

Environmental Audit Committee

Oral evidence: Addressing the risks from Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS), HC 852

Wednesday 10 September 2025

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[Watch the meeting](#)

Members present: Mr Toby Perkins (Chair); Dr Ellie Chowns; Barry Gardiner; Anna Gelderd; Alison Griffiths; Martin Rhodes; Alison Taylor; John Whitby; Sammy Wilson.

Questions 150-185

Witnesses

[II](#): Dr Andrew Schwarz, Chief Business Officer, Fluorok; Duncan Sanders, Director for England, ATG Group; and Professor Luisa Orsini, Professor of Evolutionary Systems Biology and Environmental Omics, University of Birmingham, Co-founder and CEO of Daphne Water Solutions Limited.

Written Evidence from witnesses:

[ATG Group](#)



Examination of witnesses

Witnesses: Dr Andrew Schwarz, Duncan Sanders and Professor Luisa Orsini.

Q150 **Chair:** Welcome back, everyone, to the second panel of part of our addressing the risks from perfluoroalkyl and polyfluoroalkyl substances, otherwise known as PFAS. We have an excellent panel in front of us. I start by asking the three of you to introduce yourselves, the organisation that you represent and your particular area of interest with regard to the topic that we are discussing today, starting with yourself, Mr Sanders.

Duncan Sanders: My name is Duncan Sanders. I am a director of a company called ATG Group, and we are contaminated land remediation contractors. We clean up contaminated land. I am the PFAS lead for our company, and that is our area of expertise and specialism.

Professor Orsini: My name is Louisa Orsini, and today I wear two hats. One is as a professor at the University of Birmingham. I am a professor in systems biology and I look at the impact of pollution on the environment and particularly on fresh water. I am also CEO of Daphne Water Solution, a start-up that delivers sustainable wastewater treatment to remove persistent chemicals from water.

Dr Schwarz: I am Andrew Schwarz, and I am the chief business officer at Fluorok. I have been in the chemical industry around 15 years, from academia through to corporate through to start-up. I am representing Fluorok, which is a UK-based start-up spun out of the University of Oxford. We are developing new chemical processes to take waste materials and waste fluorinated products through to new fluorochemicals in a safer, cheaper, more environmentally sustainable way. We are hoping to introduce a cyclic economy to the fluorochemical industry, maybe for the first time.

Chair: Excellent. Thank you very much.

Q151 **Sammy Wilson:** The first question I want to put to Mr Sanders and Professor Orsini. In the last evidence session, we heard that contamination can occur in many different situations: water, land, landfill sites and so on. What are the challenges that you face in identifying the contamination and source of contamination in those complex environmental situations?

Duncan Sanders: I will have a crack. The first thing to say is that the role of site assessment and investigation is largely with the environmental consultant, and we are the remediation contractor that then comes along to clean up once the contractor has determined what is there and in what concentration. We work very closely together.



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I do know one of the answers to your question, which is historic use. The process in the UK is to have a phase 1 desk study as the first part of the investigation, which looks at the previous site use of the site. Was there a chemical use, industrial use or indeed fires on the site that may have caused the contamination in the first place? In other words, do we suspect there is likely to be PFAS? If that is the case, they are required to sample and analyse for it. There is a process of: is it above a certain threshold? Is it a risk? If it is a risk, we remediate it.

Professor Orsini: Looking at the entire life cycle of PFAS or chemicals in general, I can see several challenges. One has been mentioned before, which is persistence and ubiquity. It is everywhere and we do not get rid of it easily. The other is the complex chemistry, which makes it difficult to detect. You need advanced technologies to do that. There is then the problem that this PFAS is just the top of the iceberg. It mixes with other chemicals and therefore it becomes complicated to disentangle the problems for responsibility assignment. Then there is the remediation difficulty, because it is persistent but it leeches into other substrates and very often occurs in trace levels. These are difficult to remove unless you use very extreme conditions like a high dosage of chemicals. If you look at the entire life cycle of the chemical, there are several challenges there.

Q152 **Sammy Wilson:** One of the things that we have been told is that the Environment Agency itself has limited resources. Would it depend on independent assessments? What role would there be for the Environment Agency in identifying those complex contamination issues?

Duncan Sanders: I think it has focused on the known source areas, which are military sites, airports and those sorts of things and, obviously, manufacturing sites that have produced the chemicals in the first place.

