



Science and Technology Committee

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

Monday 7 June 2021

3.30 pm

[Watch the meeting](#)

Members present: Lord Patel (The Chair); Baroness Blackwood of North Oxford; Baroness Brown of Cambridge; Viscount 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. 13

Virtual Proceeding

Questions 139 - 150

Witnesses

James Sprinz, Vice-President of Strategy and Business Development—Europe, Energy Impact Partners; Dr Jeffrey Chamberlain, Chief Executive Officer, Volta Energy Technologies, LLC, Board Member at the Faraday Institution and formerly of the Argonne National Laboratory at the US Department of Energy; Beverley Gower-Jones, Managing Partner, Clean Growth Fund; John Bromley, Head of Clean Energy Strategy, Legal & General Capital.

USE OF THE TRANSCRIPT

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

Examination of witnesses

James Sprinz, Dr Jeffrey Chamberlain, Beverley Gower-Jones and John Bromley.

The Chair: Good afternoon, all. I particularly welcome Mr Sprinz, Dr Chamberlain, Mr Bromley and of course Ms Beverley Gower-Jones. Thank you all for joining us today.

We have heard all kinds of evidence about how the Government are investing lots of money and want to encourage more investment in battery and fuel cells, but we have heard very little about private investors investing, so this session is extremely important to us. Lord Sarfraz will ask the first question.

Q139 **Lord Sarfraz:** I would just like to add my welcome to all of you. Thank you for your time and for being with us.

Batteries and fuel cells seem to me to be about both early-stage venture funding and later-stage high capex funding. Can you tell us a bit more about your own investment strategies, why you picked the stage and ticket sizes that you did, and what makes investing in batteries and fuel cells different from other technology sectors? Can we start with Dr Chamberlain?

Dr Jeffrey Chamberlain: I am the CEO of Volta Energy Technologies, a very specialised venture capital firm whose scope focuses on battery storage and, agnostically, how to store energy, as well as on ancillary technology, like recycling, fast charging, et cetera. We were spun out of Argonne National Laboratory in 2016 where, I am grateful to say, I was able to lead the nation's largest battery research institute in the US for 10 years and where we grappled with these very questions with the US Government, so thank you for inviting me to speak here today. Also, for full disclosure, I am a trustee on the board for the Faraday Institution in the United Kingdom.

As I mentioned, our scope is batteries and storage but, in particular, we currently have a full \$385 million under management and we aim to invest in technologies that are going through the transition in which the development phase is over. We expect to deploy 80% of our capital into technology companies that have finished their development or have come very close to finishing it and are either in revenue or on the cusp of revenue.

It is important to start there in order to answer your question: why do we invest at that stage? First, we build a very special purpose venture capital group that in a way is like IP Group: we marry technologists with financial experts, so that, first and foremost, we can identify when a technology is ready. Secondly, we need to identify when the market is ready to bear the cost of that new technology. That is what we call an inflection point—the point at which the company is about to go through a hockey stick of growth in sales. So from a purely financial perspective we believe that the way to decarbonise is to invest in technology whose development is mostly all complete and the market is ready to adopt that technology.

What you should hear underneath that is that we enjoy the luxury of and expect the support of Governments from around the world to invest in such technologies at an earlier stage than we do, meaning at the research stage. I was part of a group that participated in seed funding, via government grants, research at places like MIT, Argonne and Berkeley, and even Cambridge. The idea is to seed those research projects a decade prior to when a venture capital group like ours needs to invest.

Lord Sarfraz: Thank you. Mr Bromley, Legal & General is of course a very important LLP, but what makes you excited about doing directs in this space?

John Bromley: I work in Legal & General Capital, which is the part of the Legal and General group that invests from some of our own balance sheet equity funds. We have been making some investments in private companies in the clean energy space.

As a wider group, we manage a lot of pension funds and capital that is looking for lower-risk, possibly longer-term, stable revenues, so that we can invest at a larger scale. We recognise that there is an opportunity to use some of our own capital to move a little earlier into some of the technologies that are rapidly evolving, and a lot of the system change that is happening at pace in the UK, and help.

That is partly for our own institutional learning and understanding of how these investments are developing and how the technology is emerging, and partly to bring the financial perspective of a larger-scale, longer-term investor. It is also to support those companies and technologies and to explain what and how this could shape up in the future and become more suitable for the sorts of capital that we have at scale.

I will give you two immediate examples of very early-stage research and development investments. One is in solar photovoltaic technology, in a company called Oxford Photovoltaics, and we have a small investment in fusion technology in Tokamak Energy in Oxford.

More recently, we have moved our strategy closer to where I think Jeff was articulating his strategy is, and we have invested in companies at revenue with a proven and good product, but they need support in scaling up. Those companies are in electric vehicle charging infrastructure and in electric heat pumps, particularly using ground source energy. Finally, as you might imagine, we have the typical, more infrastructure-style, investments in onshore wind and solar, and we have also invested in offshore wind.

