



Environmental Audit Committee

Oral evidence: Outdoor and indoor air quality targets, HC 1411

Wednesday 14 June 2023

Ordered by the House of Commons to be published on 14 June 2023.

[Watch the meeting](#)

Members present: Philip Dunne (Chair); Duncan Baker; Barry Gardiner; Caroline Lucas; John McNally; Chris Skidmore; Cat Smith; Claudia Webbe.

Health and Social Care Select Committee Chair present: Steve Brine.

Questions 1 - 77

Witnesses

I: Professor Frank Kelly, Battcock Chair of Community Health and Policy and Director, Environmental Research Group, Imperial College London; Professor Sir Stephen Holgate, Professor of Immunopharmacology, University of Southampton and special adviser on air quality to the Royal College of Physicians; Professor Alistair Lewis, Professor of Atmospheric Chemistry, National Centre for Atmospheric Science and University of York, Chair, DEFRA Air Quality Expert Group and Chair, Department for Transport Science Advisory Council.

II: Jim McManus, President, Association of Directors of Public Health; Matthew Clark, Member of the Environmental Protection Advisory Panel, Chartered Institute of Environmental Health.

III: Tom Bradshaw, Deputy President, National Farmers' Union; Emily Hunter, Lead Policy Advocate on Land Use, Woodland Trust.

Written evidence from witnesses:

[Royal College of Physicians](#)

[National Centre for Atmospheric Science](#)

[The Association of Directors of Public Health \(ADPH\), The Association of Directors of Environment, Economy, Planning and Transport \(ADEPT\), and Chartered Institute of Environmental Health \(CIEH\)](#)

[Environmental Research Group, Imperial College London](#)



Examination of witnesses

Witnesses: Professor Frank Kelly, Professor Sir Stephen Holgate and Professor Alistair Lewis.

Q1 **Chair:** Good afternoon and welcome to the Environmental Audit Committee for our initial oral hearing taking evidence in our new inquiry on outdoor and indoor air quality. We are very pleased to meet today, in the first of three panels, with some distinguished academics, from my left Professor Alistair Lewis from the University of York. Please tell us, Alistair, what you do in this area.

Professor Lewis: I am professor of atmospheric chemistry at York and the National Centre for Atmospheric Science. I chair the DEFRA Air Quality Expert Group, which provides advice to Government on the physical science of air pollution, so where it comes from and what it turns into. Also of some relevance today, I chair the Department for Transport's Science Advisory Council.

Chair: Please hold us up if we are straying into areas of advice to Government that we should not be talking about. Sir Stephen Holgate from the University of Southampton, welcome.

Professor Sir Stephen Holgate: I am a Medical Research Council clinical professor in a subject called immunopharmacology, but my major interest is in lung disease and the mechanisms of lung disease, particularly asthma and allied disorders and allergic disorders. I am also a special adviser to the Royal College of Physicians on air quality and a UKRI clean air champion.

Chair: Excellent. Thank you.

Professor Kelly: I am professor of community health and policy at Imperial College London. I am a toxicologist by training, but I run a team called the Environmental Research Group, which covers all aspects of air quality, air pollution and health. I have previously chaired COMEAP, the Committee on the Medical Effects of Air Pollutants, for 10 years, and I am an adviser to the WHO on health and pollution matters.

Q2 **Chair:** Thank you very much. I perhaps should disclose that I have a lung condition. I have rarely experienced poor air quality, I have to say, but I am increasingly sensitive to it.

We will start by asking for some general scene-setting answers about why we have a greater understanding and awareness of air quality issues and the impact that that may have on public health and, in particular, why the Government have decided to introduce air quality targets as part of the Environment Act and the extent to which scientific understanding of the quality of the atmosphere that we live in, wherever we live in the UK, has improved. Could you set a bit of context, Sir Stephen?



Professor Sir Stephen Holgate: We are all aware here, of course, of the Clean Air Acts of the 1950s and the early 1960s, which had a transformative effect on improving human health, particularly in our urban conurbations and London specifically. Since then, of course, air pollution has not gone away, and we have different sorts of air pollution that have come in now and are starting to cause increasingly severe problems that we are recognising. These emissions are focused around the internal combustion engine in large part, but also secondary pollutants that are formed.

The important aspect of all this is that the medical science and the clinical science linked to it, particularly in the last, say, seven to 10 years, has accelerated at a huge rate. The knowledge base now around adverse health effects and air pollution is very high indeed. What we are talking about here is non-communicable diseases in large part, which includes cancer. We are also talking about exposures that begin at conception and spread right across the life course to death. As with tobacco smoking, air pollution has a cumulative effect over time on the human, as was the case, of course, in the old days with the bad pollution of coal burning.

The important aspect here is that the nature of air pollution is changing compared with what it was in the 1950s and 1960s. This is to do with the sources of emissions that my colleagues can talk more about in a minute. In essence, these air pollutants, particularly the very small particles that make up the serious side of air pollution in large part, particularly the long-term exposures, can pass through the lung into the circulation. I think that it is this that has caused the flurry of research into multiple diseases demonstrating that air pollution is one, and only one, of the important factors that can accelerate the progress of these diseases.

The final thing I will say is that air pollutants can cross over the placenta into the foetal circulation. There have been several recent studies demonstrating particles embedding in the liver, in the brain and in the heart of the babies—the foetuses. We now know that these pollutants can alter the way that organs develop in the foetus, such that when the child is born their lungs or their brain may not be as well developed as they would have been had their mothers not been exposed. There is a dose response relationship between the mother's exposure and the baby's content of these pollutants. That is the other aspect of this, a greater focus on children and the next generation and what air pollution is doing to them.

Q3 **Chair:** Has this research that you have referred to, particularly on pregnant women, been targeted or assessed based on their entire pregnancy? What proxies do you use for their exposure to air pollution? Maybe you are, but I do not imagine you are asking people to wear devices throughout their pregnancy. I imagine that is fairly unusual.

Professor Sir Stephen Holgate: Frank Kelly's group has been involved in one of these studies. Do you want to say something about that, Frank?



Professor Kelly: The other thing that has happened in the last decade, let's say, is that we have had technical advances that have miniaturised the measurement equipment, which means that instead of having one monitor in the centre of a city, for example, and everybody being associated with that one set of readings, we now can put equipment on individuals. Yes, we have studies with pregnant ladies and the questions we have generally been asking are: is the exposure more important during the first trimester, the second trimester or the third trimester, right through pregnancy, or even before pregnancy? There now is research showing sperm mobility and so on can be affected in men.

Q4 **Chair:** Is that revealing that health inequalities play a big part in the susceptibility to damage from air pollution?

Professor Kelly: It is one of the components of it. Certainly, many people who are in the lower socioeconomic classes are exposed to more pollution. We can demonstrate that again through the personal measurements. Many of those properties are near busy roads—a big source of pollution. Then, of course, the child is also growing up in that neighbourhood, where they are exposed to more pollution during early life, the first five years. I think that many of you will have heard about the study that was done in east London. It was probably five years ago when we finished it. We demonstrated that children who were exposed to higher concentrations of nitrogen dioxide—the main gas that comes from diesel vehicles—by the age of 11 had somewhere between a 7% and 9% smaller lung, which is an important metric of health going forward.

Q5 **Chair:** Alistair, how much credence should the public place on the wide-ranging estimates of the number of people who will die through exposure to air pollution? There are some quite big figures put out from time to time. The Health Security Agency I think puts out a figure quite frequently.

Professor Lewis: It is a broad range, because it is built up of uncertainties from lots of places. We have uncertainty, for example, in what individuals will be exposed to and uncertainty in the response, as Stephen has already mentioned, to a particular pollutant. It is in the end a statistical relationship. It is something that loads the dice for probability. Lots of those factors add together to give you what seems to be a pretty broad range of size of statistical effect on mortality, but if one was to take the central estimate of that and say, "Am I confident that this is a real and genuine effect?" I think that overwhelmingly science advice would say, yes, it is a real effect.

Of course, often what happens is that typically the very highest number is reported by one person and then the very lowest number is reported by another as a way of separating and creating disagreement. If you look down the centre of those predictions, I think you could be fairly confident that that is a real effect.

Chair: We are joined at the Committee today by the Chair of the Health



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and Social Care Select Committee, Steve Brine. Steve has some questions in this area.

Q6 Steve Brine: Yes. I am appearing on the Committee for one night only. We are doing a big inquiry into prevention of ill health at the moment with 10 different workstreams across healthy places, healthy workplaces, major conditions, cancer, and there is obviously a crossover from all this. We had the CMO in at the very start of that inquiry and you will be aware that Chris placed air quality as the central theme of his annual report last year. That has given it quite a high profile because of who he is.

I want to ask about to what extent the general public is on this journey. The thesis that you bring to us in evidence, which we read and we understand and is a very well accepted and very clinically accepted thesis, is around the dangers of air quality. I am learning things all the time. Placenta crossover from Professor Holgate this afternoon was one of those. When it comes to cancer, we are very well versed in the signs and symptoms of certain cancers. We are very well versed in risk factors around type 2 diabetes. When it comes to the challenge of the risk factors around air quality, how do we get the very understandably complex scientific argument that you are making and turn that into a retail communications message for the public? Is that even a fair challenge?

Professor Sir Stephen Holgate: I presented scientific and clinical evidence to the second inquest of Ella Kissi-Debrah that led to air pollution being listed on the death certificate of her death from asthma. The "Prevention of Future Deaths" report, as you will probably be aware, came up with some quite interesting observations.

First, the health profession itself is poorly informed about air pollution, right from the start of medical student education through to the postgraduate qualifications and then updating postgraduate knowledge over time.

