



Science and Technology Committee

Corrected oral evidence: Long-duration energy storage

Tuesday 19 September 2023

11.15 am

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Members present: Baroness Neuberger (The Chair); Lord Borwick; Lord Holmes of Richmond; Baroness Neville-Jones; Baroness Northover; Lord Rees of Ludlow; Lord Sharkey; Viscount Stansgate; Lord Wei.

Evidence Session No. 4

Heard in Public

Questions 31 - 38

Witnesses

Matt Harper, Chief Commercial Officer, Invinity Energy Systems; Jim Isherwood, Study Manager, io consulting; David Surplus OBE, Co-founder, B9 Energy Storage Ltd.

USE OF THE TRANSCRIPT

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

Examination of witnesses

Matt Harper, Jim Isherwood and David Surplus.

Q31 **The Chair:** Welcome to our second lot of witnesses for session 4 in our inquiry into long-duration energy storage. We are hearing from Matt Harper, chief commercial officer at Invinity Energy Systems, who is joining us remotely, Jim Isherwood, study manager at io consulting, and David Surplus, co-founder of B9 Energy Storage. You are all very welcome.

We are going to try to keep this crisp. You heard us before. It is tight because there is a lot to say. I will start and then we will go around the Room. You have each been invited to give evidence because you are recipients of funding from the Government's longer-duration energy storage competition, which funded all sorts of different types of energy storage projects.

I am going to ask each of you to outline the project that was funded, briefly describe the technology it uses and say what your project is intended to accomplish. I am also going to ask you—please just add this in—what the current status of each of these projects is. I will start with Matt Harper, if that is all right.

Matt Harper: Thank you for the opportunity to speak today. My company, Invinity Energy Systems, manufactures vanadium flow batteries. I was pleased to hear in the last session that they are already familiar to many of you, so I will not say too much, other than that vanadium flow batteries are one of the more established and longest-standing forms of longer-duration storage to serve the electric grid.

The project we are developing under the longer-duration energy storage programme is one where we will take a 30 megawatt hour vanadium flow battery manufactured in the UK and deliver it to a site that will be providing regulation and energy-trading services directly on to the electric grid.

The status of that project is that we are in the development phase. We are securing final site permission, final financing and some of the final design considerations that will ultimately see the battery developed and installed. We expect that we will be moving into the manufacturing phase at our facility in Bathgate, just outside Edinburgh, and into the construction phase in the second quarter of next year.

The Chair: Will you keep us up to date on that, please?

Matt Harper: We absolutely will, yes.

Jim Isherwood: We were involved in the StrataStore project, which was an advanced compressed air energy storage project located in Cheshire, utilising some existing salt caverns there.

The ACAES technology essentially takes electricity from the grid and uses it to compress air to a high pressure, which you store in the cavern.

When you want to return the electricity to the grid, you release that air and it turns some turbines and sends electricity back to the grid.

The ACAES technology also stores the heat of compression, which is used in the discharge process, without which you would have to have an external source of heat, such as you would have in a traditional CAES plant such as Huntorf in Germany. That boosts the round-trip efficiency and helps with the overall process.

The competition-funded project was specifically located in the Cheshire area. The objective of the project was to look at de-risking the technology for application in salt caverns. We evaluated at a feed level a pilot-scale plant and at a pre-feed level a grid-scale plant. The pilot-scale facility was 5 megawatts with a six-hour duration; the grid-scale facility was 100 megawatts with an eight-hour duration.

The project was successful in the respect that it was de-risking the technology, so much so that the consortium partners felt we did not need to do the pilot-scale plant and could go straight to grid scale. However, currently the project is on hold due to the lack of a viable commercial pathway for the project.

David Surplus: I am from B9 Energy in Larne, Northern Ireland. Our aim in the longer-duration energy storage competition was to deploy an end-to-end hydrogen economy at a location called Ballylumford, which is close to Larne. It involved the feed study for a 20-megawatt electrolyser using PEM technology, which is able to flex up and down with variable wind input, and a dedicated 100% hydrogen pipeline, which could show how those would actually be deployed.