We are trying to take a view across the energy system, because we appreciate that there is a lot of interaction, and increasingly so, as the energy system, particularly in the UK, is becoming more electrified. That is changing the nature of the investments and the prospects for growth.

The simple summary is that we have investments across a range of that risk spectrum, but we are largely focused on at-revenue and the need to really scale up and hopefully reduce costs, on becoming a wider-use solution and on making those solutions potentially viable and attractive

for our pension fund money in the longer term. That is how we can hopefully bring more scale to some of this sector and some of the technologies that need to be scaled up, and how we can support the government efforts to do that.

Lord Sarfraz: Finally, Ms Gower-Jones, on pre-revenue.

Beverley Gower-Jones: I am a managing partner of the Clean Growth Fund. The fund achieved first close in May 2020 and is currently raising the rest of the capital required to reach the target fund size, which is £100 million. We have secured £20 million of that, so it is now a £60 million fund, and we are well on the way to securing the other £40 million.

I have spent over 15 years working in the UK in low-carbon clean tech, helping technology entrepreneurs to commercialise their technology in a wide number of sectors, understanding the barriers to commercialisation and what it takes for those entrepreneurs to be successful.

In the fund itself, we have invested in two companies to date. One is in flexibility trading, and the other is in electric vehicle infrastructure charging, a vehicle-to-grid company in Malvern, and we are just making an investment in a domestic heating solution at the moment.

We have done a review of the battery storage landscape in the UK. I can tell you that there is a large number of very exciting innovations in battery storage at the moment, and one of the things we are looking at is how we commercialise those.

Lord Sarfraz: Thank you. I am sure we will have an opportunity to hear from Mr Sprinz on his investment strategy later in the session.

Q140 **Lord Kakkar:** I would like to pursue this discussion a little further. To be clear for the committee, what are the key considerations when making investment decisions, and who are making the major investments in the UK at each stage for batteries and fuel cells? Would Mr Chamberlain like to start?

Dr Jeffrey Chamberlain: I am happy to, but I am probably less able than other witnesses to answer the question about the investments inside the UK.

I would start by articulating as best I can, and I hope I am not tangent to your question, the difficulty for venture capitalists like me to invest in this space. Part of the reason why we launched Volta is that we saw venture capital becoming intoxicated by the returns from information technology investments, and not just intoxicated but intoxicated for 20 years. If you are managing someone's money, you cannot say no to investing in an area like information technology where the returns are just so exceptionally good and the scale-up costs of those businesses are, relatively speaking, low.

If you apply the same mentality to investing in physical hard technology, it does not work. So the more direct answer to your question is that, first and foremost—and this is coming from a technologist who is a

technocrat, so it pains me in a way to say this—we bear a fiduciary responsibility to the limited partners who have dedicated their capital to us. So, first and foremost, we must find investable companies and technologies that will generate a return. That is our fiduciary responsibility. In order to find those technologies, we believe that you must have scientists, engineers and financial experts looking at deals at the same time to analyse the likelihood of success of those investments to give a good return.

In short, the answer to your question from the Volta perspective is to carefully pick technology that is ready to be commercialised. In a way, we built ourselves to serve entities, like the clean energy strategy, because we want to filter and help mature, with our \$5 million to \$20 million cheque sizes, the technologies that will then be ready for debt or mezzanine capital for a buildout of plants.

Lord Kakkar: Beverley Gower-Jones, would you like to pursue this, and give a view on whether the UK is attracting sufficient finance for these particular areas: batteries, fuel cells and so on?

Beverley Gower-Jones: Certainly. In terms of major investment, I think the UK Government are investing in innovation through the Faraday Institution and others via Innovate UK.

In terms of pre-seed and seed in the UK, you see investments by angel groups like the Green Angel Syndicate.

Moving on, we have Series A, Series C, the business growth fund, Parkwalk, and of course some of the corporates—Shell, Legal & General and so on.

On the institutional, infrastructure and scale-up side, Gresham House and Gore Street Capital have a portfolio of utility-scale batteries which they install and operate for revenue generation. Downing is just making its second investment, which is a 53 megawatt hour project. Its first was Arsenal Football Club, which was much smaller at 3 megawatts. So I think you see investment across the piece.

Is it enough? I think that was the other question that you asked. Probably not, but I think it is increasing, and based on some of the public valuations that we see there is clearly a lot of demand from the public markets for these types of companies. They are large, but I think we will come on to that question.

Lord Kakkar: We will. Mr Sprinz.

James Sprinz: Same question?

Lord Kakkar: Yes, indeed.