The second thing is that the public were unaware because the visibility of air pollution as a problem is not apparent. One can walk into a primary care setting or a hospital and you never see a mention of air pollution anywhere. You will see mention of diabetes, smoking and climate change, but air pollution, no.

What I would say about this, spending one part of my life in it, is that it is out of sight, out of mind. It is not like the air pollution in the 1950s, which you could see, with black smoke and dirty buildings and all the rest of it. This you can't. In a way, that is the issue we are dealing with.

Q7 Steve Brine: Whose job is it to make that leap? When the link between smoking and lung cancer was made, I know it seems like a strange world now but before that time the link was not established and, therefore, it was not understood. It had to be established before it was understood. This is before we even get to the issue of indoor air quality, which sounds



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like an oxymoron in itself, doesn't it? Professor Kelly, even if we can make that argument to the public, are they justified in feeling a sense of helplessness that they can change their air quality, certainly outside in the environment?

Professor Kelly: Finishing off Stephen's point, as chair of COMEAP for those 10 years we were coming across new evidence nearly every six months and producing numerous reports. It was quite clear that there was a deficit of understanding by the public and there was call after call for the then Department of Health to do a national education programme. That came from many of the royal societies and from our committees. It just has not emerged in the same way as we had it for seatbelts and smoking. I think that is the first issue that we have to deal with. The public is generally ignorant about an invisible challenge.

Then if we tell them about it, we do not want to be scaremongering, but we want to be educating. There are many things that can be done. For example, at the moment we have an air pollution episode here in the UK. One of the major things that can be done is that we can advise people not to use their vehicles today and contribute to the problem. We can advise them that if they have a respiratory or any other health condition and they are sensitive to air pollution to stay indoors or to make sure that they do not go out at the worst time when the pollution is high. All the information is available to them to avoid and to mitigate.

Q8 **Steve Brine:** Finally, because there are so many colleagues who want to come in, are you looking to the Office for Health Improvement and Disparities to be the leader on this? It was part of the split-out of Public Health England, with UKHSA being the other half. Are you looking to it and do you think that it is fit for purpose to do that?

Professor Kelly: I am looking to it. I don't know if it is fit for purpose, to tell you the truth, but I think that it does have a major role to play—I hope that it does play it—in outdoor air pollution and indoor air pollution, which we are not covering today. I think that both will be major challenges and many Government Departments will need to work together.

Q9 **Cat Smith:** I have some questions about meeting our targets on outdoor air quality. I will start with Professor Lewis, but if the rest of the panel want to come in, please do, although I am conscious of time. Could you outline where you are most concerned that the progress towards meeting the outdoor air quality targets is falling down?

Professor Lewis: We have air quality targets for a whole bunch of different pollutants, so we have to split them down by pollutant. There has been a lot of progress if you look at a 50-year timescale. Air quality today is very much better than it was 40 or 50 years ago. A lot of the benefits were gained in the early 2000s and at the end of the 1990s, and for quite a few pollutants there has been a plateauing off. The rate of improvement has slowed over the last decade, and there are reasons for



that. Some are related to policy, but some are scientific. The rate of progress on nitrogen dioxide is progressing in a relatively steady fashion, and that is because vehicle exhaust emissions are improving for internal combustion engines. We see a pathway for that to continue to go downwards.

Particulate matter and this category $PM_{2.5}$, which is the one that gets the most attention, is much harder to control because around half of that in the UK comes from either natural sources or transboundary, so from other countries. Progress is slower in the last decade on that because not all the $PM_{2.5}$ is under national control. Quite a substantial fraction of that particulate pollution does not come directly out of an exhaust pipe, but it forms in the atmosphere through secondary chemical reactions as well, which makes it non-linear in its formation.

Then we have ozone, which is the one that is particularly high at the moment. That is a highly non-linear pollutant, which is really almost intercontinental in scale. Our fate on ozone has slowed because of the growth in methane emissions in the atmosphere.

It is a pretty complicated mix. Some of it is steady progress. Some we see quite positive-looking pathways into the future. Some are much harder to abate, and for some the chemistry and physics of the atmosphere works against us and makes it harder and harder to achieve targets, the most prominent being achieving the 10 micrograms per cubic metre, which was set in the Environment Act. That is tough because of the fraction that is actually under UK control versus natural and transboundary. That is the hardest one.

Q10 Cat Smith: Do you think that the UK targets are adequate?

Professor Lewis: This is a hard question to answer because you have to set some preconditions. The first is: do you think that there should be a single target for the whole of the country or should it be regional? We have a national target. That very much makes the challenge based around the south-east of England. The other is a philosophical point. Should a target always be achievable or not? You can see pros and cons in having targets that are aspirational versus targets that should always be achievable.

If you start from the perspective that you want a national target and you want it to be achievable, the figure of 10 micrograms per cubic metre that was set was probably about the right number. Then the discussion becomes: when do you want to meet it? Is 2030 okay, or 2035, or 2040? Then it comes down to your interpretation of where you think emissions are going to go in the future.

I have layered a load of caveats on that, but I think that this issue of whether we should have national or regional air quality targets is an important one. If we say we would like a national environmental target for a particular pollutant, it will mean that certain regions are the slow



lane movers, sometimes because of effects of geography. London is badly affected by the fact that it is not as wet and windy as the north-west of Scotland and it is closer to mainland Europe. There are some of these broader questions around what framework you want to set for targets before you even get to setting a particular concentration.

Q11 Cat Smith: You mentioned Europe. Since the UK has left the EU a lot of these targets have been imported across. Does the UK's exit from the EU give us opportunities to perhaps go further or do you think that the targets are just about right? I am conscious that I should probably bring the rest of the panel in as well.

Professor Sir Stephen Holgate: If I could come in on this one, there have been some debates in Brussels recently about all this and about targets. As you will be aware, the WHO introduced new targets in September 2021, which are 5 micrograms per metre cubed for PM_{2.5}. They are working now to achieve that within the European Commission. There is a discussion going on about whether they will or not, but the point about this is that targets are not ceilings that you fill up to. There should be interim targets that we are trying to aim at so that we can track, over a period of time, more precisely what we are achieving by cleaning up the air, rather than having these absolute numbers that we try to target by long distances of time in the future.

Certainly, the 10 micrograms should be an interim target on the way down. The adverse health effects are overwhelming now. It surprises me, as a doctor spending my life in this area, why this is not recognised by the health organisations as a serious issue equivalent to obesity in this country with its morbidity and mortality effects, yet we do not consider it in that way at all. We consider it as, "Oh, well, somebody else will look after this."

I would love to see a greater health ownership of all this agenda rather than just an environment or transport ownership. This has been the missing piece over these years. The health aspects of local and central Government have not taken sufficient ownership of it, and neither has the profession. It is not just the Government. I would like to see a shift of that responsibility or a shared responsibility. Chris Whitty is leading the way here, so let's hope that continues.

Professor Kelly: Briefly, this all translates through to these targets. There is a general lack of ambition behind the targets and there has been for a long time. This translates through to the fact that we do not tell the public often enough that there is an air pollution problem. For example, if we used the WHO guidelines that were published, as Stephen explained, we would be increasing our warnings to the public from 20 times a year to maybe 100 times a year because they would be triggered by that lower guideline. That guideline is what we say we need to protect people's health. That is what I assume that the laws of the country should be set at, if it is achievable, of course. Alistair was explaining that there are different challenges in different parts of the country.



Q12 **Cat Smith:** Stephen, you touched a little bit there on the opportunities for achieving it. What are the changes that perhaps the UK Government could make for that progress?

Professor Sir Stephen Holgate: Getting vehicles off the roads would be a good starter for 10. Not just changing to electric, which is where the mantra is, but getting vehicles off the road and concentrating on public transport and active travel. If we could get people in our urban settings to achieve walking, cycling or other forms of active travel for 50% of their journeys, which was set out in the Bill, that would be a phenomenal achievement. We will gain all the added value of cardiovascular health, mental health and all those other things.

Likewise with green spaces, which is another very important part of the equation, not only for mental health and for being able to exercise but because green spaces tend to enable corridors of cleaner air to occur, as was shown by the experimental studies that were undertaken here in London. If you move away from the roads and into the parks you see the fall-off of the pollutants and the health effects of that accordingly.

In essence, we need to concentrate much more on what we can achieve locally with removing the sources and emissions of pollution. The best way of achieving that is to know what the levels of pollution are locally. Having these values that are recorded across the whole country with monitors 20 miles apart gives you a certain level of continuous exposure, but the thing that killed little Ella Kissi-Debrah was not what was happening 20 miles away. It was what was happening 25 yards away where the South Circular Road crossed her house.

We need to have more visibility of what the air pollution levels are in our urban and rural settings. That information needs to be sent to primary care and hospitals and to be available to the public. We need to make sure that our public health communities and our local authorities that are responsible for planning and organising our roads are better connected such that they can make use of this data in the way we want to plan our urban environments going forward.

Q13 **Cat Smith:** To be very explicit, you say that there was not enough monitoring of local air pollution, that the monitoring systems that we currently have do not—

Professor Sir Stephen Holgate: Yes. What has happened now is that there has been a fantastic investment by this country in research in air pollution under the UKRI and the Met Office. They are developing new models now and new air quality measurement systems, which will augment the DEFRA systems. We will be able to have much more granular knowledge about what the air pollution is in your local area. That needs to be made more visible to the public and to those who are looking after health. We do not have that at the moment. In many countries around the world they do have that.