There is then the Islandmagee Energy salt cavern storage project, which has been in development for about 10 years. They drilled a test well there some years ago. The aim was to use that test well to do the storage of the hydrogen from this pilot-scale development.

Finally, we are going to use the hydrogen in a 20-megawatt open-cycle gas turbine generation module being decommissioned from a North Sea oil and gas platform. The oil industry is interested in knowing whether those end-of-life engines could be used for hydrogen service onshore because hundreds of them are becoming available as the decommissioning programme progresses.

The main reason we were doing this was to balance otherwise curtailed wind farms. Northern Ireland now has both chronic and acute curtailment and constraint of wind farms. That is running on average at about 10% per annum, with a peak so far of 14.8% in 2020. This has caused a loss of revenue, business interruption and an erosion of investor confidence to invest in any more wind farms at the time when the Government want to put another gigawatt into the system. It is a very serious problem. That was our main focus: providing longer duration and balancing electrical loads so we could switch those on rather than switching the wind turbines off.

We also then intended to show how you could do decarbonisation of the power generation sector by switching from natural gas to hydrogen, using

hydrogen blends initially and then full hydrogen in the end. When there is no wind or sun, yet there is still a requirement for power, the large storage volumes in the salt caverns could provide security of supply.

What is our status? The project required us to have a pilot system on the grid by the first quarter of 2025. Unfortunately, the grid connection options at that location were not available until 2026, so we were not compliant with the scheme. Everything else went reasonably well.

We found that the reconditioning of an existing end-of-life gas turbine would not be secure enough to guarantee that it would start every time on the electrical network. It would have to be brought back to a factory, refurbished and brought back. The cost of that was about 80% of buying a new machine. The new machines come hydrogen ready. That was the other status we had.

Q32 Lord Holmes of Richmond: Good morning. What specific niche do you see for your technology in providing longer-duration energy storage for the grid? What advantages does your technology have over other solutions? Over what timescale is your technology most suited to energy storage?

Matt Harper: As we have heard, there is a wide variety of flavours of long-duration storage—anywhere from eight hours up to weeks of energy. We have focused primarily on what we think of as the high-throughput version of longer-duration energy storage, which is primarily shifting energy within a 24-hour period.

Typically in the projects we consider, we are looking to regulate the output from renewables either in regions where you have high generation of solar power or in regions where you have onshore wind, where the peak production periods are typically in the morning or the evening.

We usually look at projects that have a full cycle of up to 15 to 20 hours. The reason we do that is that, where a technology, such as ours, is optimised around being able to do very high cycle counts over its installed life, it is a very good fit for doing that longer-duration that still fits within a 24-hour period and so can cycle every day.

Jim Isherwood: The ACAES technology is probably best deployed in support of the grid at a size where economies of scale would make it most cost effective. That is nominally in the 200 to 500-megawatt range of dispatchable electricity with a six- to 12-hour duration. It can work outside that range with the right market mechanisms and arrangements.

Fundamentally, ACAES would be able to help replace the fossil-fired peaker plants that currently service the grid and help support the rollout of VRE and reduce the baseload fossil plants. In the right market conditions, it would be very competitive in that niche area.

David Surplus: The main thing we are interested in is an application of the load for greater than 10 hours. That is the typical length of a curtailment episode. With hydrogen electrolysis, you can certainly do that. We also have good part-load efficiency, if it is not on full power.

When an anticyclone weather system comes along, where we have light winds for anything up to two weeks, there will be a big demand on thermal power stations to pick up the generation. To be able to have a two-week supply of hydrogen available for the full power system is one of our basic ambitions.

If we ever get to the point of injecting hydrogen into the gas network and using it for heating, the heating season is very volatile. It is very high in the winter and very low in the summer. For that seasonal storage application, the salt caverns are a prerequisite. It may not be as important for transport and power generation, which do not have the same variations, but it complements those.

When you have such very large stores at hand, you can keep the price of energy stable because you know you have all these weeks and months ahead where the supply is definitely there. As we see, fossil prices can be very volatile for all sorts of reasons. A well-founded hydrogen gas storage project should be able to modulate the prices for all those market sectors.

Lord Holmes of Richmond: Briefly, to each of you, what is your sense of when your technology would be able to be deployed at scale to the grid?

