HOUSE OF LORDS

Science and Technology Committee

Corrected oral evidence: The role of batteries and fuel cells in achieving net zero

Tuesday 25 May 2021

11.05 am

Watch the meeting

Members present: Lord Patel (The Chair); Baroness Brown of Cambridge; Lord Hanworth; Lord Holmes of Richmond; Lord Kakkar; Lord Krebs; Baroness Manningham-Buller; Lord Mitchell; Baroness Rock; Lord Sarfraz; Baroness Sheehan; Baroness Walmsley; Baroness Warwick of Undercliffe; Lord Winston.

Evidence Session No. 12 Virtual Proceeding Questions 129 - 138

Witnesses

Rob Millar, Head of Electrical and Battery Systems, Williams Advanced Engineering; and Expert Panel Member, Faraday Institution; David Wong, Senior Innovation and Technology Manager, Society of Motor Manufacturers and Traders (SMMT); Buta Atwal, Chief Executive Officer, Wrightbus.

USE OF THE TRANSCRIPT

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

Examination of Witnesses

Rob Millar, David Wong and Buta Atwal.

Q129 **The Chair:** Good morning to our witnesses. I thank Mr Millar, Mr Wong and Mr Atwal for joining us today. We appreciate you making time to join us, and we look forward to a very interesting session. I shall kick off with a brief question. As we move to batteries and fuel cells, what are the key suppliers and organisations that will be important, as opposed to what we currently have in conventional manufacturing? You can list them if you like.

Rob Millar: Good morning. I am Head of Electrical for Williams Advanced Engineering, an engineering consultancy that does a lot of work in the battery field and with the vehicles that go alongside it. I have been there for five years, and I have now been involved in the electrification of vehicles and their batteries for 15 years.

The landscape for suppliers involved in this industry is something of a pyramid. If you consider the battery to be the top of the pyramid, there are a variety of suppliers that get larger as we go down. The principal next layer from whole-level battery is dominated by the cell suppliers. Those are the principal technologies that are hard to come by; the others are somewhat more like conventional vehicle technologies. Then we delve down further into the people who supply processed raw materials, and then the mining companies at the bottom. That is a rather simplified view, but it describes it in outline.

David Wong: I am the Senior Technology and Innovation Manager at the Society of Motor Manufacturers and Traders. SMMT is the UK's automotive industry body representing the sum total of UK automotive, including all major vehicle manufacturers, component suppliers, systems integrators, engineering firms, the independent aftermarket and, increasingly, a number of mobility start-ups.

Our view on the key players in the supply chain is very much the same as what Rob just articulated, but I would perhaps analyse it slightly differently, looking at the whole value chain. It really starts from the upstream, which is basically mining and refining—as we have heard already, not least in the session before this—and then down to cell manufacturing, module, pack, and finally integration into vehicle manufacturing, principally by the vehicle manufacturers.

We have heard quite a lot already in the previous session about where the value sits, particularly in terms of mining and refining. However, when it comes to the batteries themselves—cell manufacturing, module and then pack assembly—a lot of these suppliers are currently companies originating from the Far East, dominated particularly by the South Koreans, the Japanese and the Chinese. Of course, there are some emerging companies in Europe, not least in Britain.

Buta Atwal: I am the CEO of Wrightbus and a company called Ryse Hydrogen. We are producers of both technologies—battery and zero-

emission buses, and hydrogen zero-emission buses. Ryse Hydrogen actually produces hydrogen for consumption in vehicles.

As some of the panellists have rightly said, one aspect of the supply chain is that batteries tend to be from the Far East. If you look at hydrogen technology, the fuel cells are predominantly from either Canada or America or from mainland Europe. On the production of hydrogen, we have some very good companies in the UK. ITM Power in Sheffield is a very good example of this. End-to-end production of hydrogen lends itself more to the West, and batteries lend themselves towards the East.

Q130 **The Chair:** Mr Wong, why is there reluctance on the part of our current vehicle manufacturers to partake in any kind of discussions? How confident can we be that we will have a major industry in vehicle manufacturing?

David Wong: What sort of reluctance was that? Reluctance to participate in—?

The Chair: In any discussions.