Professor Lewis: One of the crucial sectors that will have to be tackled in the future alongside vehicles is emissions from buildings. That is our combustion of fuels in commercial buildings and private homes. If you measure, for example, nitrogen dioxide in central London now, half of it is from space heating and the other half is from transport. This is how the world is changing very rapidly around us. Vehicles have been hugely important and are still hugely important, but if we only focus on vehicles, we will not get where we need to be. It brings it much closer to people's homes. This is a change that we will need to make inside pretty much every house in Britain, taking the combustion out and changing it to something that is not emitting.

Professor Kelly: Can I just state the obvious? When we burn anything, when we combust anything, we produce pollution, so we have to stop burning. We have to stop using fossil fuels.

Q14 **Chair:** Picking up on the observation about evidence, you said, Professor Holgate, that GPs and hospitals need to get this data. With the introduction of the ICB and ICS systems, is there any responsibility at that level for gaining access to the data and then dispersing it around their areas?

Professor Sir Stephen Holgate: Very much so. That is just the sort of organisation, but do they have 2,000 other things to do so that air quality again slips under the radar? That is the great worry about ICSs. They have so many responsibilities in their local communities for public health. Is air pollution high enough up the agenda? We think it is, so that is why that organisation, that grouping, is exactly the right grouping. Public health and the local authorities and so on are joined up.

Q15 **Caroline Lucas:** I want to come to Professor Kelly and push him a little bit more on PM_{2.5} and, in particular, to ask him whether he thinks that the new Government targets that were set in January are ambitious enough to achieve the best public health outcomes.

Professor Kelly: All the evidence that links poor air quality with poor health is regularly reviewed by the WHO. The WHO did that in 2021 and said that a figure of 10 was not sufficient to protect public health. It recommended a guideline of 5 micrograms per metre cubed. Anything above 5 will not be protecting public health. In reality, as Stephen said, if this Government are going to go for 10 by 2040, as they say they are, it is not a sufficient target and it is certainly far too slow to achieve that target.

Q16 **Caroline Lucas:** I think that my colleague is going to come back on to the WHO angle of it in a second. Parking that, do you think it would be possible to achieve the 10 micrograms per cubic metre by 2030 instead of 2040?

Professor Kelly: We were asked to look into this question by an organisation called the Clean Air Fund. We are expert modellers of air pollution information and health metrics. Our studies showed that 99.8%



of the UK could achieve a figure of 10 micrograms per metre cubed by 2030 and the 0.2% that could not were certain hotspots in London, which again if you took extra measures on you could probably eliminate those as well.

Q17 Caroline Lucas: I know that the London Mayor has said that he thinks it would be possible, were he to be given some extra powers, to be able to meet that by 2030. Not wanting to put words in your mouth exactly but would you say that the Government, if they are not going to go for the five—and we appreciate how ambitious that is—should at the very least go for the 10 micrograms by 2030 rather than 2040?

Professor Kelly: I think that would be an ambitious approach and I would certainly welcome it.

Q18 Caroline Lucas: Is there anything more you can say about what would be necessary to achieve those targets? I know that we have talked generally about getting people out of their cars and on to public transport and not burning fossil fuels, which are the obvious ones. Is there anything extra that you would need to do to get to 2030 that you would not have done?

Professor Kelly: No. Everything that we are talking about doing in respect of generally turning over the fleet into a more modern one, by getting rid of the sales of fossil fuel cars by 2030, moving more to heat pumps as opposed to gas boilers—if all those things happen that we say we want to happen, I think we are nearly there.

Professor Sir Stephen Holgate: If we follow what the Government want to do under net zero, this will be achieved. The modelling that has taken place in Europe has already calculated that and we have already heard Frank say that their own study supports that.

This is the other bit of the equation that is frustrating. There seems to be very little obvious connectivity between climate change issues and air pollution issues, yet 46% of the climate-forcing gases and particles comes from air pollution. If we hit those, first, you would get the climate improvement much more quickly than you would if you just concentrated on CO₂. Secondly, you would have this incredible health gain as well, which should be much faster than you would achieve by getting CO₂ down.

I think that some effort needs to be made to bring these two communities together. The net zero climate change agenda has a huge energy around it in this country at the moment, which is great and I think that the public has bought into it in large part. We need to bring air pollution into that. If we could do that, it would ease the communication strategy considerably.

Professor Lewis: Can I add something on the net zero aspect of this? It is a slightly pedantic point, but it is not about not burning fossil fuels, it is about not burning fuels. If I take sustainable aviation fuel made from



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plant residues and burn it, it produces exactly the same air pollutants as burning a fossil fuel does. If I burn hydrogen, even if it is made in the most clean way with renewable energy, it will still produce NO_x pollution.

There are many aspects of net zero strategies that will be excellent for climate change, but exactly how we implement them has enormous implications on air pollution. You can come up with a climate-neutral fuel but the way you deploy that fuel can have implications on air quality. Broadly speaking, if we use fuel cells, for example, with a fuel it is completely clean. If we put it in an internal combustion engine or a boiler, it produces air pollution. The devil is in the detail of how net zero is delivered with the co-benefits for air quality.

Q19 **Caroline Lucas:** I have one last question. Is it possible to calculate—or maybe estimate—the different health outcomes between a target of 2040 and a target of 2030? Could we estimate how much extra public health problem there is as a result of going for the less ambitious target?

Professor Kelly: Yes, it can easily be done with some effort. I am not sure if it has been done, Stephen, but I know what has been done is that by achieving the 10 micrograms per metre cubed by 2030, we have calculated what the health benefit of that is. You see something like 350,000 less asthma exacerbations in children in London, for example. It could be done if we went out to 2040 as well. It would be a big number and a big health benefit.

Q20 **Caroline Lucas:** Is anybody working on that? Presumably if we were able to have the evidence of health outcomes it would be useful for persuading the Government and so forth.

Professor Sir Stephen Holgate: I have seen that calculation being done. I can't quote all the figures because I did not bring them with me today, but I can certainly send them to you if you would like to see them, for coronary heart disease, for mental health and for lung disease. Yes, I have access to that.

Q21 **Chris Skidmore:** Can I follow up on the Government's current target of 10 micrograms per cubic metre versus the World Health Organisation's target of 5? That is the annual mean concentration target. You mentioned net zero, and achieving net zero is also about achieving a number of gateposts along the way. With a population exposure reduction target, the reduction in exposure to PM_{2.5} by 35% compared to 2018, to be achieved by 2040 and the Air Quality Standards Regulations that concentrations of PM_{2.5} should not exceed an annual mean of 20 parts per cubic metre, where would you see the methodology potentially to use those aspirational ambition targets to drive forward change if we were to look at, say, 2030 being a new horizon or a new point at which to achieve it and then to maybe align it with a nationally determined contribution in a way that made it feasible in net zero targets? What would need to be done to uplift that from the 35% reduction target if it was then to 2030? Would you see that being possible?



Professor Lewis: The population exposure reduction target gets less airtime than the limit value because it is more complicated to understand. To me it is probably the more significant of the targets. It is probably the one that delivers the most health benefits. It is the one that stops you simply shuffling pollution around. It stops you moving a dirty bus from a place that is exceeding and simply putting it in a place where it is not. It is enormously powerful because it is a linear process. We have to achieve this as a ramp downwards.

Chris Skidmore: Year on year, is it?

Professor Lewis: There is a methodology for calculating how the mean is calculated and also how we accommodate bringing new measurement sites into the observational network. It does set a trajectory against which you can then measure progress across the whole country.

On that one, you can look at five-year time horizons and say, "Are we on the right slope to achieve that minus 35% reduction that we want in 2040?" In a way, it is almost easier to keep track of than the limit value, which is just a simple pass and fail. I hope, now that the population exposure reduction target exists, that we are plotting in real time our progress along the glide slope downwards so that we are intercepting if we are off that slope. This is not a thing that we want to see just the minus 35% occur in the last year. We would like to see steady progress.

Q22 **Chris Skidmore:** On the modelling you mentioned—and maybe everyone could chip in on this—the degree of uncertainty I saw was plus or minus 30 percentage basis points. To what extent are those uncertainties being corrected or improved? Where do you think we will go with the data and the science that mean that we could perhaps revisit the methodologies for the future?

Professor Sir Stephen Holgate: We have been heavily reliant on epidemiology. In some of the studies that have been done recently, like those in the United States with over 60 million people involved in them, the actual confidence limits almost disappear. This is a numbers game in many ways, as Alistair talked about. If we can get better connectivity in this country between health science and data science such that we can use the whole country as our laboratory, as we did for Covid-19, where it was done—even the devolved Administrations were part of that experiment—we could make a massive confident prediction. There would be hardly any, if any, confidence limits anywhere because you would have 63 million people in it or more. The health statistics you would have would be for cardiovascular; you could have dementia; you could have children. You would have NHS and NHS Digital access going into that.

Q23 **Chris Skidmore:** We talked about regionality and whether the panel agrees that taking a more place-based approach on ambition and target setting is the right one or whether the uncertainties around the atmospheric conditions make that impossible, as you said, down in the south-east. In net zero, there is this ambition potentially for trailblazer



pilots and net zero cities. Could we be looking at the same equivalent for certain cities in the UK?

Professor Kelly: To a certain extent we are at the moment because London is the leading player in the game with its low emission zones. With the large population in London and the remarkable decrease in some of the pollutants in the last 15 years, for example, it is demonstrating that this is achievable. Other cities are clearly looking to London.

