looking at putting that into practice and looking at whether that is actually coming through. It is very difficult for a regulator to wear both hats at the same time, but it is crucial. Having that long-term vision and enabling the finance to reach the companies is what is required, as is not having the money scattered around too much.

We have to be able to back and continue to back projects. Normally when doing these projects, you need the seed capital then the scale capital. Some of these are very major projects so just providing the seed is no good at all. That is where we fall down repeatedly, because the companies then have to go to the US market to find that growth capital. We have to enable that.

One of the things I have been talking about, whether one agrees with it or not, is that a sovereign wealth fund would make a big difference to the UK. We should have done this decades ago. It is never too late to start, just as it is never too late to start with pensions. Why not use that NatWest money to start investing in UK companies and to focus on some champions of tomorrow? If we focus on the champions of tomorrow, we create the ecosystem around it, whether that is expertise in research or asset management. Those are all essential. A lot of these things are interconnected.

Dr Peter Williams: Frankly, the UK is not fully competitive today for a number of investments. For me, the important parting stone would be: what does the UK want to be? Does it want to manufacture its goods? Does it want to be self-sufficient in energy? What are the strategic requirements for the UK? In one or two sectors, that is very clear. In the sector that we deal with, it is not.

It is difficult to embed developments in the UK if the UK does not want to do or to support manufacturing. It is difficult to develop new energy technologies and apply them in the UK if the UK does not support that. The policy requirements go back to understanding what we want the UK to be good at and self-sufficient in, as we mentioned earlier, and applying policies to ensure that those strategic requirements are met in the shorter term and the longer term. It will be a transition. Today, it may be carbon capture. Tomorrow, it may well be CO₂, used directly.

Baroness Northover: So you need an industrial strategy, as was referred to earlier.

Dr Peter Williams: Frankly, we do, yes.

Baroness Northover: You need an analysis of the strengths and weaknesses of the UK economy.

Dr Peter Williams: That is the honest conversation that I was trying to refer to. The UK has a headline emissions reduction number, for example, but if you take embedded carbon into the feedstocks and materials that we import into the UK, you get quite a different number. We do not look at that on an embedded basis.

We are consumers and we do not look at this from a consumer point of view. I do not mean consumers in a trivial sense but in the sense of what is required for the economy. It is about understanding the strategic requirements from energy, materials and so on to deliver a resilient UK in the future. Maybe we will be a great sustainable aviation fuels base—some of the elements are clearly there—but we will not be unless there is strong support for it that lasts beyond a five-year term.

Greg Archer: I very much agree. The fundamentals are not good in the UK: the costs of energy are truly prohibitive, compared to many other markets in which we could be developing facilities. Much of the cost of that energy is not in the costs of the electrons but in the costs of the infrastructure, the connections to the grid and so on. We really must look at how we are meeting the costs of the various government schemes from the past, which have been heaped on to electricity bills and are the reason why our costs are so prohibitively high.

The suggestion that you should look at America as some kind of panacea is also wrong. It is too soon to judge whether the Inflation Reduction Act and the kinds of tax breaks that are being offered in the US will truly be successful. Those tax incentives are operating for only a short period, which is not really long enough to make a material impact. There is the risk of political instability in the US following the election. Heaven only knows what will happen to climate and environment policy if there is a change of government.

On top of that, the US is also prone to overcomplicating its regulations. Much is said about the so-called 45Q incentives for carbon capture and utilisation, but it is enormously difficult for a company like LanzaTech to get benefits from them because of the complexity in the way they have been designed.

The UK needs to link its policies to decarbonise with policies to ensure that that decarbonisation is happening not through imports of product but through production in the UK. There are some good examples of that, but at the moment the focus is far too often on reducing the emissions rather than the benefits that could ensue to the UK economy in the way we do this. We do not have joined-up government between DESNZ, the Department for Transport, and the Department for Business and Trade. We need integrated government and better overall frameworks in which it works to make better decisions.

Q198 **Baroness Neuberger:** As you know, our reports ultimately make recommendations to the Government. I will ask you two questions at once, because we have to be quick. What do you make of the

Government's current approach, as set out in the *National Vision for Engineering Biology* and broader policies? You have said a lot about that, but is there anything specific that you would like to add about the national vision? Then I would like each of you to give us at least one key recommendation for the Government. What questions and take-home messages would you most like to put to the Government if you get the chance? We will try to translate them for you.

Dr Charles Hall: I am not sure that I have a great insight into the national vision, so I will not comment on that. The Government can create a financing environment that focuses on the UK. There are so many things they could do that would change things immensely quickly, and that is the exciting opportunity.

One key aspect is that we have had 25 years of pension deficits in the UK and are now in pension surpluses for the first time in 25 years. That is a great opportunity for the Government to think more productively about that £2.5 trillion worth of assets and put it to work to help grow our economy. That is one thing.

The second thing goes back to what we have been saying and is about having a long-term vision. This sector is all about the long term, and you have capital incentives that change every year or two and last only a few years, but planning some of these projects might take five years and then you potentially have to fund them for 10 years. If you have no certainty about the tax regime, it destroys the investment case on day one. Having that long-term vision is utterly crucial. It is the sort of thing that says: "We will put this policy in place and it cannot change", so that that tax benefit stays exactly the same for a protracted period, rather than being torn up and chucked in the bin.

Dr Peter Williams: I think I have already answered, in a sense. We really need to decide what the UK wants to be. That is critical for all the reasons that have come out in this discussion.

I have read the *National Vision for Engineering Biology* and, as I have said, in certain sectors there is clearly a strong linkage between developments and the document. From the chemical industry's perspective, the main reference is to dyes for fabrics, which is a very small part. We just have to be careful about what engineering biology is for chemicals and materials and how it is defined. We know that there are ways to use it; it is just about making sure that we support all that with the right policies and framework.

Greg Archer: The vision is very broad and rather ill defined. It lacks smart targets and many actions. It is a nice document that says nice things, but does it actually change anything? No.

If there is one thing that I think the Government should do for engineering biology, it is to look at the opportunities for creating new markets. If there are markets for our products, we can move forward. If there are no markets for our products in the short term, we will struggle to scale the technology that we have.

The Chair: Thank you to all our witnesses. We have extracted a lot from you in this session, and it is very much appreciated.