HOUSE OF LORDS

Science and Technology Committee

Corrected oral evidence: Engineering biology

Tuesday 21 May 2024

11.40 am

Watch the meeting

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. 10 Heard in Public Questions 199 - 206

Witnesses

I: Fiona Mischel, Director of International Outreach, SynBioBeta; Hendrik Waegeman, Head of Business Operations, Bio Base Europe Pilot Plant; Dr Mary Maxon, Executive Director, BioFutures, Schmidt Sciences.

USE OF THE TRANSCRIPT

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

Examination of witnesses

Fiona Mischel, Hendrik Waegeman and Dr Mary Maxon.

The Chair: I welcome the witnesses to the committee's 10th evidence session in its inquiry into engineering biology. In this session, we are focusing on international comparisons with the UK. We are very pleased to welcome Dr Mary Maxon, the executive director of BioFutures at Schmidt Sciences; she is dialling in from California where, I understand, it is 3 am, so we very much appreciate her being with us. We are also pleased to welcome Fiona Mischel, the director of international outreach at SynBioBeta; and Dr Hendrik Waegeman, the head of business operations at the Bio Base Europe Pilot Plant. Thank you all very much for joining us.

The session is being broadcast on parliamentlive.tv and a full transcript will be sent to you shortly after the meeting. We would appreciate it if you would make any minor corrections. Also, if you think of anything you would have liked to have said, or any data or other information that would be useful to our inquiry, we would be very pleased to receive that as additional formal evidence after this session. Again, thank you very much for joining us. Baroness Neville-Jones will kick off with the first question.

Q199 **Baroness Neville-Jones:** Thank you. Could I ask all three of you to make a brief opening statement setting out how the landscape for engineering biology looks, both in your country and how you see it internationally? In particular, can you tell us how you think biology research, commercialisation and scale-up are supported by the Government? For instance, are there any major policy initiatives that the UK should be aware of and which we might look seriously at adopting or might see as competition? Are there any specific policies that you would like to point us to as being particularly important in achieving the objectives of a prosperous bioindustry? Perhaps Dr Maxon could begin.

Dr Mary Maxon: Hello and good morning from San Francisco. It is a great honour and a privilege to be addressing you today. Thank you for inviting me.

The landscape for engineering biology—we think of it as biotechnology in the United States—is at a very important inflection point. New technologies are rapidly advancing the ability to create new complex products of biotechnology, with great promise to change and address a lot of social issues and to derive tremendous public benefit. As it relates to a number of policy initiatives in the United States, I will focus on three.

Recently, in September 2022, the United States put forward an executive order that created a biomanufacturing and biotechnology all-of-government approach to maximise the public benefit of discoveries from biological research. This whole-of-government approach focuses on measuring the part of the US economy that is a bioeconomy—the part that is directly derived from biological innovation—and on regulation. I can speak to the issue of regulation later.

In terms of research and development, what are the initiatives? What infrastructure is needed? What are the data opportunities? This whole-of-government approach, from September 2022, is under implementation now. I believe that it will have great benefit in the future.

The first one is at the level of the President and the White House. The second one is at the level of Congress—that is, the Senate level. The National Security Commission on Emerging Biotechnology is well under way in looking comprehensively at a biomanufacturing opportunity in the United States.

Last is a public/private partnership bringing together companies, universities and government funding for specific manufacturing innovation institutes. This has great promise for, again, translating engineering biology discoveries to public benefit.

Baroness Neville-Jones: Has any public money been involved so far or is this all, in a sense, organisational? It sounds very important—I am not trying to belittle it—but is there finance anywhere in there?

Dr Mary Maxon: Yes. In the case of the manufacturing institutes, federal monies are required. One of them—BioMADE, an engineering biology manufacturing initiative that is separate from biomedical innovation—was launched with $87 million. That was matched by an equal amount—actually, a greater amount—of university and private money.

In the case of the national security commission, we are still waiting. A report that will have legislation attached to it is scheduled for the end of this year. My expectation—indeed, my hope—is that new monies will be set aside by Congress for that. At the time of the executive order in September 2022 for the biomanufacturing initiative that I mentioned, there was an announcement of $2 billion.

Baroness Neville-Jones: Can you say whether the private money is from private investors or companies—or is it a mixture?

Dr Mary Maxon: It is a mixture.

Baroness Neville-Jones: Right. What kind of institutes are the national manufacturing institutes?