David Wong: I do not think vehicle manufacturers are reluctant to participate in any discussions. I think they are waiting with bated breath to see whether there is the possibility of sourcing from locations—I refer to batteries and fuel cells—that are nearer to where vehicle manufacturing currently is, which means either on European or British shores.

There is always the importance of offtake agreements. These basically get around the chicken-and-egg problem of whether batteries and fuel cells or vehicle manufacturing come first. The offtake agreements are to be discussed and agreed. Vehicle manufacturers are always happy to enter into discussions, but, of course, there are no obligations to agree.

The Chair: We will come back to that in more detail with a later question.

Q131 **Lord Mitchell:** 2030 is eight and a half years away, and that is the point at which there will be no further sales of internal combustion engines. I think this inquiry really has to have a feeling for how much involvement vehicle manufacturers have in the supply chains for batteries and fuel cells and for supporting infrastructure such as chargers and hydrogen supplies. Secondly, are the vehicle manufacturers actively engaged in the development of these technologies, or do you buy off the shelf? This really follows on from Lord Patel's previous question.

David Wong: It may be easiest to answer your question in reverse, dealing first with the final part on the role of vehicle manufacturers and how they collaborate with suppliers—whether they buy off the shelf or whether it is a closer collaboration.

It is quite unlikely that vehicle manufacturers will buy everything off the shelf, particularly when it comes to such an important component as the battery. It is more likely to be in partnership with cell manufacturers. This is not to say that cell manufacturers will do everything and then, like a

turnkey project, hand everything over to the vehicle manufacturer. It is more likely that the development process is a joint one whereby the vehicle manufacturer specifies the very specific performance attributes they are looking for from a particular batch of cell purchase.

Some of them may then escalate, for example, to an agreement for the battery manufacturer also to assemble the pack, but some vehicle manufacturers do everything in-house. They are looking at collaboration with the cell manufacturer but do it in-house, as at the battery gigafactory in Nevada. However, there are other vehicle manufacturers that will collaborate with the cell manufacturers in specifying the performance requirements, and then they will do everything in-house from the module and the pack assembly onwards. That is not really buying off the shelf.

On the general involvement of vehicle manufacturers in infrastructure—you asked about infrastructure—the automotive industry believes that vehicle charging infrastructure is not really in our gift to provide. The responsibility for rolling out infrastructure really lies with the infrastructure sector, and there are a lot of very good infrastructure manufacturers and network operators. We are of course talking not just about charging infrastructure but also about hydrogen refuelling stations. What is needed is closer collaboration between the infrastructure providers, infrastructure operators, vehicle manufacturers and government to ensure that the rollout of infrastructure is capable of delivering the Government's ambition to end the sale of internal-combustion-engine cars and vans by 2030, and we need a lot of infrastructure to make that work for consumers.

I have one more thing to add on infrastructure. At the moment, we see that the pace of the rollout of the charging infrastructure, for example, is slower than anticipated. Credit where credit is due: I think we are doing quite all right compared to a lot of other markets in Europe, but it is still slower than what is needed, simply because we have an end of sale in 2030. Some manufacturers have resorted, at least in the near term, to taking matters into their own hands by investing in high-powered charging stations, particularly those along motorways. A good example is Ionity, which is basically a consortium of five vehicle manufacturers investing in the rollout of these chargers because they felt that the pace of rollout was not as fast as desired. In the longer term, it should be the role of charging infrastructure providers and operators as well as hydrogen refuelling station operators.

Rob Millar: We see a very large number of different vehicle manufacturers involved in the development of the technologies that are of relevance here. Particularly in cell and pack manufacture, we see some fundamental involvement at chemistry level by certain manufacturers. Tesla is an example of one of those, but we have manufacturers in Europe that are adopting a similar approach. Whether they go on to produce those cells by themselves remain to be seen, but they definitely want to understand the chemistry involved in their batteries and ensure that it is tailored to their needs. They are very involved in that technology development.

From an infrastructure perspective, Tesla, in order to seed the market for its vehicle, has produced its own infrastructure, and that has worked very well. That is one reason for doing it, to generate the market, but the other example you could point to is Porsche, which has generated some very high performance chargers in order to satisfy the needs of its customers.