James Sprinz: I will quickly introduce my firm. Energy Impact Partners is a clean-tech venture capital and growth equity firm based in North America and Europe. We invest primarily in Series A and Series B companies. We are backed mostly by energy companies, so most of our capital, most of our investors, are corporates that have a strategic

interest in the energy transition. That influences a lot of the thinking on where we want to focus and who we invest in.

In terms of whether the UK is attracting enough investment in these spaces, I would generally agree with the last answer. On a relative basis, the UK is performing well, but on an absolute basis you could certainly argue that there is more to be done. Within venture capital M&A, I think the UK is pretty consistently within the top three to five markets globally in terms of the number of deals we see each year and the amount of capital that is invested. It is a very, very distant third or fifth place behind the US, which is always the largest market by far; it has orders of magnitude more venture capital within the energy storage space than basically anywhere else. In some years, China comes somewhat closer.

Relative to our peers, I think the UK does quite well across different stages, as was just laid out. Overall, though, the numbers arguably could be more when we consider the general consensus view of how important energy storage will be in the core energy space and in automobiles.

So more can be done, but it is about looking at the earlier stage financing of new technologies and commercialising those. When you look at infrastructure deployment, the UK is certainly one of the largest markets for stationary storage systems. Over 1 gigawatt of stationary storage capacity has been deployed in the UK over the last decade. That is quite a bit more than almost anywhere else in Europe. It is behind China, Korea and the US, but it is very large for a country of the UK's size.

The success of that is due largely to some of the market opportunities that were developed by National Grid, such as the enhanced frequency response products, which it launched, which was an opportunity for energy storage developers to make money in the power market in a way that was very tailored towards the beneficial characteristics that energy storage has. So, overall, I would say that the UK is performing quite well on that front.

Q141 **Lord Kakkar:** Mr Bromley, specifically on the question of battery gigafactories, does more need to be done to attract investment in order for the UK to succeed in its ambitions and needs?

John Bromley: I am not close to the detail on the gigafactory proposals, but I am certainly aware that it is considered that we might need three or four gigafactories to meet the potential demand from OEMs based in the UK.

There is certainly a lot of capital that is looking for what we call ESG—environmentally, socially and, from a governance perspective, robust and well thought through investments. There is a growing appetite and a very clear direction of travel for achieving net zero targets, so there are some really good absolute-headline directions of travel that can bring some conviction to investors.

Specifically on the gigafactories, the challenge I perceive is the scale, where some of the things that we have just been discussing in relation to the different stages of development are sort of packed into one large

investment. As an investor looking at my investment criteria and wanting to invest there, I would be very keen to understand how the supply chain, the research, the development and the engineering and then ultimately the product will fit together in a way that makes a robust outcome and I can have the conviction and confidence that there will be an offtake for that product.

As Jeff alluded to, a lot of the investments in this clean energy storage space require potentially small amounts of higher-risk capital at the intellectual property and technical development stage. Quite often, people might say, "In the lab", but when you go to the fabrication and scale it up for commercial scale production, the capital costs there can be quite substantial.

At a gigafactory scale, those same investments and that same risk profile are scaled up by a magnitude. Significantly larger amounts of capital are required, and it is a quite concentrated investment in that particular supply chain and value point.

I know that government funds are being considered for this space, but investors would want to see very clearly what the nature of that government support is and factor it into an overall business case before considering an investment. There might be different stages in the gigafactory plan to invest in, and different finance might come in at different stages—building out the huge factory and some of the hard equipment and the site. That might start to move towards more asset-backed infrastructure-style finance, because by that time you would hope that the product was well proven, there was high confidence that it could be manufactured in a consistent way and that there were OEM off-takers ready to pay for that product.

The Chair: Thank you very much. It might sound as if you think the investors do not go for investing in big gigafactories because the level of investment required is large. Is that correct?

John Bromley: I could not comment specifically on whether investors will moot it or not, but it does change the decision about how much capital you have available to accept that risk profile.

In absolute terms, if you have all the capital that might be available to you in a fund and you have a limited amount of risk appetite for that capital, the question is how much you would deploy into each investment that you make in order to diversify your risk across different investments. As soon as the scale ramps up, you start to move the risk profile. Even if the profile of the risk of the investment in the Gigafactory was the same as other potential investments, due to size it might well go outside the capability and the scope of many of the funds that are specialist and want to look at this space.

I will certainly let Jeff comment for himself, but I think in his previous response he discussed ticket size and what sorts of scale of investment he wants to make and at what stage. They might need to be larger in the earlier stages of the gigafactory context, so it might not fall squarely into that remit.

Again, I have looked at a high level at this investment opportunity, and we would certainly review it on its merits. That could well be a challenge if it is not carefully structured and thought through.

The Chair: Thank you very much. We might come back to Jeff, but Lord Mitchell has a question first.