Dr Mary Maxon: In the case of BioMADE, the last biomanufacturing institute, the E in BioMADE stands for Ecosystem. These manufacturing institutes are aimed at creating innovation and manufacturing to move the US to new styles of manufacturing—in this case, engineering biology for purposes outside of biomedical such as clean energy and new materials. It was sponsored by the Department of Defense, and that brings with it an expectation that there will be new materials and chemicals that are of value to the Department of Defense. In my opinion, though, that particular institute has gone well beyond the mandate of defence in bringing forward new opportunities around engineering biology for all kinds of products, including traditional chemicals, lubricants and all kinds of paint additives—things that biology can bring forward relatively rapidly.

When private money and public money come together, the most important part is that the partners that participate in those joint ventures also have an opportunity to share their IP, which means the ecosystem can benefit much more rapidly.

Baroness Neville-Jones: Is it in fact a DARPA initiative?

Dr Mary Maxon: It is not DARPA per se but broadly the Department of Defense.

Baroness Neville-Jones: Just to probe a bit further, is it only at the research stage that this is operating at the moment, or is it meant to get into actually making product immediately?

Dr Mary Maxon: That is an excellent question. The manufacturing readiness levels are generally at the level of research, but there are many large companies engaged in this that are already manufacturing at scale, so the expectation is that this will pull that research and development more quickly into commercialisation.

Baroness Neville-Jones: Thank you very much. You are painting a rich picture. I ask Dr Waegeman to tell us a bit about the scene in Germany.

Hendrik Waegeman: I can interpret the question as a Belgian or as a European. As a Belgian, my story would probably be pretty short because Belgium is a small country, as you can imagine. I would rather see it more as a European question. I shall start with what engineering biology is. I define it as industrial biotechnology

or precision fermentation—the use of micro-organisms and engineered micro-organisms to produce a range of products in a broad way to replace fossil-based products with the exception of medical products, which I think is similar to the definition in the United States.

In Europe we have an advantage, although sometimes it is a disadvantage. Typically, when we talk about big investments in a certain sector in the United States, that is always from the federal point of view, whereas in Europe you have funding at both the national and the European level, and if you sum all those up then there are often substantial amounts of support available.

We have to go back in history a bit, because the question you in the UK are asking yourselves was asked at the European level in 2010-12. Basically, Europe was investing too much in early-stage R&D and not enough in getting those innovations to market. In 2012 the first initiative, BBI, the Bio-based Industries joint undertaking, was launched. BBI was basically a collaboration between industry and the European Commission, with a total investment of €2 billion in supporting R&D at the higher technology readiness level—typically, pilot and demonstration scale. In 2014, I think, although I do not recall the exact date, industrial biotechnology was also recognised as a key enabling technology—I think you call it strategic technology in the UK—and as a result additional instruments were created in support.

Where I see the big difference between the UK today and what Europe has is that there is more support available for later-stage development work and pilot and demonstration activities. As I said, traditionally there has been Horizon Europe. BBI has turned into CBE, Circular Bio-based Europe, which has a budget of €2 billion for seven years. There is the EIC, the European Innovation Council, as well as pathfinders and accelerated programmes. I have not even talked about all the national funding that is available to support scale-up in Belgium, where there are specific instruments available to support that. The same applies to the Netherlands and Denmark but, as you can imagine, every country has its own specific instruments. Generally speaking, there are quite a lot of funding instruments available.

Baroness Neville-Jones: When you said it was felt that the work being done was not close enough to market so you tried to move up the TRL level, is that money now being spent in member states? What has actually happened?

Hendrik Waegeman: With BBI, €2 billion was invested in the period 2012-19, resulting in a lot of pilot work, but also in

supporting flagships—that is, first-of-their-kind production facilities. One example is a Scottish company, ENOUGH, which invested in a microprotein production facility in Sas van Gent in the Netherlands, which is close to Gent, on the border between Belgium and the Netherlands. It is co-sited with the Cargill sugar refinery.

Fiona Mischel: Thank you so much for having us here today. I am speaking here for SynBioBeta, the world's largest networking and media organisation for the synthetic biology industry. I sit at the intersection of every sector of this industry, from food fuels materials all the way through to health, as well as every stage of development of this industry, from seed all the way through growth, public companies and multinationals. As you can probably tell by my accent, I am not from the UK but from the States, but I have lived here for the last three years. I can bring a perspective from both what Mary has spoken about in terms of what has come down from the Biden Administration and what was talked about in the previous session in respect of the Inflation Reduction Act, as well as my observations of what is happening here in the UK—which was talked about in the previous session—in that we export our talent, mostly unintentionally, predominantly to the US.

