

Transport Committee

Oral evidence: [Fuelling the future: motive power and connectivity](#), HC 973

Wednesday 2 March 2022

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[Watch the meeting](#)

Members present: Huw Merriman (Chair); Mr Ben Bradshaw; Ruth Cadbury; Simon Jupp; Chris Loder; Karl McCartney; Grahame Morris; Gavin Newlands; Greg Smith.

Questions 141–167

Witnesses

II: James McMicking, Vice-President – Strategy, ZeroAvia; and Rob Bishton, Group Director for Safety and Airspace Regulation, UK Civil Aviation Authority.

Written evidence from witnesses:

- [UK Civil Aviation Authority](#)
- [ZeroAvia](#)

Examination of witnesses

Witnesses: James McMicking and Rob Bishton.

Q141 **Chair:** Good morning. I ask the witnesses to introduce themselves.

James McMicking: Good morning. I am vice-president for strategy at ZeroAvia. ZeroAvia is developing the world's first practical hydrogen-electric powertrain for aviation. This is an engine with no carbon dioxide, no nitrous oxide and no soot particulates in its exhaust. We are going to bring that to market by 2024 by retrofitting a commuter aircraft capable of flying between London and Glasgow, as an example.

We are a young company, but we are backed by major investors, including Bill Gates's Breakthrough Energy Ventures and the Amazon Climate Pledge fund, as well as the Aerospace Technology Institute here in the UK. It is a great example of how Government funding, through technology, can support and crowd in private investment and grow jobs here in the UK.

Chair: You are not in the sustainable aviation side of things; you are in the alternative to that.

James McMicking: Future technologies.

Rob Bishton: Good morning, Committee members. I am representing the UK Civil Aviation Authority. I am here to share our insights with you on the opportunities for UK aviation and the role we are playing in enabling that.

Chair: Good morning to you; thank you for being with us. The two Members who are going to lead on this session are Simon Jupp and Gavin Newlands. Simon, I think you are starting.

Q142 **Simon Jupp:** Good morning to you both and thank you very much for coming along this morning. James, you have answered one of the questions I was going to ask. When we are looking at sustainable aviation fuel versus hydrogen and electric, the Government at the moment are backing three horses. Should they back just one? I am guessing you are backing two via what you have just said. How is that going, in your view? How is that a better option than sustainable aviation fuel?

James McMicking: I think, ultimately, hydrogen-electric is the only true zero emission way forward for the sector, but it is going to take a long time to replace the fleet. There are aircraft that will have useful life in them today, and the immediate thing we can do to help reduce emissions is through alternative fuels like SAF. There is not sufficient feedstock to meet the entire demand of the sector. The sector will continue to grow rapidly. We believe we can scale hydrogen-electric in time to address that entire market.

Q143 **Simon Jupp:** Specifically, you have mentioned the London-to-Glasgow route as an idea of the length of journey you could sustain using that technology.

James McMicking: That would be the first-use case. Two years after that, in 2026, we would be able to develop an aircraft to fly from London to Rome, for example. This is a topic that often comes up: how far can you go? I notice that the Aerospace Technology Institute has looked at this independently and has developed concepts that could fly anywhere in the world with just one stop on hydrogen. It shows the true potential of the fuel to cover far longer ranges.

Q144 **Simon Jupp:** Out of electric and hydrogen—and I know you are backing both horses—should the Government pick a winner out of hydrogen, electric and sustainable aviation fuels? Do they need to stop having a scattergun approach, some would say, and focus on one or two?

James McMicking: I think the approach is a good one at this stage. It is very early days in hydrogen-electric, but we have a fairly disruptive approach to bringing the technology to market by retrofitting aircraft. It is a good time to invest in this type of technology and demonstrate it, but we have an existing fleet that is going to continue to operate for some time that will need alternative fuels to help decarbonise it and provide some interim benefits. It is worth continuing to invest in some of that technology to make it more efficient, but ultimately it is limited to how far it can go. I would encourage continuing to pursue both of these channels at this point in time.

Q145 **Simon Jupp:** You mentioned an aircraft that could fly to Rome by 2026, for example. At what point could the technology you are backing displace fuel-based aviation? I am talking about sustainable aviation fuel and traditional fuel as well. At what point could there be that turning point?

James McMicking: The example I gave you of flying to Rome is on an aircraft of between 50 and 70 seats in capacity. It is a typical regional turboprop aircraft. We see a pathway to getting that technology into larger aircraft, so over 100 seats, in the early 2030s.