Q142 **Lord Mitchell:** Good afternoon. As part of what we are doing in this committee, we want to get a feeling of what is good for the UK and where the UK can succeed. Of course, one of the ways of doing it is finding out where we have failed and where we have not been successful. I would like to ask members of the panel if there are examples of you as investors, or investors that you represent, deciding against investing in batteries and fuel cells in the UK and why this decision was taken. Could we start with you, Mr Sprinz?

James Sprinz: Thank you. There are examples of companies within this space that we have looked at in detail and decided not to invest, but the characteristics for that decision were really down to the individual company and not things that I would generally draw a lesson from to apply to the UK in particular.

At a more general level, when we are looking to make investments in a company at the stage we do, the key dynamics we are looking at are the company's technology, the business model and the team that manages that company. The policy environment and the country within which they are operating are very much secondary to that. We are aiming to invest in businesses that have truly global potential, which is partly why those policy dynamics or the immediate market opportunity within the UK might come as a secondary consideration.

In the examples I am thinking of—it would not be appropriate to disclose the names of the companies—there were issues such as what their near-term commercial pipeline looks like, what the traction is, what we think about the team. In all the cases I am thinking of, the fact that they were in the UK meant that they were further ahead than some comparable examples we had seen in other parts of Europe.

Going back to my response to the first question, I do think the UK is quite a good market for these technologies. It is a supportive enough environment, so the examples I have do not lead to any strong lessons that can be learned for what we can take and improve.

Lord Mitchell: Are we missing out on investments by focusing our support on batteries for transport and not grid-scale batteries or applications for fuel cells? Perhaps you could follow up on that. Sorry to labour you.

James Sprinz: No, that is fine. Transport is clearly going to be the larger market. There is no doubt that the total opportunity for batteries within transport is significantly larger than that within the stationary market. It is important to remember that transport is obviously not just passenger electric vehicles, and I do think there are considerable opportunities within other segments. In maritime, for example, we are seeing a

movement towards electrification of ferries, cruises and so on. That is very early stage, but it is starting to pick up speed faster than people think. Likewise, things like construction vehicles, mining vehicles, other forms of heavy-duty transport.

I would encourage people to think about that broader opportunity rather than just focusing on bigger name and more obvious areas, like the passenger electric vehicle market, because those other segments are areas where they are at an earlier stage and there is a real opportunity for lots of different countries to take the lead, take the initiative and say, "We want to be a market that encourages electrification of those segments", and therefore the companies and capital will follow.

Norway is a good example. It is basically doing that with maritime and it has tight incentives and regulations on electrifying shipping. We are starting to see the market move there, and that is where a lot of the innovation in batteries for maritime is happening. A very similar thing is likely to happen with aviation, because it has similar targets—2030, 2040—so there is an opportunity to pursue that. I would suggest avoiding focusing so narrowly on just passenger transport when there is a much broader opportunity.

Q143 Lord Mitchell: I would like to direct a question to you, Mr Chamberlain. From your experience, how does the UK compare with the US in investment in research, scale-up and mass production?

Dr Jeffrey Chamberlain: Thank you. That is a good and very broad question that has a long answer, and I am glad you sent previews of such question to us. In short, the answer is timing. In the US, the Government started deploying capital or tax dollars into research back in the 1990s, so by the time I started working for the Government in 2006 the numbers had ramped up into the tens and hundreds of millions of dollars.

As a result, those technologies that were seeded back then are now maturing. While I was at Argonne, we licensed NMC to some of the biggest companies in the world. Nickel manganese cobalt oxide is a material that is used in almost every electric vehicle on the planet. So my answer to your question about the difference that I see is timing.

The United Kingdom has just lagged a bit in overall funding into research, but my message to the committee would be that it is not too late. Before I entered the battery industry I worked in the integrated circuit industry, and I see a trend in the battery industry that is very similar to that when I was in college in the 1980s. This is a booming market. Never before has anyone alive seen a transition like the one we are undergoing now. The last one was a transition from whale oil to rock oil. This boom will last for decades, not years. Therefore, it is not too late to ramp up your research dollars, so that five to 10 years from now those research projects are turning into companies. It is already happening in the United Kingdom. Then that follow-on funding can occur.

Lord Mitchell: Do you feel that the Government are doing enough in that direction?

Dr Jeffrey Chamberlain: I do not, but I would also argue that outside China no Governments are doing enough. To accentuate what I just said about it not being too late, we have spoken a lot about what I would consider to be early-stage precommercial investment. John spoke a bit about after that for the gigafactories. I want to partly answer your question and go back to the question asked of John. There is enormous opportunity for investing in gigafactories, but one must first recognise a very important and significant trend that has started to occur only in the last year or two years: the automotive OEMs are quietly taking over the value chain, the supply chain.

Lord Mitchell: Could you just explain what you mean by automotive OEMs?