The other point I was going to make is that it is very difficult if it is a point source or a more diffuse source, because if you have had a fire and the foam is everywhere and it has got into the groundwater, then that PFAS can be coming from all sorts of different places and it is very difficult to pin it down.

In my experience, it is not usually the Environment Agency's role to go and find it. Once it has turned up—usually triggered by the development process, which then requires planning and then into the assessment procedure—the EA gets involved in terms of how it is cleaned up.

Q153 **Sammy Wilson:** Mr Sanders, you have identified the issue that I wanted to ask about next. Once you have identified that there is contamination, if, for example, there has been a fire and the foam that was used has PFAS in it, and the factory that caught on fire was producing PFAS, how do you identify who is responsible? I imagine there must be lots of different, complex situations. That is one of the things that we have been looking at. How do you identify who is responsible for that contamination?



Duncan Sanders: It is a good question and a very difficult area. I was talking to a water company recently and agreeing that it is a collective responsibility. We are finding that you have a site owner who has some PFAS on their site and they are being clobbered and have the responsibility of cleaning it all up, when in actual fact it is coming from everywhere: landfills, discharges onto land and wastewater treatment plants. It is a collective problem. Responsibility is a big political question. The science and the technology is a slightly different one.

Professor Orsini: If I could add to that, there are cases in which responsibility can be assigned because certain industries use specific mixtures of PFAS and if you do chemical fingerprinting, you will know what the source of the problem is.

In the majority of cases, I agree with Duncan. They will be diffused. They will come from different sources. At that point, in my view, it is more a tiered responsibility. It is true that the industry that produces PFAS should be co-responsible, but producing is not something these industries did out of the law; it is just that we do not give them certain thresholds to respect. Regulation should be the first step, enforcement has to follow and then clean-up should be a collective responsibility including the Government, private consumers and industry.

We do have examples of this. For example, in the US, as I think was mentioned before, there are two ways of going about it. Either you bring them to court—there have been cases like DuPont paying billions in damage to private industries, especially water industries—or there are the superfunds, where the Government provides support to remediate these very highly contaminated sites. A combination of the two might be the best way forward because it is our collective health at stake.

Q154 **Sammy Wilson:** You have anticipated my last question. What lessons can be learned from other countries in terms of monitoring, detecting and then finding ways of getting remediation where there has been contamination?

Professor Orsini: Something that has not been mentioned at all, which is important, is that we can classify the chemicals and we can group them, but for us to know if they are bad for our health and the environment, we have to go through toxicity tests. We have to assess if they are toxic or not. That is another sore point, if you want, because the way of testing toxicity nowadays is outdated and very crude: you expose animals to certain concentrations and when it kills 50% of the population, you say, "This is not a safe concentration". However, we have learned over and over again that trace contaminant exposure for an entire life cycle creates much more long-term effects, like cancers, autoimmune responses and so on.

There is a way to accelerate and modernise toxicity, and science has already been there for a while, which is the use of new approach methodologies. Instead of looking at animals dying when exposed to



chemicals, you expose them to real concentrations that you find in the environment and then you measure their biomolecular response, gene expression or metabolite changes, and that allows you to see the impact on certain functions.

The important thing is that this is high throughput—you can process many samples very fast—it is more sensitive, it gives you the idea of what functions are impacted, and many of these are conserved across species so you can also identify potential targets for human health. That reduces massively the amount of testing you need to do and the speed at which you do it, and this is important considering how many PFAS we have.

Duncan Sanders: There is a related point I was going to make, if I may, to your previous question, which was the background concentrations. We remediate assuming there is a problem on the site. At the moment, on two of our sites we are cleaning up to a certain standard and yet the background concentration in the river or around the site is higher than we are cleaning up to, making the whole thing a bit interesting.

We had a very interesting day yesterday. We were in Lloyd's of London pitching a new tool that we are developing called PFAS Risk to the insurance industry. It is all about taking a database, building it up and using AI to determine the risk at any point on the map in the UK. That could be quite a powerful tool, I believe.

Q155 **Sammy Wilson:** From your experience, Professor Orsini and Mr Sanders, can you think of countries that do monitoring, detection or remediation differently or better than we do it here? What are the characteristics of what they do as opposed to what we do?

Duncan Sanders: Well, Australia probably had the first problem. They were probably first hit, when they discovered issues with animals and wildlife in Australia. They have more experience and they have some interesting things. I do not know the details of that. I know a man who does, who happens to be in Australia right now. He could answer it much better than me. We could learn a lot from them, I am sure. There is the US as well, of course.