I want to highlight the example of Singapore. It put up its hands in a really big way from a regulatory perspective and said, "OK, we're open for business. We want you to come test out your technology here. We want you to go to market here for the sector of cultured meat"—sometimes it is called lab-grown meat and I wish it was not, because that is not very appetising. Singapore's approach is something to highlight for this country, where we have a complicated regulatory system. There are a lot of challenges there, which I expect to be speaking about later. A number of regions are actively participating and saying, "We want certain technologies to come to our regions because they are nationally important". We are now seeing places such as Thailand saying, "Hey, we have a lot of feedstock". They have a lot of sugar and are starting to make a lot of noise. Feedstock was talked about in the previous session. That is another critical issue for the UK, especially now that we are separated from the European market.

Growth funding is a major issue, which again was talked about in the previous session—it was a very good session—as is understanding how the £2 billion that was allocated in the national vision will be allocated and distributed. Mary gave some good examples of numbers that have already been given—$87 million goes here, $2 billion goes there—but where is the £2 billion in this country going? That is a critical question.

Something else that I wanted to highlight from the executive order of 2022 was that specific targets were listed in that of what percentage of our fuels and chemicals purchased by the US Government will come from bio based, so there is a target. That is lacking here in the UK, whether that is food, fuels, chemicals or materials. We need some numbers to go for.

Q200 **Lord Berkeley:** I want to ask the three witnesses about start-ups, scale-ups and investment. We have heard from other witnesses that getting finance after the initial stage can be quite difficult. Comparison with other countries is very important, as some of you have already said. Fiona, one related comment you have just made is about the regulatory process. We have heard from other witnesses that regulation is quite easy and that it works quite well. It is different in different parts of the field. Do you have a view on the regulatory process as well?

Let us hear about the finance and start-up, because if you have some initial research and then have to make it up to the next stage, that can be quite difficult.

The Chair: Could I just interfere for a moment? Regulation is the next question, so Baroness Young will pick that up.

Lord Berkeley: I am sorry, Chair.

The Chair: You could save that for the next question.

Fiona Mischel: I can do, though they are very closely related. I will parse them for now, but they are tied together quite closely.

From an investment perspective, we have a couple of key issues. One is the tech transfer office. Right now, we see universities taking quite a significant amount of equity out of a start-up. If you have brilliant innovation coming out of a university, the university can take up to a minimum of 10%, which is still significant compared to the US which takes around a standard 2%. Even if only 10% is taken—often it is a much higher percentage, closer to 40 or 50%—for the argument of this conversation, 50% of the cap table is gone. The universities tend to put in a clause so they cannot be diluted. This makes external investors very leery; they do not want to invest when a cap table is mostly gone. This immediately dilutes the appetite of overseas investors wanting to fund in the UK and is another reason why companies leave.

I think that is changing. I hope that this is something that this committee can suggest to the universities as a policy that could be brought forward. Another piece to that is that we can get companies up through series A, maybe series B if it is a good

funding environment, but right now it is not a good funding environment. They are exported predominantly to the United States, where they then are acquired or go public. The capital in that exit is turned over in the United States and the funds here do not grow. We do not have the massive funds which the US has, which are worth billions, because they have been through several innovation cycles. Funds are set in around seven to 10-year terms. Those funds turn over and if there is an exit, they benefit. Right now, we do not see that happening as much here at the growth fund stage.

Lord Berkeley: Dr Waegeman, you gave us some examples from two or three different member states. You did not mention France or Germany. How easy is it to get the second stage of financing after the initial research?

Hendrik Waegeman: It is always what you compare it with. With the UK it is probably easier to get the funding available. France is doing slightly better in the area of engineering biology in providing instruments to finance scale-up. In that respect, Germany is lagging a bit behind.

It is important to know, as Fiona also said, that currently it is not the best of times. Compared to 2021, we are currently at 30% of the investment level. For companies, it is very difficult to get access to finance to venture capital at very low valuations. That is one point. They are more dependent than ever on these financial instruments provided by Governments.

Generally speaking, I mainly see companies struggling. We work with companies from Europe, the UK and the US. For your information, about 30% of our turnover is realised through collaborations with US companies, so we know them quite well. The problem that has been pinpointed in the previous session, and slightly in this session, is that many companies have been able to secure funding for their first stage of developments and get to pilot scale. Then, the link to regulation is that you have to wait before you put your products on the market. That is not the best investment proposal to investors. Then, they start struggling. Especially nowadays, because it is hitting hard, many companies that were successful in the past 10 years are laying people off and having strong difficulties in surviving.