Dr Jeffrey Chamberlain: Yes. I will start with an anecdote. In 2008, two years after I started at Argonne, I asked executives at General Motors and BMW why they were ceding one of their three most important identities to their suppliers—identities being the design of the vehicle, the brand of the company, and the drive train. Way back then, 10 and 15 years ago, the decision was that OEMs would allow their suppliers to invent and manufacture the key components of the electric vehicle drive train. In retrospect, I believe it was merely because they were not taking electric vehicles seriously. They are now, whether it is Nissan right now deciding to build a gigafactory with its partner, AESC, or whether it is Tesla and Panasonic. General Motors has announced a joint venture with LG Chem. Ford has announced a joint venture with SK Innovation. Volkswagen is working heavily with Northvolt and others.

There are two significant things happening. The OEMs are now beginning to control the supply of their battery cell manufacturing. Other than Tesla, they were not as recently as five years ago. The other significant thing that is happening is that those same OEMs are reaching all the way down into innovation. Whether it is Ford and BMW investing with Volta in Solid Power—we just invested \$130 million in a solid-state battery company in Colorado—or Volkswagen investing hundreds of millions in QuantumScape, it is these two avenues that the OEMs are very deliberately and consciously going down to control who makes their cells for them and to control the innovations underneath the cell manufacturing. Where I believe they are aiming is to drive those innovations to be put into the very gigafactories that they are currently aiming to control via joint ventures.

This is an area in which Governments around the world can help, and the goal, the method, should be supporting the automotive OEMs. Support them in this move, because ultimately what will happen is what has always happened: cars are made where they are used. Well, not always, but significantly cars are made where they are used. If you support the OEMs in the moves they are making now, ultimately the batteries will be made there as well.

Q144 **Lord Sarfraz:** Is it fair to think about this like semiconductors, where you have a need for high-capex fab investing, early-stage investing and different sets of investors needed for each?

Dr Jeffrey Chamberlain: Yes, it is very similar. I admit that I am biased, because that is the industry I came from, but it is very similar. In the 1980s and 1990s, there was a raft of innovation in small companies, and they ended up being bought by the big companies like Intel, TSMC and others.

There is another parallel happening to what I just described. There seems to be a move towards something like a foundry, what I in the US call the European model. The Asian model is that the big battery giants are building plants based on the innovations that they have created. In Europe, it is more like a financial question: build a factory and agnostically fill that factory with those who will make the batteries. It is an excellent model.

ESG was mentioned earlier. One can encourage the OEMs through subsidies as opposed to just grants that are attached to carbon reduction. The other side of the coin of a carbon tax would be to give subsidies to those who can show that they have avoided carbon dioxide emissions. It is an immature idea of ours at Volta, but the idea is that if an automaker can show that it has fewer carbon emissions associated with the building of an electric vehicle, it achieves some subsidy for that. That will encourage onshore manufacturing. Every time you ship materials or batteries from China or elsewhere in Asia, that is a very large amount of CO₂ going into the atmosphere. I just give that as an example of what I mean by encouraging the OEMs to continue to go down the path of controlling their supply chain.

The Chair: Thank you. We will come back if we have time to enlarge on that question later.

Q145 **Baroness Sheehan:** Investor confidence is obviously a key element in investment decisions. I will move on to the role of government in this. What signals do investors need from government in terms of policy, regulations, incentives for investments, or other support for the sector? How does the UK compare to competitors? Could I start with Beverley Gower-Jones and then move on to John Bromley, as he has already spoken about the role of government?

Beverley Gower-Jones: Certainly. There are one or two considerations that could be mentioned here. One is that the Government do not have a formal target for storage, I do not believe, whereas in Europe that may be the case. Setting a formal target of course gives a very strong signal and sense of direction, a bit like net zero by 2050. It is a clear target, which would be helpful.

Storage is currently considered a subset of generation under Ofgem's regulation, so it is not defined as a separate type of asset, which can create difficulties in planning, licensing and so on and requires storage to pay network usage charges when charging and discharging at the grid kind of scale. That could be looked at.

The UK energy-intensive industries qualify for compensation. Energy-intensive industries compensation is what it is called, and it relates specifically to renewables and feed-in tariffs for qualifying sectors—things

like steel, mining, cement and bricks. They have to show that more than 20% of GVA is from energy for three consecutive years. The battery sector is not eligible for that compensation, so it does not qualify. As a previous witness said, incentives and so on might be worth considering.

It is worth realising and appreciating that battery manufacture and the battery supply chain is quite complex. The whole ecosystem is not here in the UK. It exists in China, South Korea and so on. If we are going to build a gigafactory in the UK, we have to have the whole ecosystem. We have to have the innovation, the cells, the battery management system, all the components. As John Bromley mentioned earlier, we have to have someone who is willing to buy the batteries at the end of the chain. It is an energy-intensive sector. When making a cell, the amount of energy involved in drying is enormous, so it has to work and fit together.