Professor Orsini: Yes, the US is the other country that has been a bit ahead of the curve in assessing the toxicity of PFAS, using new approach methodologies and also banning them ahead in further production processes. It is not as advanced in remediation, and that is probably because remediation is the challenge we also have to face.

I do not know if we will go into more detail about how many ways you can remediate, but there are intrinsic challenges in all of them. The way I see it, there are several challenges. Most of the modern technologies that use remediation just capture and concentrate PFAS. They just move the problem somewhere else. There are also the destruction techniques. They are much more effective, but they are very energy-intensive and so they



are difficult to scale. Then there are the new emerging nature-based solutions. They are more in the space of capturing and concentrating, of course, but they have less carbon footprint. Potentially, the way forward for remediation is a sweet spot between two: a nature-based solution combined with modern technology that can destroy whatever has been concentrated without creating further waste.

Our major issue nowadays is that the majority of this PFAS goes through the wastewater treatment plants. It cannot be removed, it accumulates in the sludge, and then what do we do? We use the sludge—

Duncan Sanders: As fertiliser.

Professor Orsini: As fertiliser.

Duncan Sanders: We put it back on the land. It is a great idea.

Professor Orsini: That goes back to us, and that is why we are all sick and we have problems. That chain has to be broken. Otherwise, we do not get out of this deadly loop.

Q156 **Chair:** Thank you very much. Dr Schwarz, in the previous panel we heard suggestions that the Environment Agency could be doing a lot more in terms of identifying and monitoring the level of PFAS being utilised by companies. We heard from companies who have dedicated their existence to continuing to produce PFAS products. Obviously, there is a whole range of manufacturers who use PFAS within their technologies. Unless something drives change, it may well be that businesses continue to operate in the way that they always have done. We will probably make a recommendation about what the Environment Agency could be doing.

You have a new process. How engaged do you find both the fluorochemical industry and those who are utilising PFAS in wanting to take the steps that you are now offering? Can you tell us how easy you are finding it to solve?

Dr Schwarz: The interest is overwhelmingly in finding a solution that can be both sustainable and economic. We find that anyone who is either producing or handling PFAS—they have different problems—or indeed even handling waste, as in our conversation slightly earlier, has an overwhelming need to find a solution that can be economic and sustainable long-term.

I think everybody in the chemical industry understands where this journey is going. It is going to processes and ways of producing these critical materials that are cyclic and sustainable. I think everybody has that interest in having the technology, and there are not that many options out there. It is a relatively early-stage ecosystem of technologies you can take off the shelf to be able to do what some of the other panellists are talking about, which is not just concentrate and take it out of the environment but use it for something productive, for new chemicals in the future.



Q157 **Chair:** I am encouraged by your confidence, but in the previous panel I did not get the same sense of desperate urgency to move on. I got more of a sense of, "Look, this is there. We think that it can be managed, we think it can be balanced. We think that there are no alternatives". It is interesting you feel like everyone sees a path to where we are going. One of the criticisms of the UK is that in comparison to some of the countries we have heard about but also in contrast to France and Denmark, our regulatory approach has been less critical than maybe we are laying out there. Do you think that the UK is a bit of a back marker in this area, and do you hope that as a result of studies like this, we pep up the urgency to find alternatives?

Dr Schwarz: To clarify my previous answer, I was talking on a global scale. We talk to partners across the world, from Australia to Japan to the US to Europe, as the main players who want to create solutions to move forward. They have two areas. One is their own factories and manufacturing. They have a lot of waste products that come through their manufacturing. They would love to reuse that and put that back in to provide value from that product. The other one is the wider piece about the long-term end game for their technology.

I do not see the UK is a backwater at all. What we have to think about in the UK is not just offshoring our problem, but making sure that we have regulation and an ecosystem that can remain competitive within the UK but drives forward change towards a sustainable pathway for fluorochemical reuse back into the ecosystem.

Q158 **Chair:** For the avoidance of doubt, I described us as potentially as a back marker, not a backwater. I do not want flags outside my office or anything like that. I am happy to have flags outside my office, I should clarify—let us move on.

If I could just come to you, Mr Sanders, your company uses a range of technologies for PFAS remediation. What factors determine which methods are most appropriate for a given situation?