Lord Berkeley: Okay, thank you very much. Dr Maxon, are big companies helping smaller companies with finance? Is this development phase in the United States still a problem?

Dr Mary Maxon: Yes. In my opinion, Fiona is the local expert here on investment internationally and domestically. Big companies are interested in helping smaller companies. Hendrik also mentioned government financial instruments. Loan guarantees in the United States are an important element. Both the Department of Energy for the clean energy transition and the US Department of Agriculture offer loan guarantees. Companies want loan guarantees and to be able to scale. They do not necessarily want handouts, but they look forward to being eligible.

They can get public/private partnerships in these loan guarantees in relatively short order. It is an expensive proposition, and my understanding is that, for the Department of Energy at least, there is a $400 billion authorisation through the Inflation Reduction Act. Big companies are trying to help smaller ones, and our Government in the United States are trying to help as well.

Baroness Young of Old Scone: Lord Berkeley tried to nick my regulation question.

Lord Berkeley: I am very sorry.

Q201 **Baroness Young of Old Scone:** From your perspectives, are there particular issues in regulation where other countries do better than we do, and what are the issues? Perhaps we could start with Fiona.

Fiona Mischel: Thank you; this is a critical question and there are a number of issues. I know that a number of UK companies are either considering leaving the UK because of regulatory issues or they are not bothering to come to market in the first place in the United Kingdom. I have the example of a company I spoke to the other day. I said, "This is very exciting technology. Where is your first market?" They said the United States. I asked why that is, and they said that it is bigger. The regulatory system, while very complicated—I am sure Mary can speak to that in a minute—at least offers somewhere to go. You can at least access regulators and there is a path to talk to regulators before you have to file.

It is the "Brexit moment". I know that folks have mentioned in witness statements in these meetings before that there is a potential opportunity here for the UK, now that we are no longer connected to the EU market. But there is also a potential pitfall, which is that we are a very small market now. We have become rather isolated. If we do not have a way for people to access our markets through very innovative regulation, they will go somewhere else, as we have seen already with Singapore and cultured meat, and now with the United States because there is

such a big market. If we are going to be a very individual market here, we have to make the business case for why companies should both come to the country and stay in the country for these kinds of products.

I know that we are short on time, so I want to highlight something that has been going around the industry for a while now: to regulate the product and not the technology. For engineering biology, a single gene-editing technology can now go into almost every single sector. What is the end product, and how does that impact consumers, businesses and the general public? There has been a call to have that end-user experience or product regulated rather than the underlying technology, which can be so diversified.

Baroness Young of Old Scone: Dr Maxon, do you think that the States has got it better than us? Which issues has it cracked that we have not?

Dr Mary Maxon: That is a great question. I am not sure I would say "better". In the United States, there are three primary agencies that oversee products of biotechnology. There are seven different kinds of products of biotechnology: food for humans; food for animals; pesticides; human medical products; veterinary products; industrial or consumer chemicals; and organisms for open release. What that means is these products of biotechnology are plants, animals and micro-organisms. They are live. This means that the safety of these products is challenging to assess.

Basically, in the United States, one agency oversees animals, one agency oversees plants, and one agency oversees micro-organisms. That is not strictly true, but it is generally true for this purpose. My recommendation would be to have a single organisation with oversight authority for all three—animals, plants and micro-organisms. This means having expertise in all three but having a single co-ordinated entity; that is where I would like to see the United States go eventually.

Baroness Young of Old Scone: Dr Waegeman, how do you think we are doing compared with Europe?

Hendrik Waegeman: To be honest, I do not know the regulatory processes in the UK that well but, speaking more generally, I align with what Fiona and Mary have said.

The perception of companies with respect to regulation is that the US way of dealing with it is probably the best. What you often see is that companies file their products in the US first then, later, in Europe. As has already been mentioned in answers to previous

questions, regulation is strongly linked to investment because, if the regulatory process is unclear—that is, you do not know what to expect or how long it will take—investors will probably not be interested.

A particular problem is that, in Europe, contrary to the United States, it is not possible to have any kind of interaction before you file a dossier. Basically, you file a dossier then, later on, you discover whether the file is complete. If it is not, you will probably be put back at the end of the queue and you will have to start all over again. That is a huge problem. If the UK is thinking about what the best format would be, I think that it is crucial to allow interaction with the administrators so that you can at least direct your dossier in the best way possible.

Thirdly, go for a product-centric approach, not a technology-centric one. Similar to what Mary said, is the product safe or not? That is basically the question. Everything has to be related to that. If it just looks at the technology, technology can be good or bad depending on the application you are using it for.