In the most general sense for EV adoption, I think we will end up with a largely much lower-power set of charging infrastructure that satisfies the needs of mass adoption. We already see the current fuel suppliers, such as those that make petroleum today, restyling themselves as "energy suppliers" and providing this infrastructure now at their fuel stations in order to supply the needs of their existing motorists as they transition to electrification.

Q132 **Baroness Rock:** I want to come on to the security of the existing supply chains. How secure are they? Who are we competing against for access to them? Perhaps in your response you could touch on the extent to which the supply chains have to be based in the UK. Also, are things changing because that the UK is no longer part of the European Union?

Buta Atwal: As a bus manufacturer, we design and develop our own vehicles. The first thing we look at is the customer specification and then we build from that. We manufacture zero-emission products, both battery and hydrogen, and we tend to find that battery technology tends to come from China and further afield, and therefore we are in less control of that technology, whereas with hydrogen there is more involvement by either America or the UK and we can plan a more solid growth of that based on what I call the UK economy and UK plc.

China invested in batteries a long time ago and was ahead of the curve, and it has done a very good job occupying that side of the market. Hydrogen is a more nascent technology, and investment now could help UK plc to develop technology here and use it to export that technology or for cars or bigger vehicles that hydrogen probably suits, such as buses, trucks and probably even trains. It is about looking at what your customer needs and specifying the technology accordingly, and then trying to site that technology as close to the manufacturer as possible because that is the most efficient, and it tends to drive UK jobs as well.

Rob Millar: Our perspective on this is that there is a significant problem in batteries with supply not meeting demand. We see already that the major cell manufacturers are unable to supply people who are looking for smaller quantities of cells and instead prioritise those who come along and place very large multibillion-dollar orders with them.

It is interesting that we see that with companies like Northvolt, which was mentioned earlier. Northvolt is not yet in volume production, but it already has multibillion-pound orders from the likes of BMW, and it is already starting to become slightly difficult to purchase cells from it. So the global marketplace for these cells is very difficult at the moment, which leads to us requiring the manufacturing of cells in the UK in order to provide security for our own nation in that respect.

Baroness Rock: Thank you, Mr Millar. Mr Wong, do you have anything to add on that?

David Wong: Yes. I would analyse the subject of security from three perspectives: supply, committed production, and prices. We don't have to touch on supply again—you explored it at length in the previous session—but let us take the second one, committed production. Committed production capacity in Europe through to 2030 is currently at about 600 gigawatt hours, of which the UK currently has a 2.5 gigawatt-hour share, and another 35 gigawatt hours coming on stream by 2027.

If we look at security of supply on a committed production basis, yes, there is a lot being committed to Europe, but the UK has a small fraction of that. To give you some perspective, if we think about producing 1 million battery electric vehicles with moderate-sized batteries by 2030, we need around 60 gigawatt hours of capacity. Whether they all need to come from the UK, as you asked, is another question which I will address later.

Let us quickly jump to the third aspect of security of supply—which is basically about prices. As it is in the public domain, I can say that Tesla has recently become a technical partner and decided to buy nickel from the Goro mine in New Caledonia just to secure its long-term supply of nickel, because in the last year alone nickel has seen a 26% rally in prices. Lithium carbonate prices have soared by about 70% this year on the back of strong demand for EVs. The Macquarie Bank has forecast that prices will continue to increase in the next four years by between 30% and 100%, which is a huge range.

On the back of all this, Goldman Sachs issued a warning a couple of months ago that, overall, this could mean that battery prices may be higher by about 18% some time this decade. So rather than continuing to fall, it might actually go the other way.

That is about security of battery supply, but what about fuel cells? As you heard just now, scale production of fuel cells in the UK is nearly zero. The two Far Eastern car manufacturers that currently have fuel cell electric vehicles on the road produce their own fuel cell stacks and, of course, we have a Canadian supplier as well. Going forward, there is a company in the UK—a true-blue British company—intending to build a fuel cell gigafactory in the East Midlands with a 2 gigawatt capacity that can feed about 17,000 vehicles, both light and heavy duty, by 2030. That is the sort of initiative that we need to support in order to secure future fuel cell supply in the UK.