Duncan Sanders: Just before I answer that, in the context of the last discussion, I am absolutely amazed and excited by the innovation that has been shown in coming up with solutions. I have been in the industry a fair while now, since the early 1990s. Contamination has come through and you have seen new approaches to it, but I have never seen anything accelerate as quickly and as dynamically as we are currently seeing with solutions for PFAS. A lot of that is home grown as well as international, so it is very exciting.

Q159 **Chair:** Can you just expand on what they are? We have obviously heard Dr Schwarz. What else is out there?

Duncan Sanders: Of course. To give an example—it is where to start, and I am mindful I have to answer your second question as well—there are the filtration and the concentration technologies like granulated activated carbon adsorption, which take PFAS out of one media into



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another. Up until probably a year or two back, there was very little on the horizon in terms of destruction technologies, but that is rapidly increasing. There is an example of technology called sonolysis, which is using sound waves, ultra-cavitation and high temperatures to break down—really clever stuff out of the University of Surrey that then is part of a treatment train. That is what this is all about: combining different technologies to get the best, most sustainable solution.

Q160 **Chair:** Now are you going to answer the question I actually asked you?

Duncan Sanders: Yes. I am sorry; I went off a bit off-piste there. Just remind me.

Chair: I was just saying you use a range of technologies. What factors determine which methods are most appropriate?

Duncan Sanders: It is about the concentration of the contaminant, whether it is in soil or groundwater, whether it is point source or diffuse, what depth it might be, and the hydrogeology of the site. All of those are important considerations, along with: what is the actual problem? What is it impacting? It is based on source, pathway, receptor. Our job as remediators is to break that chain from the source of contamination, the pathway of where it is going to cause a problem, and the receptor where it ends up.

Q161 **Chair:** Professor Orsini, how effective are nature-based solutions for PFAS remediation, and what limitations are there to the wider deployment of nature-based solutions?

Professor Orsini: This is a topic very close to my heart because as a developer of one, I very much believe in nature-based solutions. There are obvious limitations. One is that dealing with living things does not allow you to switch on and off a button, and therefore it requires sometimes a bit more patience or skill in order to manage the nature-based solution. However, if you work closely with end users, as we have done at Daphne Water Solutions, then you can refine the technology to meet the actual needs of industry.

Some industries are much more adventurous and support more innovation. Others—you probably have that issue as well—are much more risk-averse. There is innovation from universities, there is plenty of innovation, but sometimes this innovation dies out because acceleration between science and innovation is difficult to achieve without funding. That is where probably the UK is already in a very good spot, but it could do more in order to promote green-by-design chemistry, sustainable solutions or nature-based solutions, so that industry feels that there is a problem and so they are more in favour of adoption.

Q162 **Chair:** Thank you. Mr Sanders, what do you see as the balance between pushing towards restricting PFAS production and working harder towards remediating existing contamination?



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Duncan Sanders: Well, of course you have to shut the stable door because there is no point in just leaving it open and then cleaning up forever. It is a crazy situation. Obviously, you have to do whatever you can first to stop the pollution.

Then there is a very interesting question that we are debating at the moment in the industry about how much remediation is viable, how much is reasonable and how much is affordable. How much do you actually need to do, and on what? I think *The Guardian* reported recently a £1.6 trillion estimated cost of clean-up in Europe over the next 20 years from PFAS contamination. Who is paying for that and where does it come from? Where do we focus that?

Q163 **Chair:** You said there is a huge amount of innovation. We have just heard that. Do you think that the sector is being dragged kicking and screaming towards reducing usage, or do you feel that they are taking seriously the need to reduce PFAS usage?

Duncan Sanders: I am not so sure about that side of things because I do not know so much about the production of PFAS. The predominant issue we see is the firefighting foams, and obviously they have been tackled or are being tackled. They are causing most of the issues.

Q164 **Chair:** Professor Orsini, how effective do you think current enforcement is in managing PFAS contamination breaches? Is the Environment Agency properly resourced and with the relevant expertise to ensure that we have a regulatory framework we can be confident in?

Professor Orsini: There is first the problem that there is not enough regulation, except for drinking water, where there are very clear guidelines. For other environmental pollution we do not have limits and therefore the Environment Agency is a bit tied up. How does it enforce something that is not well regulated? That is the first point I would stress. There is a need for much clearer regulation, potentially a decision tree on whether PFAS use is absolutely necessary. Is it toxic, yes or no? Can we use something else? Then there is enforcement. Limits have to be determined.