Baroness Young of Old Scone: Does regulating the product deal sufficiently with biosecurity issues of the sort that Dr Maxon was talking about, such as releases into the environment?

Hendrik Waegeman: If it is released into the environment and you can assess that the product is safe, there should not be a problem, right? A comparison that is often made is with a knife. You can use a knife in your kitchen for cutting things with good intentions, but you can also use it in a bad way. If you just look at technology, you will make that mistake a bit, in my opinion. But, when you use direct-release applications, it can be that the micro-organism, for example, is used in environmental clean-up applications where it breaks down a specific compound but is not harmful to other environments. It is the safety of the product itself that needs to be assessed and not the technology that has been applied. I can understand that there is a kind of overarching biosafety assessment where you apply general safety precautions but, typically, they hinder the application more than they support it.

Baroness Young of Old Scone: I just want to mention one last issue. You remarked that you cannot really approach the regulators in advance. Is that a regulated requirement? Is it in statute or is it just tradition? I have been involved with a number of regulators. We were very keen to talk in advance because there was no point in having companies do fruitless work that was not going to get them the right sorts of permissions.

Hendrik Waegeman: In Europe, it is not possible. I do not know whether it is written but it is not possible.

Q202 **Lord Rees of Ludlow:** We have talked about international collaborations in several contexts, but I would like to focus on mobile talent because this sector depends very much on trained expert talent which is very mobile. Obviously, if the economy is vibrant, that tends to attract people, but are there things that government can do in this country—in terms of pay, tax, educational offers and, in particular, immigration policy and visas—to make the country more attractive for that kind of mobile talent? What would you urge the UK Government to do to address these issues? What do you think we can learn from other countries that have made themselves more alluring to mobile talent? Perhaps you could start on that, Dr Maxon.

Dr Mary Maxon: The US trains an enormous number of people from other countries. They then go back to their countries. There have long been conversations in the United States around whether we should perhaps staple a green card to every PhD that is granted in the United States. That is not the policy currently but there has long been a conversation about how to keep talent that we have trained in the United States.

I will say, because we are talking about engineering biology, that the UK could consider a strategic communications campaign on why engineering biology is important. It has been said that biology is the last hope to save the planet; young people can be very excited about this if they are made aware of the opportunities in engineering biology.

There is an example of this in the United States. It is called BioBuilder. It represents an opportunity to meet the teachers where the teachers are. It is not a new curriculum. It comes into rural environments in the United States and allows young people, for the first time, to work with their hands and to see biology come to fruition in their own two hands. If the UK were to start early and make a strategic effort to introduce young people to the wonders of engineering biology, keeping talent will then translate to attracting talent as well.

Lord Rees of Ludlow: There is a big gap, though, between the education level and someone who is a saleable commodity internationally. Who would like to speak next?

Fiona Mischel: I can jump in here, as I am an immigrant to this country. I am here on a visa route that no longer exists. I am on a

legacy renewal at this point; I learned that rather recently, which is a bit frightening.

The paths for talent to remain in the United Kingdom are narrowing dramatically. There is a conversation happening now about graduates remaining here in the UK. I echo what Mary just said about retaining talent we have trained. Of course, if we do not retain that talent, the United States—I keep highlighting the United States because, from an investment perspective or at least a venture capital investment perspective, it is an order of magnitude larger than the United Kingdom—will pay a lot of money for it. The figures are eye-watering. Part of that is because $1 or $2 buys you a candy bar but £1 will buy you the same candy bar, so it is a bit about the value of the individual unit of money, but still, there is so much money in the United States for skilled workers.

I also agree completely with Mary. Thank you for bringing up BioBuilder. It is a great organisation; it brings engineering biology and synthetic biology to kids, basically.

One of the issues that I hear from folks is that they did not even think about starting a company until they were finishing the last year of their PhD. People do not go into academia thinking that they are going to start a company; they go into academia thinking that they will be an academic, but there are just not enough jobs. We need to be encouraging folks not just to found their own companies but to work in industry broadly, because the industry is still young enough that it needs extremely skilled workers. These are good, green, clean, well-paying jobs, but again they are being exported. Singapore is another really good example: it has visas for folks to come in for industry when, right now, a lot of our visas in this sector are academic-focused.

Lord Rees of Ludlow: Dr Waegeman, do you have any views on the contrast between the UK and mainland Europe post Brexit?