We are not the only ones looking at this opportunity. The big airframers are now investing in hydrogen propulsion technologies because they recognise its potential for larger aircraft. Some of these airframers are only focused on the larger aircraft segment, so clearly they see a viable pathway. From our perspective, there is a pathway to scaling hydrogen-electric up into those categories of aircraft within the 2030s, for sure.

Q146 **Simon Jupp:** There are other companies that are looking, for example, at solely electric-powered aircraft. Why do you not go down that route?

James McMicking: Fundamentally, because the battery energy density is nowhere near where we need it to be. Weight is the big challenge in aviation. Volume is a challenge with hydrogen, of course, and that came up in the previous discussion, but it is one that can be designed around aviation, for sure. Weight is the big challenge and hydrogen is a light fuel, so that is good. Batteries simply do not have the capacity to fly the sorts of distances we need, and they are heavy, which is the big enemy of aerospace.

Q147 **Simon Jupp:** Rob, you just heard about some of the disruptive technology that is being introduced right now to try to make the aviation industry greener. Should the Government pick a winner out of sustainable aviation fuels, hydrogen and electric? Is there a view from the Civil Aviation Authority?

Rob Bishton: First, we welcome disruptive technology into this space to help us with this challenge, from our lens looking at it as a safety regulator but also across our security and broader consumer-related responsibilities, including duty.

There are three preconditions, three enablers and three approaches. The three pre-conditions are Government ambition and appetite, which is clear; industry taking that signal, which existing actors and, as you say, disrupters have certainly done; creating the right environment for innovators to do business here, which we believe we can demonstrate we are doing. Clearly, aligned with the comments made by maritime, there are the market-led conditions.

If you go then into the enablers of that, obviously, there is the right regulatory environment and dealing with demand and intent to supply. That leads us on to what the approach should be. The three elements of the approach are that we must look at the total system, not just aircraft and what they burn, and improve the system as it currently exists. That has to still be within our thinking. We have to look at what we can scale today that exists, which is why biofuels clearly need to be backed. I think everybody has coalesced around that because of the opportunity that it presents.

Equally, in parallel, it is about working with innovators who, as you say, come in and disrupt. Those are the different stages of development from our perspective. There is a very established pathway of sustainable aviation fuels, both bio and synthetic, and manufacturers like Rolls-Royce, Pratt & Whitney, General Electric and power plant manufacturers have made very clear statements about any new engine they produce being 100% biofuel capable, which is significant. It is significant for aircraft integrators to work with those power plant providers as well.

Beyond that, battery technology, as has been touched upon already, offers an opportunity, but possibly only for short-range, small aircraft operations. An operator like Loganair, a key operator here in the UK, has talked about the electrification of its fleet. It seems entirely reasonable to pursue that. It might be hybrid between electric and hydrogen, depending on how we can advance hydrogen. Hydrogen probably sits next beyond research into demonstration, and we have worked with ZeroAvia on that demonstration and proving zone before we move into certification.

As was mentioned by maritime, ammonia for us is more conceptual and more research based at this stage.

If we are going to work back from 2050 and achieve the targets we want to, it is going to be a big five years for SAF, I believe, and a big two years for furthering what we can do with solutions that are related to hydrogen, possibly bringing ammonia online as well. If you look at the targets that we are looking to achieve by 2035, domestically by 2040 and then overall net zero by 2050, clearly there has to be a range of measures, not just scalability and new technologies but looking at the system and improving the way it works today.

Q148 Simon Jupp: It is quite a big infrastructure challenge for airports up and down the country. If you are looking to fly an aeroplane between Glasgow and London that is hydrogen and electric, you need the infrastructure at both ends of that journey to ensure that the plane can continue to fly. It is the same in smaller, regional airports like my own in Exeter. What are the challenges, particularly for regional airports, in looking at this infrastructure and charging points—goodness knows what a charging point for an aeroplane looks like—and the hydrogen process?

Rob Bishton: Clearly, we have parallels that we can draw on from the automotive sector. We have to recognise that the infrastructure in place would need to support scaling of sustainable aviation fuels. Notwithstanding the difficulties in resolving demand issues and intent to supply and the market conditions and investment needed, there is a scalable solution from a logistics supply chain point of view, as long as there is production and, obviously, as long as there are pricing control mechanisms in place. There is a scaling solution.

Q149 Simon Jupp: Those smaller regional airports dotted around the country will have to become very competitive when it comes to actually providing that infrastructure, after an exceptionally difficult two years.

Rob Bishton: What I am heartened by is that despite, as you have referenced, the interruption of the pandemic over the last two years, the appetite of the industry has always been there, and the work is being done to understand that. Again, with sustainable aviation fuels it has been understood now why it is an opportunity.