Q24 **Chris Skidmore:** Should we take certain cities that are further behind the curve and look at how that improvement could be taken forward from the worst—

Professor Lewis: The way I would look at it is that if you look in other countries, there are many cities that have set themselves air quality targets that are more ambitious than their national target. Sometimes that is just to reflect favourable geography and favourable weather, but as far as I can see there seems to be no harm in a city taking an approach and saying, "If we are in the north and the west of the UK 10 micrograms looks a rather unambitious target because it rains half the time, and it is very blustery and windy. We could set a target that was considerably lower." That does occur. I think that occurs in Canada, New Zealand, and so on. I think that you could take a place-based approach but it would probably be up to those local authorities to decide what they wanted to do.

Chair: That concludes our first panel. I would like to thank Frank Kelly, Sir Stephen Holgate and Alistair Lewis for joining us today. We will have a quick pause while we bring our second panellists forward. One is coming online. We will close the session briefly.

Examination of witnesses

Witnesses: Jim McManus and Matthew Clark.

Q25 **Chair:** Welcome back to our second panel today on outdoor air quality. We are joined in the room by Jim McManus, who is from the Association of Directors of Public Health, and online we welcome Matthew Clark from the Environmental Protection Advisory Panel at the Chartered Institute of Environmental Health.

We have just heard from our first panel of academics. I am not sure whether you were able to follow that, Matthew, from where you are, but the Government have just published the air quality strategy in April and, earlier in the year, the national air pollution control programme. I will start with you, Jim. From your perspective for directors of public health, do you sense that these strategies have enough tools for you to do your job?

Jim McManus: The short answer is no, for several reasons. First, the framework is still fragmented. Secondly, it is all very well to put duties on local authorities, but if we do not have the powers to actually require



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people to comply with the duties, there is not a lot that we can do. The third thing is that there is a real issue about funding. There is not the funding or the capacity or the inspection capability. The fourth thing that worries me is that the 2018 regulations are due to expire under the sunset clause. They have not been included because of EU regulation.

I think that it would have been much better if we had gone back to the beginning and started with a blank sheet of paper and created a framework, rather than doing the incremental adding to the silt that has been there for some time, some of which is good, and creating a framework that is complicated, a bit messy and ultimately unsatisfactory. My apologies if that is a bit glass half empty.

Q26 Chair: On funding, do the local authority public health directors have to meet the new standards within the existing envelope of public health spending or has there been an additional allocation provided?

Jim McManus: There has been no additional allocation provided for air quality. The same point would be made by local authorities overall. They were given, I think, £13 million for air quality management areas, but the Government put £33.9 million into agricultural industry voluntary regulation.

The money is inadequate. If you add to that the fact that the public health grant has been cut by over 26% in the last six years and that 60p has been taken out of every pound of local authority spending, I am not quite sure where the money for this will come from. Again, it is all very well putting duties on people, but if you cannot enforce them and have no staff, you just cannot do anything.

Q27 Chair: From my experience, representing a rural constituency, the funding for public health, compared to urban or metropolitan areas, is a small fraction, so there is an inequality that may not make such a difference in this area because the worst impact tends to be in urban areas, as we just heard in the previous panel, because of transport pollution. Do you have any reflection on the existing imbalance of funding between different types of local authority, and does that make it easier for urban areas to be able to do monitoring and focus effort on this where the problem is worse?

Jim McManus: I think there are several problems, in my experience, with the monitoring. One is the imbalance of money. If you look at the public health grant alone, there is no specific money for air quality in the public health grant. Equally, poorer areas have had greater cuts per head from the public health grant than wealthier areas. There is a rural urban imbalance as well, as you have rightly highlighted. That same imbalance can be sometimes reflected in the revenue support grant and in other funding because of the formula used by the Government. I am just talking about England now.



On top of that, I think there are additional challenges in rural areas. Enforcing something in Cornwall is a very different challenge, with logistics, than enforcing something, say, in the London Borough of Hackney, which is more compact than Cornwall but has its own difficulties. Therefore, we would have preferred a framework that gave directors of public health and local authorities powers on funding to do things, and then enabled us to set the framework and work on that basis.

Q28 Chair: Is there any feedback loop at the moment on the strategy? Is it being consulted on post implementation, or was that done earlier and representations were made and ignored?

Jim McManus: I would like to say yes, but I am not sure that it will be. We jointly submitted in the consultation with the Chartered Institute of Environmental Health and ADEPT, our environment partners, and the consultation window was very small. I think there was a number of things that they missed out, such as indoor air quality. The science around indoor air quality is developing but there is a very important point on indoor air quality, which is that, as we know more about indoor air quality and the science of infectious diseases, there is enough science around it to tell us that we need to seriously look at whether we are protecting children in schools.

I know it is very polarised, but it would be remiss of us not to seriously lay to heart how we are protecting children from infection in the next pandemic, particularly in school air quality and in care homes and in hospitals. That is one of the big gaps there in indoor air quality, and indoor air quality is another big gap. Am I answering your question, forgive me, I am not diverting?

Q29 Chair: I think so. It was probably not the best-phrased question. Can I turn to Matthew and perhaps you could explain to us how the national air pollution control programme helps to develop the targets for national ceilings emissions?

Matthew Clark: It is an area that, as a local authority person, is not the focus of the local authority role, which is to look at the local air quality regime that is set out to be followed by local authority officers for air quality. The focus there is to achieve limit values that are set in legislation.

The backdrop to the regulation in question is very useful because it provides or should provide a strong, transparent, well-consulted system for ensuring that any policy decisions that are moved forwards have a rigorous and well-based footing in the evidence and that all partners are considered to create that holistic view. Therefore, we are talking about air quality particularly here and then segmenting it down to outdoor air quality in this instance today. We should not lose hold of the other regimes of water and soil quality, which have contributing factors. One is going to affect the other. It is one earth that we are serving.



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We need to ensure that those sets of legislation and policies that you are talking about hold everyone to account to ensure that there is a firm and well-recognised line looking at the specific detail that we need and holding everyone to account along the line from each individual that can look in and do their part, right the way through to Government at the top. Everybody has a part to play.

Q30 **Chair:** You welcome the principle of having public consultation prior to making any amendments to the limit?

Matthew Clark: I think it is absolutely critical to ensure that we get full consultation and consultation that gives people enough time to respond. Jim has already picked up on the fact that there was very little time made available for the air quality strategy consultation. I have had people mention to me that this seems to show air quality in a poor light, in that it is not being taken with the seriousness that it needs to be to ensure that we move somewhere to create the healthier, greener, safer place of the future.

Q31 **Chair:** That is not so much the fault of the strategy, the implementation of the strategy and the adequacy of funding and monitoring devices and so on.

Matthew Clark: I think it is all-encompassing. I suggest it is the lack of ability to have a full consultation; 10 days was given to the air quality strategy. That did not allow officers like me to go out and consult with our elected members, particularly when we think that in lots of local authorities input and air quality is a political agenda. It was quite hard to engage with that during that period, and it was in the Easter school holidays. If we are looking at people trying to find the time to correspond and consult, it was not ideal.

It also did not give us opportunities to talk to all the key stakeholders locally to understand the local flavour to feed in. Cities are mentioned a lot when we talk about air pollution, typically. They have very high levels of air pollution impacting a lot of people, whereas in rural towns across the country you will find air quality management areas and the quality of the air quality challenge might be very different.

Q32 **Chair:** I know in my area where constituents have expressed concern about it, there is a limited amount of equipment available to be able to test. That can lead to frustration because it appears as though the local authority is not doing anything, but it is doing other stuff elsewhere and it is just a matter of prioritisation. I imagine that is a fairly typical issue across the country, is that right, or are there some areas that have enough equipment to cope with the demands that are being placed on them?

Matthew Clark: It goes back to the point raised about funding split. If you look at the impact of a funding split in a city centre compared to a rural environment, you are looking at a lot less. That provides those



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authorities with a lot less resource to carry out the same suite of functions, and often more functions, that come along with the rural landscape.

Certainly, the capacity to be able to have a robust monitoring regime in place across the country is more challenging in some areas than others. That is why I am happy to see that the urban-rural air quality network is being expanded to include more monitors, but I feel there is a long way to go there.

There is no duty for a local authority to monitor. There is a duty to review and assess. It is hard to assess properly if you haven't monitored, but it is not a specific requirement. Things might be done through modelling or other means. That means that things like the air of confidence that we have in that data can slip and slide a little. There is nothing better than having good equipment in every setting to provide the public with the information that they need to bring the invisible pollutant to life in their setting, and to help encourage people to make the choices that we need every one of us to take to move us forward in this agenda.

Q33 Chair: This Committee has done a lot of work on water quality, which you touched on earlier, and a bit part of that has been in encouraging water companies and the regulators and the Government to increase the amount of monitoring. I think we have had some success in nudging the Government along in that direction.

Are either of you in a position to tell us or to point us in the right direction where we can find out how many monitors are deployed across the UK? Is this all done by local authorities rather than national bodies that are also doing monitoring?

Matthew Clark: I can jump in there. There is the national Automatic Urban and Rural Network, in which there is a number of monitors that can be googled—other browsers are available. That will pull up the list of monitors that are looked after by Bureau Veritas on behalf of the Environment Agency. At present we are seeking—

Q34 Chair: Will what you are talking about show you the locations or tell you how many there are?

Matthew Clark: It is a map. You can find places on the map, which I think is absolutely what people need. It is very hard to engage with a table with numbers and grid references in it. It is very easy if you are provided with a map and you can go, "I live here and I can see that just up the road or wherever there is the nearest one monitoring what is going on." That is a very good way of communicating with the public to have things in a map sense in that form.

Q35 Chair: Is that information already published?



Matthew Clark: That information is already held there online. Various local authorities can subscribe and put their information on to web pages like UK Air, and the local authority I work for does so. That is fantastic. It puts things into a map format and people can find it.