On the financing side of things, yes, some of the infrastructure batteries are funded by equity. We saw with wind and solar that if you can bring debt financing into those, the equity money can go much further. At the moment, it is not possible to bring debt financing into batteries, because the revenue stream is not solid enough.

Baroness Sheehan: Thank you very much. Mr Bromley, could you also address how important you think government policies are for signalling support for investment decisions about specific technologies? I would appreciate it if you could keep your answers quite succinct.

John Bromley: I broadly echo what Beverley has said before. They are all really important factors.

The most important is timing. A year or two ago, the direction of travel and the conviction that we would legislate and head to net zero was very helpful. Behind that, we have commitment to the sixth carbon budget, which certainly gives everybody certainty about the scale of the task ahead. You can see the opportunities for technologies within that.

One possible area that we could look at, and this discussion has highlighted it, is the focus on the battery EV solution. We have a specific target, a mandated date by which ICEs will be phased out in the UK. We have some specific numbers for where we would like to get to on electric heat pumps. It is eagerly anticipated in the coming weeks or months in the UK, but if I look towards Europe I can see that there is already a hydrogen strategy. I believe that a number of the EU member states have specific targets on the capacity of electrolysers that they are targeting to be installed by a specific date.

Ultimately, you would want the policy that can come behind that to make sure that the details are there, but we need to start to get a little more granular and clear about how we want to use the different technologies. We do not have to answer every year for the next 20 years, but we do need some direction of travel, because there are still many options out there in terms of system design and how much of which technologies we are going to use. That is difficult for investors to be 100% confident about.

Baroness Sheehan: Do you think that the removal of the industrial

strategy matters, given that its replacement, the plan for growth, is not fully developed?

John Bromley: I could not comment in detail on the industrial strategy or its impact. Going forward, in my view it would be better not to have many different strategies about individual sectors until we have a good, cohesive view of what the overall energy system and outcomes that we are looking for might be. Hydrogen is part of the energy system, and there is a debate about how we are going to use that to decarbonise heavy industry or heavy transport versus the current debate about domestic heating. It can become a little confusing when at the same time we want heat pumps.

In terms of systems, timing and the cost of technology, we might expect electrification to accelerate in the next decade and many more applications of hydrogen and batteries to come through as the costs come down. Having more cohesion and detail about how government intends to support that or seeing some direction in that regard is always helpful, because it gives investors more conviction and confidence to take some of those risks now, and confidence that there will not be a sudden shift or change away from the technology that they might be backing.

Q146 **Baroness Sheehan:** In terms of investor confidence, can you quickly address what role the public Green Investment Bank plays? Do you think that the new UK Infrastructure Bank will be effective? Could you also address the role that you think the British Business Bank could be playing now in doing things and investing in a way that it is not currently doing?

John Bromley: To the first part of your question, before I joined Legal & General I had some experience of working with the Green Investment Bank. At the point at which projects that were more at the infrastructure scale were ready to be built and had project sponsors and equity, the Green Investment Bank was able to help crowd in, support and increase the amount of capital from the debt markets, which was very successful in UK offshore wind development.

As I understand it, the difference in the current plans, ideas and concepts for the UK Infrastructure Bank is that it will be more flexible and will look at both equity and debt, but that it will also provide guarantees to give other investors and private capital more confidence to invest and know that some of that risk is being shared in those projects. That flexibility is helpful. It needs to be careful to crowd in private capital and/or support where that capital is genuinely not available because we have a stage to get past in the technology or there is complexity that makes it more difficult for private investors. That could be an important role for it.

I could not comment in detail on the British Business Bank. To the extent that there are further sources of financing that can come forward and support some of the early-stage commercialisation of the technology, that is always very helpful, and quite often a co-investment proposition with other sources of capital to help to scale a business, a solution or a technology can be very helpful indeed. We have done that working with partners in some of our earlier-stage investments; we have taken

confidence in shared resource to work on some of those earlier-stage investments.

Baroness Sheehan: Thank you. I will put the same questions to Mr Sprinz and then Dr Chamberlain on the whole subject of the Government's role in investing.

James Sprinz: To me, the Government can provide a clear role in creating clear frameworks for the end market and opportunity for these technologies. There are great examples of where it has worked and great examples of where it has not. Providing clear market opportunities where these technologies are still at a stage where there is considerable risk in developing them commercially, knowing what the revenue profile will look like and getting investors comfortable backing them is a really important thing to do.

The hydrogen targets in Europe were mentioned. I lean towards that not being a great example of how that Government should act, because they have these high-level targets for building electrolyzers, but underneath that there is no certainty about where the revenue will come from, how you make money building these electrolyzers, and who will back it. It is a high-level ambition but without anything underneath it.

I would encourage members and the Government to think about what the real business opportunity is if you are investing in that technology today and how you will make money from it. Can something be done to provide guidance and clarity there? Often that comes at the level of Ofgem and the regulatory structures, or National Grid and the market and the rules it creates in things like the energy market, rather than high-level goals 10 or 15 years from now.