The other point is that very often environment agencies are understaffed and so when it comes to imposing regulation they do not have enough people. That probably has to change, in terms of how we ask an agency to regulate when they are understaffed.

Q165 **Chair:** Yes. If you were to look at the UK's performance in terms of regulation in comparison with what you are aware of elsewhere, do you do think that we are relatively similar to other countries or are there other countries that have stronger regulatory regimes and enforcement?

Professor Orsini: I suppose you are somewhere in between. There are regulations in Europe that are much stricter. There is REACH, which imposes much more controlled PFAS release on industry. There is also permit regulation in place where we do not have them, and there are



countries in Europe that voluntarily are asking for a ban of more than 10,000 PFAS.

Some countries are very ahead of the curve, others are behind, and I would probably see the UK somewhere in between. Definitely, this consultation is an obvious indication that there is a need for understanding and a push for action. If we can accelerate that, that is great, but I also see this as an option for regulation of more chemicals. It is not just PFAS, right? We have so many. Can this be an example for the regulation of other persistent chemicals?

Duncan Sanders: To your point earlier about toxicity, to be fair to the Environment Agency, there are limited resources, there are limited staff, and in our experience—we have come across them on various sites and we have worked together—they have not known exactly what to do. There is not a specific number that lets you just go, “Well, there you go, clean up to that and we will back it up”, because no one knows. It is the blind leading the blind, in a way. We have been leading some sites, just trying to be pragmatic about it and saying, “Look, let’s do a betterment solution. We can do this. We can achieve that. Are you happy with that?” and they are saying, “Yes, that is fine”. That is a gross simplification, of course.

What I was getting on to say was that back in the early days we had the Dutch standards for soil, and what we did originally was that we had a number on a chart and if it was above that number, it had to be remediated. We dug up huge volumes and took it all off to landfill, and that was just horrendous. We remediated far more than we needed to. We are navigating through that middle ground. What is sensible, what is sustainable and pragmatic, and what is also protective of human health and the environment? It is very difficult.

Q166 **Chair:** Sure. We heard from the previous panel—I think you are repeating it—that by and large, Britain does need to have a more serious regulatory regime around PFAS chemicals. It needs to set the rules and needs to resource the Environment Agency to enforce those rules once it has made them. Is it fair to say that is the recommendation that you would support?

Duncan Sanders: Yes, given some of the previous comments I just made about understanding the complexity and difficulties of that.

Q167 **Alison Taylor:** Dr Schwarz, do you consider there to be essential or protected uses of certain PFAS, and what are they?

Dr Schwarz: Other members of the panel have given effective answers here. We are experts in making fluorinated materials, not their use, but there are certain scientific properties of the fluorine-carbon bond that mean that its use in industry is very difficult to replace, if not impossible, especially the Johnson Matthey systems in electrochemistry and battery technology. Pharmaceuticals and agricultural chemicals have not really



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come here. Again, those properties are unique to that carbon-fluorine bond. I would say these are not replaceable across the board.

Q168 **Alison Taylor:** Thank you very much. Professor Orsini, do you have anything further to add?

Professor Orsini: I totally agree there are things that are easy to replace and others that are more difficult. Essential use could be medical. It could be aerospace. It could be in flame retardants. These are obvious priority areas. However, there are many that already, for example, REACH in Europe has identified as substitutable, and these include cosmetics, food packaging, textiles and so on. These are less critical. We all wear and breathe PFAS here, but do we really need a jacket to last for 20 years? Probably not. Those are the kinds of questions we have to ask. Where it is necessary, yes, we keep it, but where it is not, let us substitute with something better.

To go back to regrettable substitutions, let us see if the replacement is toxic or not. That is critical because with many short-chain PFAS that have been replaced recently, we have started discovering that they are much more toxic than the previous ones. Let us do a thorough assessment before we replace.

Duncan Sanders: Was it GenX that was the one, for PFOA?

Professor Orsini: GenX is bad.

Duncan Sanders: That was an example of that.

Q169 **Alison Taylor:** For uses where an alternative can be found, what responsibility should industry and Government take for designing safer alternatives to PFAS? I will start with Professor Orsini.

Professor Orsini: As I probably mentioned before, I think there is a shared responsibility here. There is on one hand the enforcement for industry. I see that happening through permits for PFAS that could follow a decision tree: if the PFAS is absolutely necessary, if it is toxic and whatnot. Also re-evaluation periodically, because some of these might be replaced later.