This data is available from the other bits of lower tech pieces of equipment, like nitrogen dioxide diffusion tubes. It is often hidden away in annual status reports that local authorities produce. It takes extra effort and time to keep a mapped resource up to date, if local authorities indeed have the capacity to even think about. We have all that data through those annual status reports. It is provided to DEFRA annually. All the data is in a consistent format. It would be possible to map that dataset and then have every diffusion tube in the country as a pinpoint on a map, which would add some extra granularity to the continuous monitor data that we have available currently.

Q36 **Chair:** Is there anything you would like to add to that topic?

Jim McManus: I think Matthew has nailed it. The point I will make, that I think he made, is he implies that even the monitoring of air quality data is fragmented and depends on which data you can get, which does not bode well for the health of our population.

Q37 **Duncan Baker:** I want to come on to what I think is a very interesting subject about the traffic road traffic control measures, which of course we are seeing rolled out in very many cities around the country. The closest to me, Cambridge, is the latest area to be in consultation about this. I have two questions rolled into one and I will go to Jim first.

What is the evidence that the traffic control measures—and we all know what we are talking about here, whether they are the low traffic neighbourhoods or London's ULEZ scheme—are being really effective in reducing pollution emissions? Then, working on the basis that they are successful, what is the impact on the health outcomes that are coming from those reductions?

Jim McManus: I think that the evidence for the value of these I think is accumulating well and nicely. Most recently there was a review by the University of York on London's ULEZ zone, which I think showed some benefit. There is also some evaluation going on with the Sheffield 60 mph zone on the M1 and the benefits that that is giving, and we know that Birmingham has had some research.

We know that the more particulate matter you take out of the environment from traffic the better the air quality. We also know that there is a significant association between types of particulate matter and attributable deaths. The Chief Medical Officer's report published for 2022 focused on air quality. We have known that since the Health Security Agency published a report on this some years ago. About seven years ago, DEFRA produced a briefing for directors of public health, which is a



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mere 87 pages, telling us what we could do about this. Therefore, I think the evidence is accumulating.

It is difficult to draw a direct line between you have bad air quality here and this child dies there. That is scientifically a challenge, but I would go back to the point of, surely, wouldn't we want good air quality to enable our children to be as healthy and safe as possible? We know that there is an association between air quality and respiratory disease and struggling. Outside work I am a trustee of a hospice, and our heart failure and COPD patients always fare worse in areas of London where the air quality is poor. Am I answering your question?

Q38 Duncan Baker: Yes, you are. Just to go back, did you say before that it is hard to actually be able to prove the linkages between the two?

Jim McManus: It is difficult because you are working on associations and on impacts and attributable fractions of death in the most tragic circumstances, rather than saying, "We can draw a direct line between your lung cancer in all cases and the fact that you have been in an area of poor quality environment." The translatability of epidemiological research to that level of clinical stuff is not as precise as perhaps some people would want it to be.

Duncan Baker: I see. Yes, I think the public perception is it is obvious but to link it specifically together is more difficult.

Jim McManus: Yes, it is difficult to link but it is very clearly there. The evidence is there that poor air quality harms human health and contributes to early death.

Duncan Baker: I put the same question to Matthew.

Matthew Clark: Thank you. The impact of the clean air zone measures or ultra low emission zone measures is now getting well documented. We have lots of them around the country. We know that levels of nitrogen dioxide in Bath fell by 21% between 2019 and 2021, when they introduced the clean air zone. There was a 13% reduction in nitrogen dioxide in the first six months in Birmingham when they introduced the clean air zone, and we will continue to have new evidence coming forward. Earlier on this year Sheffield launched its clean air zone, Bradford had previously, and so we will have more and more weight of evidence showing the impact of clean air zones.

It is important to mention that the impact often starts before you turn them on, so six months or a year beforehand. Bradford is fairly recent and they have seen a reduction in emissions and the compliance of vehicles certainly starting way before, where they have been able to see bus compliance come on board or schemes that have been put in place to enable businesses and individuals to get their hands on cleaner technology and cleaner vehicles. They have seen the fruits of their



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labours before pressing “go” on the clean air zone itself. We know that that data exists, and we will get a wealth of more information as we go.

On the health impact, it is possible if we want to look at an individual. If we take the case of Ella Kissi-Debrah—and you have had Stephen Holgate this morning provide information—the data that led to that coroner verdict linked two and two together to a very high level, didn’t it? However, in population health, as Jim said, it is more nuanced and much more difficult.

I point to the future a little bit here to say keep an eye on Bradford. They have an ongoing birth cohort study and an arm of it called Born in Bradford Breathes, which will be looking at a whole raft of conditions. The clean air zone has recently been put into place since the cohort study started and they already have lots of background data. That will be a large population-based study, which might help to provide some more specifics around the question that you have specifically posed. I am looking forward to seeing the fruits of the labours from that project. It is early days yet, too early to tell.

This challenge of invest now for a health impact that we might not see immediately in the population that will be able to be measured straightaway in the population creates its own challenges, particularly if we have short-term Administrations and cycles of Administrations in governance. It takes a very brave, committed stance to say, “We will nail our colours to the mast and provide the interventions now to see the fruit maybe in another regime’s time”, but that is the kind of brave, decisive action that the agenda needs.

Jim McManus: It is worth adding that the estimate for central London is that the NO₂ levels are 26% lower than they would have been without the emissions zone.

Q39 **Duncan Baker:** It is definitive that the pollutant levels are coming down, but the time period in which you can measure the health outcomes will be longer, as you would probably expect, but it is just how much longer.

Jim McManus: I think the Bradford study will be the important one, as you will learn more about child lung development in pollution free air.

Q40 **Duncan Baker:** Fascinating. Slightly playing devil’s advocate with this now, one of the other problems that we have with this is the impact that it has on business communities, who see a reduction in volumes of traffic coming in and, therefore, potential footfall of visitors into an area, and of course, also, on people who are on low incomes. As I said to you before, the area I know best is the Cambridgeshire one, which is close to Norfolk at least.

There is an awful lot of discussion going on there because you will have to pay £5 as a nurse or a carer to go to work for the day in any vehicle, because EVs are not exempt and a scooter or a moped is not exempt. It



is very different to the scheme in London. Of course, if shops are not viable, business rates collections will start to diminish, and it is a vicious circle then, isn't it, for revenues into local councils? What sort of evidence are you now beginning to see on negative impacts on small businesses? I suspect it will be harder to see it in London because of the density of the business community, but in some of the places, like Bath and Bradford that you mentioned, is there a demonstrable impact on the businesses?

Jim McManus: The evidence is variable. In some places there is an impact, but that is where you haven't either got good active transport infrastructure to replace the movement away from cars. If you look internationally—and it is probably best not to look at North America but to the European mainland for this—where you see really good integrated planning at local level of public transport that is sustainable, and active transport means to replace cars, you can see businesses being protected.

We have an unfortunate habit in the UK of pitting a successful economy against human health. We don't realise that we cannot compete with China if our population cannot breathe well enough to actually walk to work. I think that is a real challenge. We have to see—

Duncan Baker: That is a bit far-fetched.

Jim McManus: It might be, but I think it is possible. If you have an unhealthy workforce, and we know from studies that if the workforce cannot be sustained—and we have seen the significant levels of people exiting work for sickness levels for all sorts of reasons—poor health damages the economy. We know there is good research around that.

The challenge that you are giving us, which is a really welcome challenge is: how do we articulate a local plan where businesses can be protected, because we need them for wealth, but not pitted against health? I think the best people to do that are local authorities who can do a local planning structure. The direct evidence on businesses is there in some places but limited, and I think it is contradictory, but we know enough to know that if you do not have local integrated transport planning to make up for the zones—

Q41 **Duncan Baker:** If you do not have good local infrastructure planning, should you wait until you have, or do you put it in to force the local councils to catch up and put that integrated transport in?

Jim McManus: There is a third way, which is to give local authorities the ability and the powers and the money to do the integrated planning in their local area, which includes transport, parking, active travel and low emission zones. That is the best way to do it if you do it all as a package.

Matthew Clark: I certainly second that point. I think it is making those links between all agendas. The air quality agenda sits very comfortably alongside the compartment agenda when it comes to looking to get newer and fewer vehicles into our congested urban centres.



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I think the question starts with often there is a perception around if you reduce the number of cars that you will reduce the footfall. I don't think that is necessarily evidenced and we would have to look outside this room for the specifics, but if you provide an area that is now less desirable to drive through, it might increase footfall, and I do mean footfall: people on foot, walking.

Q42 **Duncan Baker:** Generally speaking, if you impede people from getting somewhere you will have fewer people coming in. I get what you are saying. Nothing is absolute, but if you impede people into a city, a town or a village you will, therefore, see a decline in footfall.

Matthew Clark: No one is trying to impede people getting into these places.

Duncan Baker: Well, you are charging them money. That is the point.

Matthew Clark: These interventions are designed to get cleaner vehicles in and potentially to look to have fewer vehicles in. They are not looking to have fewer people. I think that is the wrong framing to use. Town centres are very people-centric. Local authorities and businesses all want people using and creating vibrant, thriving town centres. Creating a place that has fewer vehicles in those centres can create some of those desirable aspects that we are after. It is something you may need to speak to business, chambers of commerce and those kind of people to bring to the—

Q43 **Duncan Baker:** Okay. Very quickly then, and let's do 30 seconds on the last question and, Matthew, I will carry on with you. Do these traffic control measures receive the appropriate amount of attention in tackling poor air quality? I think you could probably argue that certain parts of the country receive a lot of attention.