Dr Jeffrey Chamberlain: My singular response would be that, as an investor outside the UK, the removal of the industrial strategy signals a decrease in seriousness by the UK Government. It may not be an accurate perception, but it is a perception, and I mean relative to others. Having spent 10 years working for the Government in the US and co-ordinating activities in Europe and Asia, I can say that no one is more serious in their industrial policy and strategies than China. With reference to this worldwide boom in electrification and all the jobs and wealth generation that come with that, we all have to constantly consider that that is our competition. Whether it is accurate or not, that is the first signal that I heard, I felt, when I heard that the industrial strategy was being removed.

The Chair: But the Government would say that building back better is a better strategy.

Dr Jeffrey Chamberlain: It may be. It may be a communications issue. It may not be a policy issue. I do not know. I am just saying that as an outsider that was my first feeling.

Baroness Sheehan: Thank you. That is very interesting.

Q147 **Baroness Brown of Cambridge:** I will take the advantage of being the questioner to follow up on the China comments that we have heard.

Dr Chamberlain and James Sprinz, is there an anxiety that China will do to batteries what it did to solar and manage to undercut everybody and effectively pull the rug out from investments that are currently being made in Europe and the US?

Dr Jeffrey Chamberlain: There is an anxiety with that, yes. However, the counter to that anxiety, which we as a panel here discussed earlier, is continued and increasing investment in research. Creating and garnering intellectual property will prevent the bottom from dropping out on costs. We all need to recognise that every major and minor OEM on the planet right now is trying to catch up with Tesla. That means that there is the need and the opportunity for new innovations to be commercialised. That is first and foremost.

Secondly, as I discussed earlier, localised manufacturing will matter. There are all kinds of policy and incentives that can be put in place to prevent all manufacturing from being in China.

Baroness Brown of Cambridge: James, do you have a view on that?

James Sprinz: Yes, broadly in line with what Dr Chamberlain just said. Taking the example of hydrogen, we have been looking quite closely at a number of companies in the electrolyser space, and there is a lot of great, interesting innovation coming out of Europe. There is just always an overarching concern that China will do exactly what you mentioned with the example of solar. We are already hearing that electrolyser production costs in China are about a fifth of what they are in Europe, and those companies have not yet started to compete here.

I do think that the counterbalance to that is by supporting what the end market and end application will be, so that it makes sense for companies to set up shop and be developing and investing within the UK closer to the actual final customer they will be selling to. Supporting the actual market and then also introducing incentives and potentially regulation on local content requirements and domestic manufacturing could bolster that.

The state of things today is that a lot of companies operating within Europe will say that their advantage over China is quality, but those kinds of things tend to get eroded over time. Ultimately, people often choose to go with the lowest cost rather than quality, which is harder to verify initially. So government really does have to play a role in supporting the local companies through various means.

Q148 **Baroness Brown of Cambridge:** Thank you both for that. Let me move on to what is almost the opposite of that, which is something that Beverley touched on earlier. Do you think that we are seeing something of a bubble developing in the form of some unrealistically high valuations in the battery, electrolyser and fuel cell technology areas? If so, do you think there will be unfortunate negative consequences to this? Is there something that we could therefore be doing about it? Beverley, you highlighted this a little earlier, so let me start with you, please.

Beverley Gower-Jones: In particular, Ceres has a market cap of nearly £2 billion and the electrolyser company ITM has a market cap of €2 billion. In the US and Israel we have seen substantial valuations for QuantumScape and StoreDot at \$7 billion and \$3.5 billion each. These companies have limited revenue and some of their knowledge is relatively immature, which results in other early-stage high-risk companies feeling that they can be valued on a similar basis. That hike in the valuation presents problems, because technology and commercial proof points are lacking for many companies.

Eventually, that collapses, because they then have to raise additional money at a lower valuation, which causes a big down round and seriously impacts founders' equity holding. In worst-case scenarios, we see those founders having to go back to the market without the good news and proof points that they were expecting and finding themselves unable to raise further capital. That then threatens their ability to survive. Some of those innovations are quite promising, but they then fail to come to market.

Baroness Brown of Cambridge: Is there anything we can do about that? Is there anything Governments can do to try to stop it?

Beverley Gower-Jones: I am not sure that there is. I would be interested in the opinions of the other witnesses. It is quite a difficult thing to try to keep a lid on.

Baroness Brown of Cambridge: Thank you. John, is that your experience?

John Bromley: Beverley makes a really important point there. The current valuations possibly have implications for what we would call the entry valuation, if people are making new investments in that space today, and the expectations of those companies.

The discussion is valuable, and I would highlight that quite often in these types of ventures and technology development investors will look for milestones for valuation points in the company's progress, and that becomes an important judgment for deciding whether to follow-on invest and keep putting more money into that business and how you get a feel for its success.