When it comes to other technologies—hydrogen and electric—ZeroAvia has test-bedded the first project in the world to support its programme on the supply at airport of nitrogen. We can draw parallels from other transport sectors like road haulage. There are things we can learn from and use and develop about the supply of nitrogen into that logistics chain.

You are correct that the investment that is going to be required by airports and others and the change needed is considerable.

Q150 Simon Jupp: One quick question—my colleague Gavin Newlands is going to come in for this section, too—is about Government funding. An all-electric flight took place from Exeter Airport to Newquay Airport probably about the best part of eight months ago. That was funded by BEIS and DFT. When you are bidding for cash for development for these projects, you are essentially looking at two different departments. Should

it be simplified? Could it be one?

Rob Bishton: From our perspective, the appetite across numerous Government Departments has been clear, and it has certainly helped us progress our conversations with innovators, manufacturers and operators, so from our perspective that approach is working.

I think we need to revisit the funding amount required because of the challenge that lies ahead, if we wish to move at the pace we need to move at. It has to be a combination of public and private funding.

There are many other innovators like ZeroAvia. We have had 400 exchanges with innovators through our Innovation Hub over the last three years. We know there is considerable investment by heavy hitters behind this opportunity, and a lot of advisers working in the public sector as well. An amalgamation of all those factors will be the recipe for success.

Q151 **Simon Jupp:** The same question to you, James, obviously knowing you have access to Bill Gates's PayPal as well, so you may be less reliant on Government funding.

James McMicking: We are definitely reliant on Government funding. That private investment came because Government stepped in to help to de-risk the investment. It is an absolutely key relationship.

I want to make a comment on the question around the funding mechanisms. Over the last few years, certainly, the work between BEIS and DFT and the collaboration around the Jet Zero Council is a really positive development for co-ordinating around this. The technology funding is world class, provided it continues, which remains a concern for the industry here, but it is a very good mechanism.

Where there is a bit of a gap, in our view, versus what other countries are doing, is around more of the physical infrastructure and developing hydrogen airport networks. We are seeing significant movement overseas. The problem for us is that we need to demonstrate our technology somewhere. Clearly, if there are environments in which we need to do that, that means we need to go there and participate in their systems.

Q152 **Simon Jupp:** Would it be easier if you talked to one Department rather than several?

James McMicking: Not necessarily. As I say, we have had really good interactions with both DFT and BEIS, and I think it is well joined up generally. It would be nice for the funding to work as well as it does with ATI to look at some of the infrastructure challenges and fuel challenges that are mostly led by DFT.

Simon Jupp: Fascinating. Thank you, Chair.

Q153 **Gavin Newlands:** To continue the funding theme, we have been speaking to the SAFs sector, which is looking for a contracts for

difference model, which I would tend to support. If they were to achieve that and get a contracts for difference model, would you be concerned that they had a leg up on other forms or terms of propulsion?

James McMicking: This is why it is really important to understand the relative benefits of these different fuel types on ultimately achieving the goal, which is zero emissions for the sector and ensuring that a disparity is not driving the wrong incentives.

We see, ultimately, that if we can scale hydrogen sufficiently, the economics actually work in its favour versus SAF, because SAF will be reliant not only on biofeedstocks but power-to-liquid, which is an extremely expensive process, in order to meet demand as it goes. At that point hydrogen will be a lower-cost solution, provided the economies of scale have kicked in to support its generation, its storage and its transportation to the aviation network.

Q154 **Gavin Newlands:** On reducing hydrogen or hydrogen-electric taking over gradually from SAF—SAF is obviously going to come in in the near future—what sort of timescale were you thinking of for the takeover, and do SAFs have a long-term or medium-term place in the mix?

James McMicking: Absolutely. We will see both technologies operating side by side in the aviation system. It is going to take a long time to change the fleet. There is a big fleet of aircraft out there, so it is logical that those that need to burn kerosene have access to SAF and are therefore as clean as they can be, and over time hydrogen-electric will scale up and replace those. I think the economics at some point will kick in and drive that uptake because it will be a lower-cost solution for operators to use a hydrogen- electric powered train rather than a SAF kerosene-burning powered train.

Q155 **Gavin Newlands:** I think that Rob brought up the split. Does the primary responsibility to decarbonise the aviation sector fall on Government?

James McMicking: I think it is a joint endeavour between aviation and Governments, because this is going to involve breaking down big technological hurdles.

Q156 **Gavin Newlands:** Is that 50/50? Who bears most of the burden?

James McMicking: I am not sure quite how to answer that question, to be honest. Perhaps I could construct a response and come back after this session with something a bit more thought through.