Matthew Clark: Yes. The vast majority of clean air zones, if not all of them, across the UK have been mandated by the Government, "Thou shalt look to have a nitrogen dioxide plan that looks to create the target levels of pollution that we aspire to in the quickest time." Clean air zones have shown that they can deliver that, time after time. There has been a study on every single place that has been named throughout this session that has a clean air zone, so we know that they can deliver in that sense.

The challenge is in places where there isn't a mandate from central Government. You can imagine that in those scenarios it might be politically disconcerting to look at introducing a clean air zone, given what we see from the areas where they are put in place.

If I can give a local example, stepping out of my CIEH role just for a minute, we have been promoting an information campaign to residents in my local patch where I work and inviting comments on social media platforms. Folk contact us by email or when we have been out and about in local areas talking to people.



We get a lot of negative connotations with the introduction of something like a clean air zone. I think that is born out of people's experiences of seeing the way that these things are framed and often how they are debated in a negative light. As Jim put it earlier, it is seen as a trade-off: "We've got health, not wealth." All these factors need to be brought together to create good positive framing around the agenda to enable everything to move forward together.

Duncan Baker: I am going to finish it there because we have to get on to the next questions.

Q44 **Barry Gardiner:** I want to focus on domestic combustion and industrial combustion. Clean Air London has said that the 27% of PM_{2.5} is coming from domestic heaters, smoke from burning logs, and DEFRA said that the industrial combustion of biomass fuels was contributing to 18% of PM_{2.5} nationally. First of all, a point of clarification, please. Can you clarify whether that 18% PM_{2.5} nationally includes or excludes Drax?

Jim McManus: I would have to check the figures and come back to you, if I may, rather than misquote. That is the first one. I will come back so that I don't mislead you.

Q45 **Barry Gardiner:** Yes. Okay. How can you, as local authorities, begin to reduce the pollution that is coming from combustion?

Jim McManus: I think that it is a system approach, and it is quite a complex approach because as the percentage of combustion from agriculture and industry reduces, the percentage contribution of domestic indoor air pollution increases. If you read the summary of the Chief Medical Officer's report—you may not want to read the whole 200-odd pages of the detailed report, but if you do, it is worth reading—what we know about indoor air quality is not as much as we need to.

So far we know that the first thing we need to do is improve ventilation without reducing energy efficiency. That in itself is a challenge, particularly for some new build housing, because housing build standards have deteriorated and actually worsened air quality.

Q46 **Barry Gardiner:** What are we talking about there? Are we talking about filtration systems?

Jim McManus: We might be talking about filtration systems. We might be talking about reducing indoor combustion from wood burners, which is a problem. We might be talking about better filtration of the types of energy we use in our kitchens for cooking. We know that electric houses are much less likely to have severe levels of indoor air pollution than oil-fired burners or other burners. Electric is better. However, I think that the jury is out on the plethora of measures that we need to take in a way that we can say is cast iron.



Q47 **Barry Gardiner:** Let me throw a few in front of you. Asthma and Lung UK has said that there should be fines for burning in smoke control areas. It has even suggested that there should be pollution awareness courses, like speeding awareness courses, for repeat offenders. Would you support that?

Jim McManus: I don't know about fines. I would prefer to start by not exempting wood burners. With DEFRA-exempt wood burners you could take some action there. I would like us to see the kind of voluntary things that we could do to change the culture to get people onboard. I have to be honest and say I haven't considered the idea of fining people for using energy in their own homes. When I was a kid, we had smokeless fuel zones. I grew up in a mining village and somebody used to come around and knock on the door if you didn't comply with the regulations. We do need to find a way of building our responsibility towards each other, and towards children, in indoor air quality.

Q48 **Barry Gardiner:** Well, let's look at that responsibility because the regulations have said that there is a mandatory certification scheme that demonstrates wood solid for combustion—that is under 2 metres—should be drying up more than 20% of moisture, and that it should emit less than 5 grams of smoke per hour. That is the latest regulations but before that the recommendation was for 3 grams per hour. Why was that change put in place? It has become more lax, hasn't it?

Jim McManus: Yes.

Barry Gardiner: Why?

Jim McManus: It is a policy decision that has been made by policymakers, I think, sometimes to kind of ease off the regulations. I don't think, as a nation—

Q49 **Barry Gardiner:** Who would be lobbying Government to ease that regulation? Is that the smoke burners—Chair, I should have declared an interest at the beginning: in a previous house I put in a smoke burner until I realised how polluting they were—*mea culpa*—so I understand what you are saying. Educate people first by all means, but once you have educated them—

Jim McManus: I think, Mr Gardiner, what you are getting at—and I really like the line of questioning and, forgive me, if I am not giving you the answers you want—is the fact that for too long in the UK we have focused on individual responsibility, not social responsibility because individual responsibility and health just does not work. I know Matt is indicating. The second point is that our regulation on air quality has been too lax for too long in this country on almost every area of regulation, and we are paying the price now. It still feels to me like we are dragging our feet in policy terms, way behind what the science says.



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Q50 **Barry Gardiner:** I want to bring Matt in, but before I do I want you to give me three things that you would like to see in our report as recommendations to the Government that would improve the regulatory environment.

Jim McManus: Thank you. The first thing is to sit down with local authorities as partners and have an honest conversation about the fragmented and unhelpful network of regulations and the cat's cradle of stuff we currently have, and let us together rewrite it into something that will genuinely improve air quality. The second thing is to absolutely commit to giving local authorities the powers to enforce that, including the regulatory and enforcement methods and the powers. The third thing is to commit to have an absolute consensus on the science, and to regularly revisit the regulatory framework when the science develops. Those are my three overarching strategic asks, if I might be so bold.

Chair: Thank you very much and just quickly from Matthew.

Matthew Clark: Related to domestic burning, we know that this is the biggest single source of PM_{2.5} in the UK now. It took that accolade earlier on this year. There is an ongoing increase, and it is slightly dated. There is 2018-19 research that suggests that 40%-odd are burning for aesthetics and creating a polluted environment for themselves. Again, we feel that awareness is probably very low, that people don't understand that they are polluting themselves in the room, as well as creating pollution that lands on their locality and their neighbours.

The first step here has to be a concerted effort to inform the public of the health impact of these devices. On cigarette packs, when people are putting smoke into their own environment and lungs, there are pretty visible warnings now on the packets. But people can go out and buy a log burner tomorrow with no knowledge and no information that this is going to create a pretty toxic living space for you in your own home environment.

The first thing is information to educate and that might help stave off the ever growing increase of domestic appliances, solid fuel appliances that are being installed every year. In creating a better—

Q51 **Barry Gardiner:** Matt, can I just interrupt you there for a second? HETAS Ltd has pushed back and said that it would all be fine if people just got rid of their old woodburning stove and installed a new one, but I take it that you don't agree with it there. I would like you to point the Committee towards the evidence that shows that HETAS are on a marketing exercise rather than a scientific one.

Matthew Clark: The evidence is—and you have partly named it—that we know that even the cleanest appliances burning the cleanest fuels are producing some 3 grams to 5 grams of particulates every hour that they are burnt. I cannot find the reference for this, but a lot of articles out there suggest that 200,000 appliances are installed a year in the UK.



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Let's say that some of them are replacing new, several of them are not replacing something that is worse, so there is an ever increasing contribution from this source. We do not have the monitoring network in the right place to understand the impact. The monitoring locations we mentioned earlier—the Automatic Urban and Rural Network that is out there—are typically positioned to show background results and roadside contributions, because transport has been the focus in the past.

We need monitoring to inform this debate, but it is quite a challenge, isn't it, to understand where do you go and monitor? This is different in every single street in every single neighbourhood across the country. There is an urban-rural field split to this, so looking for the next stance might be towards removing them from places and looking at the air quality. The air quality strategy has made it very clear that there is no consideration of a ban, which I feel is limiting. It has limited itself by saying there is no suggestion of a ban at this time. I think that we still need to have that focus, to have all tools on the table to understand how to move forwards.

A ban in a rural environment, where someone isn't on mains gas, as an example, might be a very different sell in those circumstances where people are burning for heat, compared to someone burning in an urban environment because it feels nice and it looks nice and it is an attractive environment to be in.

Q52 **Barry Gardiner:** Should they be licensed?

Matthew Clark: A licensing regime could work. You could base it in a similar polluting stance, so the bigger the polluter, the polluter pays method, which we see through a permitting regime. However, that needs to come with the allocation to whoever is going to be the regulator. I suggest that would have to fall to local authorities. They are the best placed, but that would be a heavy burden on local authorities. Maybe a national—

Q53 **Barry Gardiner:** Jim is nodding but maybe he wants to see that as part of the public health grant, including air quality provision.

Jim McManus: If the Government want us to take on more work and give us the money, I am very happy to do that.

Q54 **Barry Gardiner:** Is that a recommendation you would make?

Jim McManus: Licensing for sources of pollution is a recommendation I always make, because the directors of public health have the ability to comment on other sources of pollution.

I wonder, Mr Gardiner, if there is anything you would like from us after this session or, indeed, any members of the Committee. We are more than happy to assist by putting our heads together and coming back with written answers to anything you are not satisfied—



Barry Gardiner: I think the thing that you mentioned about getting your heads together and what a framework might look like—if you could have some thoughts on that and give them to the Committee, that would be very helpful.

Chair: Thank you, Barry, I am afraid we are going to have a very quick supplementary.