On whether they all need to come from the UK, this is where the Trade and Co-operation Agreement with the EU comes into the picture. The most important date is 2027, because by then 55% of the value added has to be local content—originating content—from either the UK or the EU. However, on top of the 55%, the battery has to originate from either the UK or the EU. This means that, if I am a vehicle manufacturer in the UK, I can source the batteries from the EU and still qualify for tariff-free trading—no problem. Of course, ideally, we would like the batteries to be sourced from the UK, not least—as Professor Herrington mentioned in the

previous session—to anchor vehicle manufacturing in the UK, because manufacturers like to be near their suppliers, but also to create economic value for the UK.

The UK normally produces around 2.5 million to 2.7 million internal combustion engines. As we all know, last year was a bad year—the output was 1.8 million. In due course, we need to transition from engine production to battery production, power electronics, motors and drives, and fuel cells. So we need to create new economic value for the UK when the production of internal combustion engines is gone in years to come.

Baroness Rock: Thank you, Mr Wong. That is extremely helpful.

Q133 **Lord Sarfraz:** Leaving aside the downstream gigafactories and upstream mining, what would you specifically like to see the Government and industry do to help all the stuff in the middle—all the components and parts that are needed—and the scale?

Buta Atwal: In reference to the earlier answers, there needs to be a balance of technologies; we cannot do everything with batteries. I think we all agree with that. We have already seen prices increase and demand being shortened, so you have to have hydrogen and batteries. So the first thing the Government need to do is to encourage both technologies to be produced and consumed in the UK.

Fortunately for the bus industry, we are probably slightly ahead with a lot of government initiatives. The Hydrogen Council is looking at the production of hydrogen, and the Government have already announced a £3 billion bus fund over the next few years to decarbonise buses. They are also looking at investing to ensure that buses and the infrastructure are funded; we just need to make sure that that is accelerated.

There are some oddities out there, such as the BSOG—the bus service operators grant—which is predominantly a diesel grant. If that grant were moved into EV or fuel cell, operators would be encouraged to move away from diesel and would actively seek to go into the EV or hydrogen zero emissions field. Those types of grants, which shift from diesel to hydrogen, are very important.

In terms of the production of things like hydrogen, grants such as the renewable transport fuel obligation, the RTFO, are very restrictive. They require new wind rather than existing wind power, which would accelerate hydrogen, balancing the requirement for both EV and hydrogen.

Rob Millar: There are very many suppliers involved in batteries other than the cell suppliers. Among those, we have very good capability in the UK across most technology areas. The one area that is currently causing significant concern at a global level is the supply of electronics. Silicon chips, which go into those devices, are in short supply, but I anticipate that that will be a short-term problem. Of the technologies that help us to make use of our cells, the battery management system and the technology—essentially, the algorithms—that go into that are of great

importance, and continuing to support the academic research that goes into the development of these things is very important too.

Lord Sarfraz: Mr Wong, do you agree that the chips shortage is a short-term problem, or do you think it is an issue of national security and that we should be thinking of it in that way?

David Wong: All I can say is that it is a short-term problem at the moment, but it could threaten to become a full-blown, longer-term problem if it is left unresolved. So it remains to be seen. That is all I can say regarding the chip shortage. Do you want me to comment on what is needed or what we would like to see?

Lord Sarfraz: Yes please.

David Wong: First, the Government must create the right conditions to ensure that the UK is a competitive location for companies to invest in the supply chain as well as in locating vehicle manufacturing. We want the UK to be seen as the location of choice for both vehicle manufacturing and for battery, power electronics, motors and drives, and the fuel cell supply chain. But we need the right environment, and to facilitate that you have to start with a comprehensive transformation plan that is truly comprehensive—not just platitudes, but a really comprehensive plan that is fully costed and funded.

The second thing is government investment. The planned fuel cell gigafactory in the East Midlands that I mentioned earlier will require some government support. The project has been costed and it is estimated that to deliver the gigafactory and the jobs that come along with it in the UK will cost £120 million. The counterfactual is that it costs £90 million to deliver that in China and £85 million in Poland. So that consortium will need some government support.

Similarly, the amount that has been committed to the automotive transformation fund is admirable, but we need more if we are to attract gigafactory investment in the UK, particularly by 2027. Bear in mind that it takes something like 30 to 42 months to get everything off the ground, including development, construction, test runs and, finally, the commissioning of a gigafactory.

The third thing is streamlined processes. We need the Government to put streamlined processes in place for obtaining permits and licences, for example, as well as streamlined processes to have access to skilled and productive labour.