Ultimately, we would be looking at the business case for the ultimate end market scale that we anticipate, what proportion of that market we think this technology or solution can capture, and that would allow us to judge what the current valuation of the company needs to be. If expectations are substantially out of kilter, that could deter us from making an investment even if we were excited about the technology and felt that the other ingredients were there.

Going back to Jeffrey's point right at the outset, we have to make a good return and demonstrate that. That is where it could have some implications. I really could not offer much on how government could do something to intervene in that.

Q149 **The Chair:** Thank you very much. Dr Chamberlain and maybe James

Sprinz, you gave an example of several motor manufacturers now taking a greater part and interest in investing in the commercial production of batteries and even in R&D on newer technologies, if I understood you correctly. You did not mention the UK at all or any motor manufacturer in the UK. Is that because there is none, or was it an oversight? Secondly, what is your intelligence telling you about the new innovations in battery technologies that might come through?

Dr Jeffrey Chamberlain: The answer to the first question is that I consider Ford an automaker in the UK. Ford is very clearly reaching down into its value chain through the recently announced joint venture with SK, as well as tens of millions of dollars being invested into battery start-ups that are still pre-revenue.

I did not mention JLR, but JLR is very active in the space. I do not know that it has made investments yet, but I know that it is circling some of the same technologies that we are at Volta. Likewise with Nissan. Nissan has not invested in the research, as far as I know, but it is following the same path of beginning to control its supply chain. What was the second question, I am sorry?

The Chair: What is your intelligence telling you about the new battery technologies that are at a research and development stage that might come through?

Dr Jeffrey Chamberlain: It is a very important question and, again, what I am about to say mirrors what happens in the semiconductor or integrated circuit industry. There will be a 10 year-plus roadmap of innovation—what is coming next. Everyone on the committee should understand that, at a very high level, the manufacturing methods that are used for lithium-ion batteries were developed in the early 1900s – tape casting. The core technologies for making lithium-ion batteries were invented in the early 1900s. They have been modified and changed, but I start there, because innovations that will take hold because they are low cost will be able to be fitted inside the existing manufacturing processes.

I say that for a couple of reasons. One is that if the United Kingdom Government starts investing in gigafactories for the OEMs, do not worry too much about being obsoleted by new technology, because the manufacturing processes will substantially remain the same. That said, things like a move from graphite at the anode to silicon are bound to happen. Pure silicon can hold seven times as much lithium as graphite can. What will come after that or perhaps during that transition is a transition away from liquid electrolytes to include solid-state electrolytes. That is what you hear about lithium-ion batteries or lithium-metal batteries.

The important answer underneath the question you are asking, and I have heard variations of this during this session today, is that it is not all about the batteries. What is also coming is new embedded sensors that can measure the state of health of a battery, which ultimately will lower the cost of ownership of a battery system. The same thing with recycling technologies: recycling technologies are emerging wherein you can mine cobalt and nickel out of waste batteries and waste materials and

ultimately make less expensive electric vehicles out of that mined material.

I believe that the committee already understands this, but I just want to drive this point home. Innovations that are coming are things that you might consider to be ancillary to the battery itself. New electric motors that will be more efficient and require less of a battery on the vehicle, or an electric motor used in wind turbines to make for a more efficient transfer of energy from the wind into electrical power, are the kinds of innovations that we see coming—wireless fast charge, new materials in batteries, new manufacturing processes, and all the ancillary integration hardware and software around the battery.

Q150 Lord Krebs: I would like to pick up on Dr Chamberlain's very last sentence, in which he referred, *en passant*, to wireless fast charge. As you know, one of the many challenges in this country for the rollout of electric vehicles, according to the Government's plan, is the lack of charging infrastructure. Could you expand in a sentence or two on that concept of wireless fast charge and where we are with it?

Dr Jeffrey Chamberlain: Yes. At last it is being recognised that the ubiquitous fast charging of electric vehicles is a very important bottleneck. If you have a ubiquitous fast charge network, you can make cars with smaller batteries so the cost can go down. The next wave of what is coming in technology for the fast charge is wireless. We have seen three or four start-ups that all have viable technology. We are sorting through the intellectual property landscape right now, not only for consumer vehicles but, perhaps more importantly, for fleet vehicles, whether those are buses or last-mile delivery trucks for UPS or FedEx.

What we see happening is wireless fast charge at the curb for a bus that only stops for two to three minutes but can pull enough energy to go many miles to continue its route and ultimately enable a smaller battery system to be put inside that bus. From a physics perspective, that technology is viable. Even from a cost perspective, we now see that technology becoming viable.

The Chair: Thank you very much to all four witnesses. It has been an excellent session. We have learned a lot and you have been most informative. Thank you, indeed, particularly to those who are in a different time zone. We very much appreciate you taking time to talk to us.