Hendrik Waegeman: I am certainly not an expert on the topic but, from a practical point of view, 25% of our 170 employees are expats. When we attract talent within Europe it is relatively straightforward; it is very easy to mobilise people from other countries in Europe. If we really wanted to hire somebody from overseas, it would be more work administratively, but it is not totally impossible. Compared to the UK and the US, Europe is probably a bit easier; it is a bit easier to attract talent from other regions.

On retaining talent, of course we need to promote engineering biology, but it is also crucial to promote entrepreneurship. To be

honest, many talented expats who have stayed here in our region, in Belgium, have typically been involved in start-ups and then built their life and career here in Belgium.

Q203 **Baroness Willis of Summertown:** I want to ask some questions on facilities. We have heard a bit from the start-ups about the lack of facilities to scale up. You clearly have built facilities internationally, so what facilities are most needed for development and commercialisation?

Fiona Mischel: The lack of infrastructure is a significant problem, and I will defer to Hendrik on this as well. Feedstocks were mentioned in the last session. It is about where we are building the infrastructure, not just what we are building—well, it is about what we are building, because what are we feeding into these fermenters? Biomass is a significant issue in an island nation. Where is the access to feedstocks? That has not been properly studied. One of my concerns about infrastructure is not just how big it is but what inputs it can take. That is a significant issue.

There is a general lack of manufacturing facilities that are GMP grade. One of the issues with GMP right now is that there is a lot of pharmaceutical manufacturing in this country—it is an excellent industry—but we do not have a lot of food-grade, for example, or broader-use manufacturing facilities. GMP is very expensive, because it requires so many layers of cleanliness, security et cetera.

From my perspective—and this is just my perspective—the north of the UK has an excellent manufacturing history and expertise, but those are old fossil-based industries. Is there a way to adapt and convert those industries? That is an open question from my perspective, but I hope that the answer is yes.

Baroness Willis of Summertown: Mary, what is your view on the sorts of facilities that are needed to scale up and about the US versus the UK?

Dr Mary Maxon: I am hearing the same things that you are hearing: that the lack of pre-pilot and pilot scale-up facilities is critical. We do not have enough in the United States, and we hear over and over that, because the European Union invested in this, many start-ups in the United States are relying on the infrastructure that Hendrik just talked about in other countries. Slovenia, Slovakia and other countries have infrastructure waiting to be used. When companies are standing in line in the United States—and every minute counts as, for a small company, time is money—it is much easier to go overseas. We are experiencing the

same problem. Generally speaking, more infrastructure to scale up products of biotechnology is desperately needed.

Baroness Willis of Summertown: That is very interesting, because the US is often given as an example as somewhere that does have this infrastructure. Dr Waegeman, what about the European Union has enabled this? Do you agree with that sentiment, or do you think that there are still problems with infrastructure in the EU?

Hendrik Waegeman: It depends when you are asking about. As I said, the current climate is not ideal. If you have fewer companies investing, there is also less demand for scale-up. It is very important to distinguish between production facilities and pilot facilities. Fiona has explained a little about production facilities, which I believe are certainly lacking. There is a lack of food-grade facilities in the UK such that, when people have developed technologies and want to manufacture a product routinely, I imagine that they probably do not have a lot of options in the UK. That is right.

The reason why I make a distinction about pilots is because production facilities, in essence, can be profitable. If you look on a European scale, there are many CDMOs—contract development and manufacturing organisations—that are privately owned, make money and are expanding. Many of them have expanded in recent years and some new players have entered the arena. That market basically solves that issue, because it should be attractive enough.

At the pilot scale, it is a bit different, because it is not the most profitable activity. We have made profits in past years, but always very moderate profits, to be honest. In the European landscape, about 10 to 15 years ago, five or six major pilot facilities were set up. One of them, which had existed for a bit longer but then got a financial injection, was the Centre for Process Innovation in Teesside in the UK.

There were about five or six back then, but one of them did not survive; the Bioprocess Pilot Facility in Delft in the Netherlands was not able to cope with the losses that it made every year. That just indicates that it is not a profitable activity.

In the past four or five years, we have seen that, with the big wave of precision fermentation and alternative proteins, there is an increased interest in investing in pilot infrastructure in Europe. We have seen investments in Denmark, where three pilot plants were built, and in Spain, Lithuania, Sweden and other countries, where more pilot plants have been built. To be honest, with the decreased

demands that we have seen in the last two years, I am very sceptical about whether these pilot plants will survive in the end. It is always easy to set something up with government money, but to keep it operational in the following years and make a profit, because profit is essential to maintain business, is another thing.

I agree about the United States: there is not a lot of pilot infrastructure available, so there is a lack there. In Europe and the UK—the UK is so close to the European mainland—I do not know that there is really a capacity gap in pilot infrastructure. I am not convinced.