Skills themselves are the fourth point that I would like to make. I know you may have a question about them later, so for now I will say that the UK automotive workforce is in need of reskilling and upskilling. That is very important.

Lastly, it is about competitively priced clean energy. We have an abundance of clean energy, which is great—it is the UK's key advantage compared to China and Poland, for example—but we need it to be competitively priced in order to make us a really attractive location.

Q134 **Baroness Sheehan:** My question is addressed to all three witnesses. In the previous session we heard about the environmental impact of sourcing materials lower down the supply chain. My question focuses on the environmental impacts of the supply chain higher up. In your answers, could you address the issues of the refining and processing of raw materials, the assembly of components and the shipping of those components? In your opinion, what can be done to reduce these impacts?

Rob Millar: This is really not my principal area of expertise but there is a very obvious point: at the moment we are shipping cells in from the Far East, where there is, I guess, a great deal of less regulated activity in the production of those cells and less incentivisation for their production in a clean way. Onshoring that activity in itself would have a significant impact on the environmental credentials of batteries.[1] The majority of other components end up with local solutions, today or in the near future, and I think they are less problematic for us.

David Wong: You were right to say that there are concerns regarding emissions and the environmental impact, particularly higher upstream. To put things in perspective, when it comes to battery electric vehicles the greater proportion of lifecycle emissions is actually in production, whereas for internal combustion engines it is at the use stage. A report commissioned by the European Commission shows that the majority of emissions in battery electric vehicles are linked to production, and the figure is about 60%. Some 30% to 40% alone are actually linked to battery production.

This is a highly sensitive area, not least because there are variations due to the intensity of the electricity used in battery production. We have not even come to vehicle charging yet, but that is at the use stage, so let us focus on the upstream stage. This is where we think the UK has a competitive advantage. The problem is that, apart from a bit of Cornish Lithium, we do not have many raw materials that we can mine at scale. However, we could perhaps look at the potential opportunities at the refining or processing stage, which the panel talked about in the previous session. If you left it, for example, to China to do the bulk of the global refining of the raw materials then you would be talking about, at least in the near to medium term, the use of dirty electricity, if I may put it that way, to refine those materials. So why not look at the possibility of capturing that value in the UK, because we have an abundance of clean energy?

When it comes to the raw materials themselves, yes, there is some environmental impact. That is where R&D comes in really handy. Of course R&D is not an overnight thing—it has a long gestation period—but none the less we need to invest in R&D activities aimed at reducing our reliance on some critical raw materials. We have already made great progress in NMC chemistry, moving from 622 to 811, reducing cobalt reliance from 20% to just 10%, and now we are moving to NMC 9.5.5, which is basically just 5% cobalt. These are the sorts of incremental gains

[1] Due to the reduction in both transportation emissions and hoped for reduction in manufacturing emissions.

that we need to reap if we are going to be more sustainable in the entire battery value chain.

Going forward, we anticipate that there will be a regulation on the EU side, which perhaps the Government in the UK may wish to reflect and then follow. It is an EU battery regulation with a requirement for recycled content for cobalt, lithium and nickel.

Buta Atwal: My belief is that manufacturers should have more responsibility to reuse and recycle their material. That starts at the design phase in designing products that actively do that, whether that is with regard to fuel cells, batteries or the total vehicle. The fact is that batteries are harder to recycle now and will be for the foreseeable future, whereas our fuel cells can be reconditioned. You take it out of the pack, and then you can recondition it and reassemble that pack, which gives it a secondary and a tertiary life.

It is that type of activity that needs to be encouraged and supported by the Government with engineering grants. We in this country are uniquely placed with our universities and our technical skills, so that type of investment in the UK economy and UK universities will deliver more jobs and lead to better products coming out of the UK, which will support the growth of these markets.

Q135 **Baroness Walmsley:** What role does the recycling of batteries and fuel cells currently have? How will that change as manufacturing increases? Is there a need for government support for recycling industries prior to economies of scale making recycling cost-effective? Given what Mr Atwal has just said about design, is there a role for UK legislation on the recyclability of batteries, given that all the car manufacturers use differently manufactured batteries? We know that China has legislated already and, as we heard earlier, the EU is about to do so.