Industry is responsible, but there is also a need for tighter regulation and Government intervention. As one example of this difficult challenge, the water industry is responsible for PFAS but is not producing PFAS. We also have to be fair. This responsibility has to be shared. If we look at the entire life cycle of a chemical we could identify real responsibility for production, but how do we remediate once it ends up in the environment in a mixture that is not planned?

Q170 **Alison Taylor:** Dr Schwarz, do you have anything else to add?

Dr Schwarz: I would just like to add that we need to make sure that we enable the chemical industry to be competitive globally. If we bring onerous regulation onto the chemical industry, the challenge is that it will



be very hard to nurture and build businesses within the UK. You might solve the problem as in you outsource everything, but you are still going to have the imports of the products coming into the ecosystem. My only argument would be that there needs to be balance and it should be scientifically led. It should be led by real, specific, demonstrated harm, rather than broad-brush regulation that makes us uncompetitive.

Professor Orsini: The other thing, if I might, is incentivisation. Can you incentivise industry to go green, to be sustainable? Sometimes punishment is an escape for them because fines might be cheaper than if they are forced to remediate. If the next stage is, "If you pollute, you have to remediate, and if you innovate, we give you incentives". That is probably a better compromise than just trying to impose limitations, because it could also impact the economy. It is a balance, at the end.

Q171 **Alison Taylor:** Thank you very much. I am sorry, but I am sticking with you, Dr Orsini. What do you think would help to ensure that PFAS alternatives are truly safer before they enter widespread use in production? We heard a little bit in the previous session about regrettable substitutions. If you could just expand on that, please.

Professor Orsini: Sure. Some concepts have already been mentioned. PFAS is not just one chemical. We have more than 40,000, and more coming. How do we make sure that they are safe?

Grouping chemicals by classes in order to test them is the first step. Looking at their chemical characteristics is the next, because they might have byproducts that could be even more toxic than the actual PFAS. The third weight of evidence, if you want, is testing if they are toxic to humans, animals and wildlife. This can be done, as I mentioned at the very beginning of this session, by moving away from traditional toxicity approaches and going for more sensitive and high-throughput approaches like new approach methodologies. I can expand on that if you want.

Q172 **Alison Taylor:** That is probably enough, because I know we will be short of time, Chair, but it might be that the Committee want to follow up for a little bit more information afterwards, if that is okay. Professor Orsini, just one final question and then I am going to bring in Dr Schwarz. How should the industry be encouraged to share data on PFAS production, use and testing to ensure safe substitutions?

Professor Orsini: That is a sore point that you are raising there, and a very valid one. There is a lot of data that we have no access to because they are very often behind a firewall of IP protection. However, being a business owner as well, I know that you can release data without infringing your IP and sharing commercial secrets.

Incentivisation again here could be a way forward: innovation incentives and also acceleration to market for new products for industries that share data. If data are in the public domain, say, scientists could approach them, use them, model and reach conclusions much faster. Nowadays, if



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I have to put my scientific hat on, our major problem is getting money in order to discover things. If we have much faster access to data, we have the instruments to do that.

Q173 **Alison Taylor:** Thank you very much. That has been really helpful. Dr Schwarz, do you want to come in?

Dr Schwarz: Just a couple of quick points to build on that. I think there is opportunity to create a consortium across industry to create new standards. It has been raised a few times that there are not clear limits. This might have some contamination, but what is the number that makes sense? Typically, other industries, like the automotive industry, would set standards. They would set standards across all the stakeholders, from Government to producers to disposers. That would be an effective way to share data and incentivise setting standards.

I have one quick point on the previous question about incentives. Fluorinated chemistry is a hugely valuable business, a \$30 billion business globally. There is no native fluorine that is currently being mined in the UK. If we can extract these materials and reuse them, it offers an important economic incentive to localising production and building industry in the UK.

Alison Taylor: That is really helpful. Thank you both for your contributions.

Q174 **Barry Gardiner:** I wanted to first of all ask you, Professor, about the bioremediation work that you have been doing with Daphne. Part of the problem with that is that it is a slow process, is it not?

Professor Orsini: A slow process in what sense—developing the technology or the application of the technology?

Q175 **Barry Gardiner:** I had understood it was the application.