Q204 **Viscount Stansgate:** One of the advantages that the United States has is the ability to support innovative projects through public procurement such as DARPA, which works with the Department of Defense. Incidentally, two years ago, Britain set up its own mini-equivalent, which is known as ARIA. Could you comment on how this works in the United States and the lessons that the UK could learn to use procurement more effectively? I suppose I had better start with the person for whom it is now 5 am—Mary.

Dr Mary Maxon: Thank you. Public procurement as an innovation pull is one of my favourite topics. In the United States, an Act of Congress gave rise to a programme called BioPreferred. It has two components. One is a certification of bio-based components from the US Department of Agriculture, so it first certifies that the products are bio-based.

The second component is mandatory purchasing procurement from federal agencies and contractors. I think that the United States got the first part right, and I think that we are still working on trying to implement the second part better.

There is a fix there. There are two places to focus. First, if the UK were to set up something like this, the training of federal procurement officers would need to focus on the procurement officers' ability to understand and access the products. That is critically important, because if the products exist but there is no easy way to purchase them, it does not make sense.

The second part, I think, is mandatory regular reporting by the government agencies and contractors to the Government. Setting advance market commitments gives companies certainty. If a Government are going to establish a renovated facility in the Midlands, for example, and will need X amount of paint and products that are bio-based and available, that advance market commitment can give companies certainty to get loans and

manufacture the product so that it will be ready when the government entity needs it.

Those two focus points—regular reporting to show which agencies are actually doing the right thing, and helping the federal government procurement officers understand the opportunities and the products that are available—are where I think improvements can be made in the US. If the UK were to do a bio-based procurement programme, those would be good places to look, to make sure that mistakes that have been made elsewhere do not get made.

Viscount Stansgate: Thank you. That is very helpful. Does anyone else want to comment?

Fiona Mischel: Yes. Like Mary, I am a big proponent of government procurement for the engineering biology industry. I think it creates a number of really positive levers. One is stability. As the national Government are a huge organisation, they require a lot of products, and one of the challenges that we see in the industry for start-ups is that a lot of big players do not necessarily want to partner because they cannot produce enough. If the Government were to say, "Hey, we want X amount of tonnes and we will support your scale-up infrastructure", that would stabilise the supply, increase the demand and bring in economies of scale. It would also support further investment from venture capital, who see that there is a stable supply.

One of the biggest lessons that folks say about the venture space is: never ever, ever use your venture money for infrastructure. So where is that money going to come from? Your customers. If your customer is government, that is also a really big signal to broader industry, saying, "Okay, we like this. This is a good product, and it's safe and it's stable".

Another point is that, right now—Mary has talked a little bit on this in terms of DOE and Department of Ag—there are various procurement models. But still today—Mary, correct me if I am getting this wrong—most of what is acquired for the United States comes through the Department of Defense. What are the MOD vehicles that are looking at engineering biology? Is that the right avenue for the UK?

I know that ARIA is a vehicle that has been set up. Personally, the jury is still out for me in terms of how that will actually feed back into government. Obviously, DARPA is a very direct line. Some of the things that we are looking at now, such as biocomputing and biosensors, are very specific things that the DOD wants—the

branches of military say, "We want this in the field, and this can be used in nine other places". I do not think that we have that here as much. As Mary said, BioPreferred is a great programme if it is implemented correctly. Where are the vehicles for UK companies and possibly external companies to sell to government? Where are those contracts? I think there is a lack of awareness and a lack of a pathway. I think it would be really beneficial for government to do.

Viscount Stansgate: Thank you. Dr Waegeman, is there anything you would like to add?

Hendrik Waegeman: As far as I know, there are no similar procurement programmes in Europe. What I do know is that in discussions on a European level, very often the BioPreferred programme is referred to as a good example. I think it is a great tool that, indeed, for the arguments that Fiona just raised, could really support the industry.

Q205 **Viscount Stansgate:** Are there any international examples of companies or Governments who have successfully encouraged the use of more sustainable feedstocks, such as recycling? If so, what could the UK learn? Does anything in that area come to mind?

Fiona Mischel: This is a tricky one, because different regions have different feedstocks. The US has an unbelievable amount of corn, mainland Europe has quite a lot of sugar beets and Thailand has a lot of sugar cane. As was talked about in the previous session, the UK does not really have much of that. We have limited arable land, and we need to use that, obviously, for growing food for the human population as well as for biodiversity protection. What does that mean for us? A lot of that means gasifying waste and valorising waste. That will be a critical path for the UK.