Q55 **Claudia Webbe:** Yes, just very quick, Chair, although Jim McManus slightly answered my question in advance. All I was going to say was that basically Leicester is one of those cities outside of London that has not consistently met the legal limit for air quality. What further support can be given to local authorities to help them, but particularly with the resilience of businesses? One of the significantly high areas of pollution is in the town centre area of my constituency, the Belgrave Road. I can see the problem of providing the evidence base. I see traffic and factories as being key problems, although I read in our report that 38% of particulate matter came from outside, from the farming industry into Leicester.

Notwithstanding that, what additional support can be provided to give local authorities the evidence base so that they can take it on? Every time the local authority tries to do something for Belgrave Road in that town centre area it gets defeated by the business lobby and, therefore, nothing happens. It has done a great deal of work in the city centre, but those town centre areas are problematic.

Jim McManus: I could point you to a number of areas. There are areas where local authorities have got demands from the Government to act on air quality, but the air quality issue is caused by the fact that the M25 runs through the middle of it and that belongs to Highways England.

Bearing in mind the configuration of Leicester with the network of A roads around it—the A6 and various other things—there are probably several things to be done. First, enable the local authority to do more monitoring of the air quality in the area and give it some funding. Secondly, give it some powers to require things to be done. Thirdly, we need to give due weight to the evidence of impact, which means that you need to have the monitoring equipment to do that, and you need to give the local authority some funding. Somebody needs to go out to put the machines in place, monitor them and collect the data. If you had some diffusion tubes and some other air-quality monitoring equipment for a couple of years, you could probably amass the data on harms.

I know Ivan Browne, the DPH for Leicester, very well and I know that he is very exercised by this, but I think he is tied by having no money, no powers and a very well-funded industry lobby that uses the same techniques that industry always uses. The response is that it is down to individual responsibility and the industry is not that harmful. We need to counter that.

Chair: We will have to halt there. Thank you very much, Jim McManus



and Matthew Clark for joining us for this panel. We will now move swiftly to our final panel.

Examination of witnesses

Witnesses: Tom Bradshaw and Emily Hunter.

Q56 **Chair:** Welcome to our panellists for our third panel on outdoor air quality. This is getting to the real outdoors. We are joined by Tom Bradshaw, deputy president of the National Farmers' Union, and Emily Hunter, who is the lead policy advocate on land use, at the Woodland Trust.

I will kick off by disclosing that I am a member of the National Farmers' Union and have a farm. Before reading the brief, I had not appreciated the extent to which air pollution may impact arable and potato crop yields. I am an arable and potato crop farmer. Tom, could you please elaborate on how rural air quality impacts productivity?

Tom Bradshaw: We do not have a lot of evidence about how the yields are affected. The loss of ammonia is a big problem and agriculture is contributing perhaps 87% of emissions—a significant contribution. There is a huge financial value that is being lost. If you apply the same fertiliser rates but lose ammonia, that fertiliser is not being used efficiently and effectively. That is where you will see the yield deficits. I am not sure about the evidence on air quality. I have not seen it.

Q57 **Chair:** We have heard evidence from the UK Centre for Ecology and Hydrology that ozone air pollution has generated reductions in yields of wheat, potatoes and oil seed rape—marginal for oil seed rape—of the order of 5% to 6%. Is that not something you can talk to?

Tom Bradshaw: It is not part of the evidence that has been put before us

Q58 **Chair:** Perhaps we might send it to you because it is quite interesting. Could I ask you, Emily, about natural ecosystems? Does air pollution of itself impact tree growth or other elements of biodiversity?

Emily Hunter: Yes, it does, not so much on tree growth but on the quality of the ecosystems. For example, a lot of woodland ecosystems, the typical habitat that you would expect to see, is largely composed of nitrogen-intolerant plants. Lichens and mosses are particularly sensitive to nitrogen.

The impact of ammonia and air pollution is a decrease in the number of nitrogen-sensitive plants and an increase in the nitrogen-tolerant ones. Typically in woodland, for example, you might see very elaborate lichen that is spiny. People now tend to see bare trunks or green or bright yellow algae on wood and that is to do with the air quality. It is the same in grasslands where you see more growth of nitrogen-tolerant plants such as nettles and a decrease in the nitrogen-sensitive ones and that has a knock-on effect through the ecosystem because invertebrates that rely on



the more sensitive plants start to disappear and we see the effect going up the food chain.

Q59 Chair: Is the nitrogen delivered through diffuse pollution into the atmosphere? Ammonia evaporating, I get that. Does nitrogen evaporate in the same way?

Emily Hunter: I do not fully understand the science behind it but, yes. What we refer to is nitrogen deposition and that is the nitrogen coming down as gas in the air and settling on the ground and on plants in the ecosystem. Then there are also the ammonia levels within the air.

Q60 Chair: Coming back to Tom Bradshaw, we are all familiar with methane emissions from livestock; at least we think we are. Methane is a highly toxic gas in its impact on greenhouse gas emissions. Can you talk about what farmers are doing to try to reduce methane emissions and whether methane is a contributor to air pollution per se in a rural context?

Tom Bradshaw: Methane from livestock is relatively unique in that it is part of the natural cycle. Plants take in CO₂ from the atmosphere. They convert the sun's energy via photosynthesis and take in the CO₂. Ruminant animals then digest the plant material and release methane.

Methane is a relatively short-lived greenhouse gas. After a 14-year lifecycle, it no longer has any warming effect. We feel that the way that methane's contribution to global warming is currently being calculated misrepresents the impact of ruminant livestock on the warming potential and we would rather see another metric, GWP*, being used to calculate methane contribution and the role of livestock. We have to recognise that methane from the biogenic cycle, the natural cycle, is very different from methane released from mining fossil fuels. They both contribute to warming but one is part of a natural cycle and the other is not part of a natural cycle.

Q61 Chair: Has that been subject to any scientific analysis?

Tom Bradshaw: Yes. The Oxford Martin School at the University of Oxford is very supportive of the science behind GWP*. You end up with potentially a perverse outcome where the warming impact over the 14-year period is greater but if you look at it over 100 years, it gives an outcome that probably does not truly represent the role of livestock and the methane that is coming from them.

Looking at the actions that have been taken to reduce methane emissions, DEFRA has recently consulted on the use of feed additives. That is an area of emerging science that is very interesting. Looking at breeding programmes—

Q62 Chair: Is that seaweed or beyond seaweed?

Tom Bradshaw: It is seaweed and beyond. Other additives are being looked at.



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Looking at genetic breeding programmes, although we have selected genetically for hundreds of years, thousands of years, we have not seen selection for cows or other animals with lower methane emissions. That is now happening, and the New Zealanders would say that they have already reduced methane emissions by over 10% through genetics alone. Genetic selection is a key part of the solution to reducing the impact from livestock.

However, we have to remember that 70% of the UK will only ever grow grass and we humans cannot use that feed whereas the ruminant animal is a wonderful beast that can. Sometimes we overlook the role of ruminants in a sustainable system. Looking at the footprint of those animals, ruminant production in the UK is less than 50% of the global average and it is something that we do very well. At times, we are looking for solutions at a very local level rather than looking at the global impact of changes and how we mitigate climate change.

Q63 **Chair:** Could you send us the research on calculating methane that you referred to? I have not seen that.

Tom Bradshaw: We can definitely do that, yes.

Chair: Barry Gardiner is itching to get in now.

Q64 **Barry Gardiner:** If we had 100 years, I would give you your cow emissions, but you are talking about a 13 to 14-year period in which the forcing power of methane is 80 times—I think 83 times—more than CO₂. We do not even have 13 or 14 years to curb climate change in the way that we need to. The bit that you left out of the natural cycle—I absolutely agree that it is a natural cycle—is that it is not a natural cycle on the scale that we are now doing it. Through our production levels and the intensity of the production levels, we are creating a bigger and bigger problem and as more and more people seek to eat meat, and with a larger global population becoming wealthier, that will only get worse.

I welcome the seaweed. I welcome all the inputs—the charcoal and the grasses and the genetic manipulation—that can reduce the methane emissions, but it is not on to dismiss this as a real problem in the way that you did.

Tom Bradshaw: I think we need to be displacing production from parts of the world that are above the global average. In the UK, we are incredibly efficient producers of ruminants and grass. Over 80% of the diet is grass. Looking at countries where they do not do this sustainably, we should see a huge marketing opportunity here to displace that production and sell our climate-friendly meat production. We cannot look at this just as a problem that we can solve here in the UK. We need to look at the global impact. That means that things such as carbon border adjustment mechanisms need to be considered so that we can properly reflect the footprint of production in the UK.

Q65 **Barry Gardiner:** I take that point, but poorer countries may look at us



as a very wealthy country, as one that has led the charge on the emissions that have gone up into the atmosphere, and say, "No, don't penalise us and stop us from growing our economy so that you can grow your beef and do the pollution in the UK, even if it is less."

Tom Bradshaw: Ruminant production and the numbers of ruminants in the system are dramatically reducing from their peak so arguably, they are no longer having a warming impact, when you look at GWP*. We have a falling ruminant herd. It is becoming more efficient. If you follow GWP* and we do not increase the numbers, they are not having the warming impact that they were.

Q66 **Chair:** I will stop you there. I am not going to let this debate go on any further. Before I hand over to John McNally, Emily, can you quantify the impact of air pollution on biodiversity? Has there been any research that you are aware of that can do that?

Emily Hunter: It is very difficult to quantify the impact on biodiversity. We can say, for example, that all woodlands in England exceed what we call the critical load, the level of nitrogen deposition below which you would not expect to see significant detriment and impact on that habitat. We know that all woodlands in England, and the majority of woodlands in the UK, exceed that level so we would definitely see an impact on biodiversity.