It is a shared endeavour. It is a heavily regulated industry, so the Government have a key role in supporting the regulator to enable these innovations to come through, to enable the change that has got to take place around airports. There is a really important role there for Government, as we just touched on, in ensuring that legislation that is governing emissions and the use of different fuel types does not artificially skew away from the optimum solution. I think that is the role of Government there, in addition to de-risking technology.

Q157 **Gavin Newlands:** I think that is a fair enough response. Rob, you have said already about a part private-part public partnership, but does that fall on one side, or are you 50/50 for yourself?

Rob Bishton: I think that needs to be evolved. Obviously, as we move towards mandate, which is being approached in a very thoughtful way, as it needs to be, and given industry has taken the signal and knows that legislation is on the horizon, Government's role in policy is absolutely key in creating the correct conditions.

On funding, I would say we are heartened by the response from industry. It has the space to innovate at the moment and I would encourage allowing that to continue. That enables it to work with investors as well because it sees the opportunity.

From the CAA's perspective, we will focus on how this plays through to consumers. We have been a very well-connected country and consumers enjoy choice; they know that performance on safety, security and other consumer protection remains high, and should quite rightly be expected to be very high.

I think that the factor on investment is how you work with suppliers to ensure that intent to supply is there, and on demand, and how you put in place those market-based measures. From that will be generated more clarity on exactly how that investment profile will work and what that make-up will entail, but I am heartened by the response from industry, investors and their advisers at the moment.

Q158 **Gavin Newlands:** My colleague asked whether the Government should, essentially, pick a winner in this, and you gave a very good answer but you did not say yes or no. I will craft it in a slightly different way. Are the Government being technology-agnostic when it comes to decarbonisation?

Rob Bishton: From the way you introduced it, I feel like I have to say yes or no. I refer back to the answer that the system has to improve the way it currently operates. We must not lose sight of that because there is improvement to be made.

We have to scale. This is simply a factor of timeframes. If those targets are to be met, you have to scale what you can scale today. Irrespective of disruptive technology, you have to work with that. Any aircraft in service of less than 10 years old is going to form part of this journey to 2050. That is the reality because of the service life of this equipment and the design and lead times. But it is absolutely key and apparent that other technologies—known that we are developing and unknown technologies—come to the fore, and we will be able to accelerate them if we have the right environment and the right conditions, which I think is what we are creating.

It is going to be a combination of those that deliver success by 2050 and domestically by 2040. Yes, I can see that we have a slightly different volumetric challenge from maritime, but, on aircraft, if you look at the

fuel options available, there are weight and volumetric challenges for big commercial transport aircraft, which is why sustainable aviation fuels becomes the obvious choice at this stage, but for shorter range and regional flying that provides the ideal test bed to develop battery and/or hydrogen technology, or a combination of both.

Once that is tested beyond small aircraft, which is currently what we are doing up to 40, 50, 60-seat aircraft, which is obviously the journey that ZeroAvia is on, we can see whether those volumetric and other challenges could be introduced. There are a lot of people who think that is currently not going to be feasible.

Q159 **Gavin Newlands:** James, the same question to you. Given Rob's point about the technology that is achievable here and now and the tough decarbonisation targets, are they being technology-agnostic—and should they be?

James McMicking: I agree with what has been said: we need to back technology that is going to help the existing fleet because it is going to be around for some time, and we need to back technology that offers us the prospect of genuinely going to zero emissions.

The good thing is that our approach is to retrofit aircraft so we are not waiting for new airframes. We are going to deliver the technology within a matter of years, and that will provide demonstration and confidence in the market then to start to invest in the infrastructure around that, and then we will scale it up over time.

The UK has a leadership position at this point in this technology and we would very much like to see that continue to be the case.

Q160 **Gavin Newlands:** I am conscious of the time and I have a couple of questions left to Rob. In terms of the CAA and your role, how can a lot of these innovations—be they hydrogen-electric or battery-electric—be safely tested and regulated?

Rob Bishton: That is the success story I would offer as regards our Innovation Hub and innovation team, which plug into the wider organisation. I recognise that a regulatory approach that has rather traditional pathways for a known and existing technology would not fit with new technologies. I think we have demonstrated through creating the right conditions that we have moved very quickly, not only in trying to help innovators to navigate the CAA and regulation in an easier way—and taking that responsibility on ourselves to do that—but in creating immediately a pathway towards not just conceptual conversations about what regulation might entail but demonstration and proving. From demonstration and proving you can move into certification, which is ultimately the test from a regulatory point of view because we have our safety responsibilities that we will maintain.