I do not see a ton of examples at this point. Obviously, Cargill is partnering with folks like Geno in the United States. They have lots and lots of corn and sugar, and—I cannot remember the exact molecule at this point—they are able to make tons of it. But one of the issues that I see is the maths in terms of what this industry looks like at absolute success, medium success and low success: what does that look like in terms of the amount of carbon—in other words, feedstock—that we need? I do not think that that has been studied, especially for the UK. That is where I see a big gap.

In terms of other nations, again, Thailand is putting up its hand. This goes back to the manufacturing question. If you can do your pilot facility in Europe, or possibly in the UK or the US, your gross manufacturing—your biggest manufacture—will probably go to east Asia, where labour is cheap and now there are feedstocks. It is a

holistic question: it is not just "Do we have enough feedstock?" and "Where is it working," but "Where will the market pull companies to go and do their manufacturing?"

Viscount Stansgate: Any other points from here or a million miles away?

Dr Mary Maxon: I will offer one. I definitely agree with Fiona that the vast range of feedstocks makes it challenging to have a global solution. I will tell a little example. In the United States, and probably elsewhere around the world, there is what are called cover crops, which are crops that are used in between cycles of regular agricultural seasons to help add more nutrients back to the soil. In the United States, that cover crop cannot be used as a feedstock, because there is a prohibition on using that for valorising, to Fiona's point. If a farmer tries to do that, they will lose access to some of the subsidies that they otherwise are eligible for. Encouraging valorisation of things like cover crops is easy to do and can help with creating more opportunities in between agricultural cycles, which currently—at least in the US—are not taken advantage of.

Hendrik Waegeman: On the use of waste, I think it is also important to know that using waste as a feedstock is, in most cases, more expensive than using virgin material. It makes sense, because when you are using sugar beet or sugar cane, you are basically extracting the sugar out of that crop, but when you are using the remainder of the plant, you have to put in a lot of energy to get the remaining sugars out. As a result, that feedstock will be more expensive than using virgin material.

Although from a technological point of view that is very clear, I think for many government agencies it is not. Hoping that the technology itself will be applied without any kind of support is a bit of daydreaming. If the UK or any other Government want to put more focus on the efficient use of waste, there should be some incentives in place to make that feasible, as there have been for the use of used cooking oils for biodiesel production.

Q206 **The Chair:** I will ask each of you one last quick question. We have heard from our UK witnesses that 10 or 12 years ago we in the UK felt that we had a leading position in this area, but over the last 10 years or so we have started to fall behind as other countries have moved forward faster than us, and that perhaps we in the UK have five or 10 years to deliver something before we will be out of this race, if I may put it brutally. I would like your thoughts—from outside the UK, if you like—as to whether that how you see it, or whether we are being too self-critical.

Dr Mary Maxon: My opinion is that the UK is still in a leadership position, and the £2 billion that was recently announced proves it and shows commitment. There is an opportunity now to focus on the translation from discovery to public benefit to commercialisation. That is where the opportunity for leadership is readily available.

The Chair: But we need to move fast, by the sound of it.

Fiona Mischel: Having come from the US and now living here, I can see both sides of this. Again, I agree with Mary: the UK is definitely in a leading position, and that £2 billion is a massive signal. The science, talent and expertise here are incredible, and that has always been the case, but we are five to 10 years behind the United States, depending on the technology, and that is starting to show. The more we delay—in terms of getting growth funding in, manufacturing and scale-up and various regulatory modifications—the greater that lag will be. If ever there was a time to give us a bit of acceleration and get us back into a stronger leadership position, this is that moment. The signals are very strong and people around the world are sitting up and paying attention, so this is exactly the moment to act on that.

The Chair: Dr Waegeman, how does it feel from Europe?

Hendrik Waegeman: I think it is not as bad as you say. I have given the example of ENOUGH. There is also Celtic Renewables, which built a facility in Scotland. It uses waste streams from the whisky industry, incidentally, which rather contradicts the statement I just made that it is impossible to make something out of waste. Having said that, the number of start-ups in this field has not increased to the same level as in other parts of Europe, so in that respect I think the comment is correct.

The key issue is that you are very strong in academic research, and in the first steps of setting up the company and creating the technology, but getting out of the lab, running pilots and demos, and getting the first commercial plans is probably the hardest part for UK companies.

The Chair: Thank you very much. I warmly thank all three of our witnesses for contributing to this evidence session, which we have found really helpful. I remind you that you will get a transcript shortly after the session.