Rob Millar: It is clear that recycling is currently a significant challenge in the UK. There is very little of it going on at the moment; in fact, I think we heard in the previous session that precisely none of it is going on at the moment. The most defensible activity is to take batteries that are at the end of their automotive life and put them into other applications, so-called second-life applications. However, that really just pushes the problem slightly further down the road.

The technologies that currently exist which we see used on the continent for the actual recycling of batteries are done through a pyrometallurgical process, which in reality means that you burn up the battery and then try to recover from the ash some of the elements that will be of value to you. That looks like a particularly indefensible approach to this.

We see a change coming among the cell suppliers. We are aware of at least one cell supplier that is offering to buy back packs and cells at the end of their life and has its own plans to recycle the materials in those cells into new cells. That looks to us like a very good process.

Another one that I am aware of has proposed a hydrometallurgical process, which means that they will dissolve out the metals in an

aqueous solution of some sort and recover them that way, which is much greener and cleaner than the current approach.

On your point about what role vehicle manufacturers and battery manufacturers play in this, it is abundantly clear that the importance of making a battery that can easily be recycled has to come to the UK as well, probably through legislation. It is not a principal consideration at the moment. While manufacturers are not forced to do so, it will probably be largely avoided, which just makes the problem worse when we come to it.

David Wong: I will say four things very briefly. First, I fully concur with my colleagues that, currently, recycling activity in the UK is nearly zero. That certainly needs to change. Establishing a battery recycling facility in the UK is pivotal, as it would not only support the circular economy but ensure that we were a competitive location for manufacturing in future.

That leads to the second thing I want to mention: the potential for raw materials to be recovered. Closely related to recycling is recovery of critical raw materials. If they are all being shipped to Umicore in Belgium, for example, we are losing some of those precious raw materials that could be recovered and funnelled back into the production process. So recovery of raw materials is closely related to creating value for remanufactured batteries.

That leads me nicely to the third point, which is that remanufacturing is a UK strength, but remanufacturing batteries is an area where we need to add to our suite of advantages. That means, for example, government perhaps looking at some tax incentives or tax breaks for remanufactured batteries so as to introduce them and increase their uptake.

My last point is about investment in R&D projects. Currently, thanks to government funding, not least through the Faraday Battery Challenge and the Faraday Institution, some really good and interesting projects are going on into recycling, recovery and reuse of materials: for example, the ReLiB project, the APC RECOVAS project and the CALIBRE project.

The CALIBRE project is really interesting and useful. It has discovered that, when batteries degrade, not all the cells degrade in a linear fashion and not all the cells degrade evenly. Some cells degrade worse than others. It has been discovered that if we could replace around 5% to 30% of the cells that have dipped below 80% usability, we could bring the battery up to nearly 100%. Rather than throwing the entire battery away, we could do something clever with just some of the cells. That requires R&D and more support for such R&D projects.

Baroness Walmsley: Presumably that requires being able to test exactly which cells.

David Wong: Correct.

Baroness Walmsley: Mr Atwal, do you want to say something about fuel cell recycling?

Buta Atwal: Yes. We are talking about recycling batteries. We all know that, currently, they go to landfill after use. They are not in a great

position when they do: they require special handling and special care, and it is a very costly process. Improving that process is required, and funding needs to be given to help to reuse those metals and repurpose those batteries, but we are a long way from it.

The key point is that there are currently technologies that are suitable for bigger and heavier vehicles, such as buses, trucks and other transport, that do not have that negative when it comes to the end of life. Fuel cells are a very good example: the recycling is easier, the technology is more nascent, it can be delivered to the UK economy more easily and, more importantly, it can deliver green energy into those vehicles. Although our concentration is on batteries, sometimes we need to look at other technologies that balance it. For certain vehicles, like cars, we may decide to go with batteries and then have the support mechanisms, but for bigger and heavier vehicles, fuel cells may be more suitable and the recycling easier. Therefore, the cost and the support from government are balanced off and it is easier to do.

Baroness Walmsley: Of course, they all need a battery as well.

Rob Millar: You spoke earlier to Paul Anderson about the ReLiB project. I think that some fantastic technologies in cell recycling will emerge from that project. We already see them in the lab, but once they reach commercial reality they will be very promising. I just wanted to mention that.