I am not aware of any studies looking specifically at the impact on any specific species, but we can certainly see those impacts. Similarly for grassland, we know that we have lost a lot of meadows and a lot of wildflower species due to changes in farming practices for a start and we know that over 1,400 pollinators and insects are dependent on meadow species, so we are certainly seeing that impact.

With the growth of nitrogen-tolerant species, generalist insects and birds might thrive but the more specialist species will not, so you will see a loss in that diversity.

Q67 **John McNally:** My questions are focused on the abatement of ammonia emissions and the first two are to you, Emily. Can you tell us what trends in ammonia emissions and ammonia concentrations in rural areas you have identified? Are these trends worsening in any way? Can you describe what you see? Given the high risk to public health, what is the likely impact if these trends continue?

Emily Hunter: Overall there has been a decrease in nitrous oxides over time, and that is largely to do with improvements in traffic and industrial emissions, but ammonia emissions have continued to go up. The most recent trends report from DEFRA on the voluntary target found a 3.5% increase in ammonia between 2016 and 2019. Ammonia is one area where the Government are not managing to get a decrease. I think Tom already mentioned that the majority of those emissions come from agriculture.



Can you repeat the second part of the question, please?

Q68 **John McNally:** If the trends continue, what are the dangers to public health, given the high-risk emissions of ammonia?

Emily Hunter: I saw a very recent study looking at the impact. We know that ammonia combines with other pollutants in the air to form particulate matter. A recent study looked at certain cities around the UK, including Leicester, which is where I am from, and found that ammonia from agricultural sources was combining with other pollutants to create particulate matter in urban areas. It is having that effect and we know that particulate matter is especially harmful to health. There is that link. Although ammonia tends to be quite short-lived in the atmosphere, particulate matter is not so short-lived, so it is having a detrimental effect on health as well.

Q69 **John McNally:** I think we are aware of that. The evidence is not quite there yet. Do you agree with that?

Emily Hunter: Yes, definitely a lot more research is needed. There is some emerging evidence. I think we had not thought about the impact of ammonia on health until quite recently.

Q70 **John McNally:** Going back to what you touched on, is the current rate of progress on reducing ammonia emissions sufficiently protecting the natural environment? For example, the National Centre for Atmospheric Science states that solutions exist for reducing ammonia emissions—there are solutions out there. In your mind, what additional measures could we be taking to reduce the possibility of worsening health across the nation? My question is probably something like Barry Gardiner's: if solutions exist, why are they not being implemented?

Emily Hunter: The solutions exist but are not easily implemented. The majority of ammonia emissions come from agriculture, from farming practices that have been established for a while and it is quite hard to change those practices. Our main opportunity at the moment is through the environmental land management schemes. That is where we would hope to see the support for farmers to change farming practices. There are solutions there but the change that needs to happen is quite significant.

John McNally: You used the word "hope". I think we need to be a bit more—

Emily Hunter: As well as leading the Woodland Trust on nitrogen, I lead our advocacy on ELM. We had high hopes for the idea of paying public money for public goods, but at the moment it does not feel as if ELM is as ambitious. For example, within the entry-level component of ELM, the sustainable farming incentive—a nutrient management standard will be rolled out, this summer, I hope, for farmers who go into that standard—there is a requirement to carry out a nutrient management plan. There are two options within that to do with planting local cover crops, things



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such as beans, pulses and clover, that fix nitrogen naturally. First, if the farmer goes into that standard, it is optional; they do not have to do all three of those actions. Secondly, originally the plan was to have levels of ambition within the standard so you could have the entry level or the more advanced level for farmers who wanted to do a little bit more. DEFRA is not taking that forward at the moment. It is a missed opportunity to do more, to support farmers to do more.

Another issue, for example around the Wye Valley, is intensive poultry units. I was speaking to somebody the other day who said that a lot of farmers looking to diversify had applied for planning permission, and got the permission, for intensive poultry units but are now being told that all those intensive units in one area are causing huge amounts of ammonia and that is bad for the local environment. They will need some support to shift away from poultry because they have already invested.

Q71 John McNally: That leads me nicely to my next question to Tom. Do you think that farmers are not being supported enough to reduce ammonia emissions? Are you having difficult conversations about how to go about that? If you are in these areas of particularly high concentration that Emily has just described, do you feel you are getting enough support and information to help you come to some sort of solution, given your very important role?

Tom Bradshaw: I think you are absolutely right there, at the end: farming does have a crucial role to play, and we need to accept the role we can play and need to play. We do see ammonia emissions and, as I said at the start, any ammonia that goes into the air is a cost to the business and a reduction in efficiency. There is no desire from anybody to let ammonia be transpired or go into the atmosphere.

It is a complicated picture under ELMs. We have to be very careful that we are not moving emissions to nitrous oxide, which some of the no-till conservation agriculture can do. We have to be absolutely sure of the science and the evidence here, that we are not switching one type of emissions into another type. That is where the science is very grey. We are doing quite a bit of work on nitrous oxide to get a better understanding of nitrous oxide itself and where the emissions come from in the system.

On reducing ammonia, DEFRA came out with a proposal to potentially ban urea fertiliser, but if that ban had gone ahead, the market impact would potentially have been very challenging because urea is a globally traded commodity that sets the pricing of nitrogen fertiliser globally. If you remove that competitor from the marketplace, you nearly give free rein for ammonium nitrate and stabilised urea products to set their own market prices because they are not being held to account by the competition from urea.

We came up with an industry solution that kept the window open for the spreading of urea. During that window, which is from 15 January when



the NVZ window opens through to 1 April, the risk of ammonia emissions is very low, but the risk of nitrate leaching is much higher. If you use ammonium nitrate in that wetter part of the year, you risk nitrate leaching rather than ammonium emissions so there is a very low risk from using urea in that period and a potentially higher risk if you use ammonium nitrate. They are complementary products. Solutions often look very simple, but they are nowhere near as simple as they may seem.

At the moment, I think that is the best of both worlds, that we have access to urea fertiliser, untreated, for that period up to 1 April. That is when it can be complementary to ammonium nitrate—it keeps the competition in the market—but after that period, you have to use stabilised urea. The industry, and I was at the heart of it, came forward to DEFRA with that solution. It will reduce ammonia emissions by 11.2 kilotonnes annually.

We have had an exceptional fertiliser season in the 2022-23 year because of the crisis in Ukraine and the energy prices. We will see an anomaly this year when ammonia emissions will be higher but without having access to urea fertiliser, food production would have been much lower.

It is not a straightforward picture. Where can we have more support? ELMS can be simplified and made to work for farmers. The incentives need to be greater. This is a very complicated policy. If we are looking for substantive change in land use or systems, are the compensation rates being set at the right level to get the desired behaviour change? I would say that they are not, at the moment and compensation is not being set high enough.

The slurry infrastructure grant scheme is crucial. There were over 1,200 applications to that scheme for the first window. I think maybe 300 have gone through to the next round. The budget was increased from about £13 million to about £31 million. If we are serious about solving this problem, that scheme will need to continue beyond the end of this Parliament into the next Parliament and substantial investment in the slurry infrastructure scheme will be needed. It is very much welcomed by farmers, and we can work with the Government on it.

At the moment, we are trying to look for a solution for the industry to come up with a self-regulatory approach to reducing ammonia emissions from dairy and intensive livestock herds rather than permitting, which we see as a very blunt tool. We are finding it difficult to get the interest from the Government to move that forward at the moment. We believe we can offer more by putting the industry in control. We would need a backstop of a permitting approach, but we think we have a solution on the table that will help drive reductions in emissions at the farm level.

Q72 John McNally: Thank you. That was a comprehensive answer and a lot to take in. I understand that behavioural change needs to be incentivised to move people on to a different way of thinking. The figure you quoted—



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1,200 successful applications—sounds pitifully low.

Tom Bradshaw: It is a budget constraint. DEFRA had flexibility and used that flexibility. I do not want to be critical of DEFRA here because it came out with a budget of £11 million or £12 million, and ended up committing over £30 million, so it showed flexibility there, but we need to see that scheme be turbocharged because I think there is a great opportunity there.

Q73 **Chair:** Can I follow that up? At the moment there are about 7,000 dairy herds in the UK, is that right, or is that just in England?

Tom Bradshaw: That is across England, I think, yes.

Q74 **Chair:** Across England, so eligible for the scheme. Roughly how many intensive livestock units?

Tom Bradshaw: Very few beef systems would be eligible for the grant scheme.

Q75 **Chair:** Do you have a feel for roughly what proportion of dairy herds have slurry management systems that do not need replacing or upgrading?

Tom Bradshaw: It could be as low as 25% that do not need to be upgraded.

Q76 **Chair:** On the scale of the opportunity that DEFRA needs to fund, if it has managed to do 300, and I think you said there were 1,200 applications, there are probably 1,500 to 2,000 potential—

Tom Bradshaw: If you said we needed to find funding for 4,500 to 5,000 businesses, that is the scale of the challenge. If only 300 have been funded this year, potentially it is a long-term investment.

Q77 **Chair:** That clearly has an impact on water quality. Does it also have an impact on air quality?

Tom Bradshaw: Definitely, yes. Ammonia emissions come from the slurry as well as from the water issue, so yes. One of the challenges there is around betterment and planning. Planning can be a barrier, particularly when people are thinking about nutrient neutrality. They will not allow the betterment of the facilities, but the betterment reduces the environmental risk from a water perspective and an air quality perspective. That is a challenge that needs unpicking as well.

Chair: You have managed to end your sentence just as the bell goes. Congratulations. Thank you very much, Tom Bradshaw and Emily Hunter, for our third panel today. It has been a long session. Thank you to Kerry for writing the brief and to colleagues for staying with us in these warm, sweltering conditions.