Professor Orsini: Many nature-based solutions take days rather than hours to clean a certain volume of water, but we have worked with industry to retrofit within their infrastructure and shorten the contact time to what they need. We can work within two to four hours to remove the chemicals, and this is their typical retention time. We are talking about medium to large wastewater plants. It is possible.

The advantage here is that we are using science to select the biological agent properties, and that is one major advantage over maybe some other technologies. Coming from a deep tech point of view, it is the science that supports the technology.

Q176 **Barry Gardiner:** In order to refine these technologies, and given the complexity of the way in which this works, is there a role for AI in identifying how to do that, how to speed it up and how to make it more efficient?



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Professor Orsini: We are partnering with companies to use AI to create digital twins of these ecosystems, but it is more for us to predict the performance. If something happens, like spills of chemicals or shock events, we want to be able to prevent it. However, the choice of biological agent is based deeply in genetics and biology because it is a biological system. However, I know of other technologies that have moved in the same way.

We find that it is very efficient. By working with end users, we can adapt to their needs. It could be refined, obviously. In terms of complexity, we have made it so self-sustaining that I can send my engineers onsite and they know what to do. Your typical employee in a wastewater plant is an engineer who does not know much about biology, but he needs to manage the system. We made it so self-sustaining that it is possible. All this is very much possible, and it could be adapted and it could be made to respond to the needs of the end user.

Q177 **Barry Gardiner:** Dr Schwarz, I wanted to ask you about recycling of the chemicals once the PFAS has been captured, because we have heard that a number of these processes gather it all together, but it still has to be dealt with. How does that fit into the sustainable management strategy for PFAS?

Dr Schwarz: There are two approaches. Today, most of this is incinerated and then you would be managing your waste gases and waste.

Q178 **Barry Gardiner:** High energy cost, high real cost?

Dr Schwarz: High energy cost, high real cost, and then you are capturing the waste products because you do not want to just emit the fluoride out into the ecosystem. That product can be used. It is typically used in low-grade sources, things like filler for cement. It is basically just mitigating disposal costs. Otherwise, the media is being captured but there are no technologies that are scalable at this stage that would be able to take those materials through to reuse or some productive use of that product.

Apologies for the sales pitch, but this is where technologies and companies like Fluorok come to the fore, where there is this clear gap in the ecosystem, which is: how do you take these products at the end of life, either the captured materials or the low-grade raw materials, and bring them back through to make productive products? Fluorok is one of a number of technology providers that are trying to develop that technology.

Q179 **Barry Gardiner:** What are the technical and regulatory hurdles that you face in scaling that?

Dr Schwarz: Technology-wise, there is always a series of challenges to bring any new technology through and you are always competing against incumbent technologies. You have to be productive and competitive. If



there is not an environment that gives those current technologies a driver for change, it can be challenging because you essentially have a fully optimised technology and a better but newer technology coming through.

Then there is the journey of scale-up and development of new technologies and new businesses, which can be very challenging. There are some very classical barriers to bringing these businesses through—so-called valleys of death—where you have proved things in a laboratory environment, so you know it is going to work and you can plan for the full-scale production, but you have not actually built the machine and showed that it is going to be productive. This is where government help and government support is critical, things like research grants and scale-up grants. Building an ecosystem and partnerships to help through that scale-up journey is super helpful.

Q180 Barry Gardiner: The valley of death. We always hear that this is a problem. One of the recommendations that you would perhaps wish this Committee to include in its report would be about ensuring that support is coming, not necessarily to your company but to the industry to make sure that we can get those technologies that have proved themselves in the lab to commercial scale?

Dr Schwarz: I think you said it. Maybe the only thing I would add is that you can look at some other case studies and examples. In the battery technology area, there is obviously a critical need for our downstream industries like automotive to transition to net zero and EVs. There has been a range of different institutions built by UKRI, from the Faraday Institution to the Faraday Challenge, which has now been rebranded as the battery scale-up partnership, through to APC, the Advanced Propulsion Centre. These have incubated technologies, scaled technologies and developed applications for those technologies, and there are businesses nowadays that exist because of that support taking it through.

Now, that is a very big commitment and investment from the UK, but also the size of the prize is very big. As I say, it is a big industry and there is big opportunity out there.

Q181 Barry Gardiner: Clearly, you have set out the case for recycling, but as part of that recycling of materials, what is the danger that you are reintroducing PFAS into the environment? We have heard the examples about textiles and so on, where you can be compounding the problem. What is the challenge you face there and how do you overcome that?