Q136 **Baroness Warwick of Undercliffe:** All our witnesses this morning have talked about the potential vulnerability of our supply chain. We have heard about the need for diversity of resources, the need to get hold at least of part of the supply chain to control it, and the need for investment in our strong research base in universities.

Given that we also know that we are working to 2030 in the motor manufacturing context, what specific policy or regulatory support do you each think is needed to establish a secure supply chain in the UK? Perhaps you could go on talk about the investment that is needed and who is going to do it. Will it be the battery and fuel cell manufacturers? Will it be the vehicle manufacturers? Will it be government? Will it be all or none of those?

Rob Millar: The principal vulnerability that we see—our involvement is mostly in batteries other than fuel cells—is with the supply of cells. For the UK to become secure, it is critical that we establish much more manufacturing than we have today in that area. It appears that many of the other supporting industries are already here in some format, whether directly involved in battery manufacturing or in something that can easily be adapted. Support for vehicle manufacturers and those industries manufacturing components would be the most helpful.

On your question about investment, although this is not my area of expertise, it seems to me that the Government always need to seed these investments to give other people the confidence to come in and invest in them. Legislation probably plays a part in that.

David Wong: I will repeat briefly what I said to Lord Sarfraz just now. First, government needs to create the right conditions and have a proper, fully costed and well-supported comprehensive transformation plan for the entire industry and the supply chain.

Secondly, on the investment side, I echo what Rob just mentioned: government probably needs to seed, and I would go as far as to say help de-risk, some of these private investments. Make no mistake: the investments will be from the private sector. Whether it is in gigafactories for batteries, cell manufacturing or fuel cell manufacturing, such investments will come from the private sector, but we need government to help to derisk them. I have already mentioned battery gigafactories as well as the fuel cell gigafactory planned for the East Midlands.

There are other aspects, such as investment in R&D, whether that is in recycling or increasing the efficiency of cells, which is where the key battleground would be: for every kilowatt hour, you want to squeeze more range out of it. That will be through R&D—increasing power density as well as energy density. Then there is access to skilled and productive labour.

I have mentioned competitively priced clean energy. That will have to be a holistic policy, because it will not just be for automotive manufacturing of course; it will be for other industries too.

One thing that I did not mention just now is that the Government could step in to facilitate some offtake agreements, which I mentioned much earlier in this session, between vehicle manufacturers and battery manufacturers, because you need both of them together.

Baroness Warwick of Undercliffe: I wonder if you could say something about any necessary regulatory change that you see the need for in this relatively short timeframe.

David Wong: The regulatory change is basically already there for the market side. We will be very clear: these are two sides of the same coin towards net zero in 2050. One is the market, and the other is the industry. We already have very stringent regulation, including end of sale. That is for the market side. On the market side, we need regulation now to ensure that the rollout of infrastructure can help to deliver the end-of-sale policy.

There probably need to be more carrots rather than sticks on the industrial side, if I may put it that way. Industrial transformation in just about nine years, or at best 14 years through to 2035, really needs a lot of support, not more sticks.

Buta Atwal: I support what Mr Wong just said. The additional point I would make is on the infrastructure side. To convert the current infrastructure to either battery electric or hydrogen requires a lot of investment and support. To give you an example that we discussed yesterday, one of our customers is a bus operator with around 140 vehicles on its site. The power required to charge those buses is equivalent to 20,000 apartments in London. You can see the structural change required in the infrastructure to support either EV or hydrogen to

go to these locations. That analysis and support are required, because infrastructure takes between 18 months and two years prior to the use of a vehicle.

The other thing we see, in central London for example, is people charging their cars and wires coming out and cluttering the pavement. There need to be other ways of charging vehicles that support the current urban infrastructure, because I am sure there will soon be a civil case that says, "I tripped over a piece of wire. Whose responsibility is it? Is it the council's, the individual's or the car manufacturer's?" We need to make sure that the infrastructure around, whether it is hydrogen or EV, can support the changes we are talking about. It is a forgotten subject, but it is the required starting point to deliver the growth in the use of cars, buses and trucks, and the support of the refuelling of those going forward.