The success of the Innovation Hub, particularly over the last three or four years and the volume of engagements we have had and the various states of development and the maturity of those projects, which are

considerable, shows that we are getting it right. People are choosing to do business with us as well, which I think is a key measure of success. There are those whom we were previously working with such as EASA and, following our exit from the EU, EASA has chosen to maintain that primary relationship with the UK. Others have located to the UK to do business. I think those are measures of the success of the conditions we are creating from a regulatory perspective.

- Q161 **Gavin Newlands:** It is obviously very important that these processes are robust and it is also pretty important that they are speedy as well so we do not lose the opportunities we may have in terms of, for instance, eVTOL as a new area. Is there any development of eVTOLs in the last few months with the CAA and the Government?

Rob Bishton: Yes, we have a lot of projects in play at the moment through Future Flight, vertiports and vertical airspace. A lot of organisations have made public statements about their intent to develop their business models in the UK. The critical point for us is that it is one thing proving concepts and demonstrating them and even certifying them; the challenge is on scalability. All these business models rely on scalability.

That brings us back to airspace. Our airspace modernisation strategy now reflects the challenges that this is bringing. We are on the Jet Zero Council. We have the Innovation Hub. We have updated consumer information and we are building our own competence and capacity in the CAA to support this, at pace.

- Q162 **Gavin Newlands:** The first part of my last question is for James: is any of the technology currently involved in producing SAFs potentially transferable, or can other plants be refurbished to help with ZeroAvia's line of work in producing hydrogen?

The second part of the question is: are the Government targets of net zero aviation by 2050 achievable?

James McMicking: There is an overlap between SAF and hydrogen, as I mentioned earlier, with power-to-liquid. This is where we need green hydrogen for SAFs, and, obviously, we are interested in using green hydrogen directly. The advantage of using it directly is that you have fewer processes and a lot less energy and cost involved. This is where you get some advantage. There is a relationship there.

Is it achievable by 2050? Yes. It not easy and I think it is a combination of all these things that are needed to deliver it, but I think continuing to accelerate technology, regulatory efforts, improved access to biofuels and SAFs in the interim but also bringing through future zero emission technologies is the way we are going to get there ultimately.

- Q163 **Gavin Newlands:** Is it achievable by 2050? Is it achievable in Scotland by 2045, which is the target there, given Loganair and the number of regional flights we have?

Rob Bishton: It is, but, as I touched upon for SAF, the scalability in the next five years and gaining momentum there is absolutely key. The success of the scalability of SAF is absolutely key, and demand and market-based measures need to be put in place beyond just intent to supply.

The parallel work that we are doing on other technologies is still absolutely key, particularly on domestic and regional targets, by 2040, irrespective of the target of 2045 that you mentioned.

Chair: Ruth, you wanted to come in there.

Q164 **Ruth Cadbury:** Rob, what is your estimate for the level of emission reductions that can be gained from airspace modernisation?

Rob Bishton: That is a question that I know has perplexed us to a degree. I could not put a figure on that here—

Q165 **Chair:** Do you want to write to us?

Rob Bishton: Indeed, I think we will provide that by return.

Q166 **Ruth Cadbury:** Does that depend on whether airspace modernisation is to increase capacity and increase flight levels, or whether it is to maintain them at the same level?

Rob Bishton: Obviously, that is key and one of our duties is to look at capacity improvement and increases as well. On airspace modernisation, we have a number of factors that do not necessarily play well together, but this particular issue has obviously been brought up the agenda in consideration of those responsibilities. I would not want to grab a figure, but I am happy by return to write back to the Committee.

Q167 **Ruth Cadbury:** Your primary duty is to support growth in aviation.

The second question, probably to James, is: is there enough green hydrogen to deliver the changes you require, given that most hydrogen now is produced by fossil fuels?

James McMicking: Absolutely—not today, but the potential is absolutely there. There is no limitation on renewable power resources, only on our ability to tap into them, and there is plenty of information out there to underpin that claim.

The good thing is that the economics stack up as well, so when we start using hydrogen in aviation it will pay for green hydrogen production and for the infrastructure ultimately when it achieves scale. There is enough green hydrogen that can be produced, but today it does not exist. We need to build that, and that is one of the things we have been doing as part of our work in the UK to develop an electrolysis infrastructure and a refuelling infrastructure that we can test and demonstrate and then we will be able to scale up.

Chair: Thank you, Ruth. James and Rob, thank you very much indeed for giving us such a lot of evidence on aviation. We will no doubt be coming

back to you again over the years. Thank you very much indeed.