Dr Schwarz: We will always fit into the existing ecosystem of the chemical industry. We are a production technology, not a product technology. We will be making existing products that are already utilised.

Many of the arguments we have had already. Where they could be replaced, they should be, and where there are substitutes, they should not be. We do not offer any risk. Technologies like ours, which are



production technologies, do not offer any additional risk in this area. They just, for the first time, drive a sustainable circular economy and drive us forward to our net zero goals.

Q182 **Barry Gardiner:** Professor, anything to add?

Professor Orsini: Our technology was developed to target the problem not at source but somewhere in between. Much of the PFAS and other persistent chemicals come through wastewater treatment and are not removed. What we thought of is that if we are removing them from the wastewater, we prevent them from re-entering the environment. That is not a final solution, but it is a good intermediary solution if it is combined with interventions at source. In the long term, this might be the way we can remove these PFAS from the environment and prevent them from re-entering the food chain.

Obviously, our technology is concentrating, and that then means we need to deal with the bio-waste. However, here the major advantage is that the technology has a low carbon footprint, almost zero. It does not use energy. It does not use chemicals. It does not use anything else. It concentrates these chemicals that are present at very low doses, and this is the biggest challenge in industry. Once you have concentrated that, you end up with a very modest biomass. Now, this modest biomass can be effectively targeted by technologies like Fluorok, photocatalysis, or anything else, and so our system becomes completely circular. There is no waste, there is disruption of chemicals, and whatever organic is left could be reused as fertiliser. That is our target. We are in fact also working with the University of Birmingham on a secondary technology to treat waste, but if anything is out there we are happy to use it so that our impact is zero.

Duncan Sanders: Just to add to that, on a practical basis, we are working on a site at the moment where we are removing the PFAS from the water stream from a power station site and putting it on to adsorption media. We have just done a study and we know that works very effectively and it is producing 95% removal rates, but for the client we have just looked at the sustainability of that longer-term and alternatives.

Some technology providers can take the media back and regenerate it now, in other countries. There is one where it can go back to Belgium, be regenerated and come back with fresh carbon. There is technology such as pyrolysis, which can break down the carbon-fluorine bonds and destroy the PFAS. This is getting more interesting. There is a thing called a gyroid sponge from Australia, which can absorb the media, and then I have heard it can be reused with a treatment and put back into products like clay bricks in Asia. They are experimenting with that. That does build the whole circular life cycle that we have been talking about, which would be the utopian solution if we could get there.

Q183 **Barry Gardiner:** Just one final question, I think. What you are talking



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about is identifying and extracting, remediating, and recycling some of it, but as more and more is coming through the production line, you are taking out a percentage of an increasing stock. Therefore, it surely has to be combined with the prevention of it coming into the market.

Duncan Sanders: The stable door. That is what we said earlier on. You have to shut the stable door.

Professor Orsini: We have said it before: the two things have to go hand in hand. Green by design might be the way of replacing toxic PFAS going into the system.

Q184 **Barry Gardiner:** Again, just trying to translate that into recommendations for this Committee's inquiry report, you would wish us to very strongly make your stable door point before focusing on the importance of scaling up the technologies that can deal with, remediate and recycle?

Professor Orsini: I would not wait for it. I would not wait for it because technologies go from research to application within a few years. If you wait, then they will not be there on time when you need them. There has to be a balance between the two.

Duncan Sanders: Do both, yes.

Dr Schwarz: Maybe I could just quickly build on that. Your "topping up" analogy makes a lot of sense, but really these materials are almost always going to be used. There is always going to be a churn of fluorine going around the system. It would be much better if we could develop the technologies as quickly as possible to be able to make that as cyclic as possible rather than focusing on other areas, making sure we have that technology available so that we can drive that sustainable chemical ecosystem forward.

Duncan Sanders: Even if you shut the door completely today, we have enough in the environment to keep us going for a very long time.

Professor Orsini: Twenty years.

Q185 **Barry Gardiner:** We have 10,000 sites to get rid of.

Duncan Sanders: Yes, exactly. It is going to see our company out, long past my retirement, that is for sure.

Chair: Mr Sanders, Professor Orsini and Dr Schwarz, thank you very much indeed for your evidence, for joining us today and for the time you have spent helping us with this inquiry. With that, I will bring this sitting to a close.