As for who should do it, I am a great believer in private industry, and I think that private industry has to lead it. It is the most efficient way of doing it, but that requires very careful and calculated government support to encourage the right behaviours and to derisk some of the future-proofing of our economy. Hydrogen, for example, is a nascent technology. Future-proofing and supporting key producers of hydrogen or the users of hydrogen derisks those private companies, which then helps the growth of that nascent technology.

Q137 **Lord Winston:** We have heard a good deal about the problem with the workforce, both in the manufacture and particularly in the maintenance of batteries and fuel cell vehicles. Do you feel that we have the right approach to reskilling people, probably from some degree of mechanical engineering to electrical engineering, in these fields?

Buta Atwal: This is a topic I feel very strongly about. We are fortunate at Wrightbus in Northern Ireland to have Queen's University Belfast very close to us. It is a very good engineering university. Even still, we have almost exhausted its resources. We almost have to sponsor A-level students who are going into university, even before they are thinking about it, to change their direction of travel. Going forward, there is a real shortage in electrical engineering, coding and people who design and develop new products. All we are doing is robbing Peter to pay Paul to deliver our products.

What are we doing about it? We now have apprenticeships for 19 year-olds coming into our business, and we are sponsoring graduates and people to retrain within their jobs. But we need a more structural change in our education to support the delivery of manufactured and electronic goods coming through just to cope with what is happening in the East. The number of engineering graduates coming out of India and China is substantially higher than those coming out of the UK, so naturally we will fall behind in design, development and technology going forward. We have to arrest that change.

Lord Winston: That is a hugely helpful answer. Thank you very much indeed. Rob Millar, do you have anything to add to that?

Rob Millar: Mostly I agree. The very clear challenge for us is that, for whatever reason, engineering is not the most attractive of degrees, which is a great shame. Even when people come out at the end of an engineering degree, we quite often find that we are competing with a finance company, or a financial industry company, for their attentions, so more support is needed to encourage them to take up a role in engineering. There is also a very significant gender bias in engineering. There are very few women within my organisation who work for me, which seems curious. For instance, I am told that if you look at Germany, you find that the gender bias is the other way around.

There are helpful programmes going on. The Faraday Institution in particular is encouraging academic studies in the right areas for us. The UKBIC is encouraging people who are skilled in the manufacturing of batteries, which is very beneficial. The rest of the activities are really company-led, where we take people with existing vehicle skills and transform them into people who can work with electrification or electrified components in some way. There is still a great need for those who have the specific skills required in our industry.

Lord Winston: Thank you very much indeed. I am looking at the clock. Do I have time to ask David Wong about his views?

David Wong: All I want to add are a few figures to put the whole matter into perspective. We are talking about manufacturing skills and engineering skills, which are related but slightly different things.

In terms of manufacturing skills, the Automotive Council estimates that about 10,000 workers currently need reskilling. This number is likely to grow to about 50,000 by 2025 and 100,000 by 2035. We are talking about reskilling manufacturing workers.

Then there are engineering skills. The current engineering skills gap, according to the Automotive Industrial Partnership, is around 5,000 workers. Engineering workers are urgently needed between now and 2025. We think that the engineering skills gap, if not addressed, will become even more acute by 2030. What are some of the engineering skills that we really need? Besides the obvious ones, we are also looking at digital simulation, verification and validation, optimisation and analytics, for example. These are more about digital engineering rather than mechanical skills.

The Chair: Baroness Sheehan, you had a supplementary. Could you ask it very quickly, please?

Q138 **Baroness Sheehan:** I was not aware that I had indicated I wanted to ask a question, but I am quite happy to ask one about the upstream environmental impacts of batteries versus fuel cells versus hydrogen. Does anyone want to have a quick go at that?

The Chair: Who has a one-sentence answer, please? Maybe Mr Millar?

Rob Millar: I think the point has already been made that, once in use, fuel cells have a cleaner profile and require less recycling. However, the

advantage of hydrogen overall is not that clear at the moment, and it will take time to develop.

The Chair: Thank you very much. I am sorry that our time is up, because it has been a most interesting session and you have been fantastic witnesses in giving us evidence.

You will be sent a manuscript of today's session, so if you want to correct anything, please feel free to do so. If on further thought you have any more material you would like us to add, please send it in and we will make a record of the evidence. For today, thank you very much indeed. We very much appreciate you coming.