Matt Harper: We are already deploying our project at scale today. The Energy Superhub Oxford project was mentioned earlier, which is already helping the city of Oxford with its decarbonisation goals. That project includes a 5-megawatt hour battery of our technology, which has been serving the grid for the last 18 months.

We expect to roll out more projects over time through some of the support and programmes that have already been mentioned, but we are already proving that commercial availability.

Jim Isherwood: The ACAES technology is fully deployable now in other jurisdictions. For example, Hydrostor, our consortium partner, is executing projects in New South Wales, which is a 200-megawatt and 1,600-megawatt hour facility, and California, which is a 500-megawatt and 4,000-megawatt hour facility. These are approaching FID within the next year.

Similar variants of the technology are on stream in China. They have a programme of such plants ongoing. It is ready to go.

David Surplus: In the UK, the cavern storage project at Ballylumford is very similar to the Aldborough project in North Yorkshire. As a pathfinder project, that one is probably going to be the first to come through and demonstrate how this whole solution would work. Ballylumford would follow in behind that project, you would say. Certainly, by the 2035 deadline for decarbonising the electricity sector, we think the full capability should be there.

Q33 **Lord Borwick:** My questions are particularly for Mr Harper on round-trip efficiency and cost stability. I gather that a lot of vanadium comes from China. Where else does vanadium come from? How much would you be

using in your redox systems?

Matt Harper: The answer is a tremendous amount. The reason that a lot of vanadium supply today comes from China is that over 90% of the world's vanadium is used in steel manufacturing—steel rebar and high-strength steel products. Even though vanadium is one of the most common metallic elements in the earth's crust—it is more common than copper or nickel—it is typically processed in steel manufacturing countries as at today.

What we are most excited about is the emergence of secondary or recycled sources of vanadium. There is a tremendous amount of vanadium being concentrated and produced as waste coming out of petrochemical refineries globally. Our goal over the next five years is to be able to exploit those sources so that we are no longer extracting vanadium from mines in new projects and instead making use of those waste materials, which are becoming more and more available all over the world.

I am sorry. You had a couple of questions. Where did you start off? I will pick those up as well.

Lord Borwick: I was asking about the round-trip efficiency of these batteries.

Matt Harper: It is roughly 70%. By the time you bring the energy from the electric grid, through the conversion systems that convert AC back into DC, put that energy into the battery, store it for whatever period and then go through that process in reverse, you get back about 70% of the energy you put in. That is higher than some other longer-duration technologies. It is roughly on par, perhaps slightly lower, with what you see in a conventional lithium-ion battery storage project today.

Lord Borwick: The vanadium in your system is not consumed in any way. It stays there indefinitely for however many cycles.

Matt Harper: That is absolutely true. The vanadium that goes in on day one is the same as what comes out after 25 to 30 years of service. That presents a very interesting opportunity for the very long-term funding of this material. The vanadium in the projects we are developing now is as much as 50% of the total project cost. If you could come up with a scheme whereby that material could be financed over a very long period, potentially in partnership with regulatory agencies and the financiers that are standing beside us in these projects, it would significantly decrease the total cost of the implementation of this technology and speed us towards the net-zero targets that we as a company and this entire group here today are targeting.

Lord Borwick: Is vanadium the only element that can be used in these batteries?

Matt Harper: In our batteries as at today, yes. Vanadium flow as a technology is comparatively mature. It has been around for 20 to 30 years in industrial practice. There are other forms of flow batteries using other metallic or inorganic couples. There is very interesting research

around those other potential technologies, but our view is that those remain a fairly long way from full commercialisation, so we are sticking with vanadium as the most likely technology for now.

Q34 Lord Rees of Ludlow: I would just like to follow up by asking whether you have encountered any unexpected obstacles or barriers in your work up until now, which might affect the scalability and economic commercialisation of this technology. Do you anticipate any further problems? In this context, are there any areas of technical operation or safety where more research will be needed before it can be scaled up?

Matt Harper: First of all, from a safety perspective, one of the good things about our battery is that we do not have the same flammability risks that lithium-ion batteries do. This is a significant advantage. We sometimes joke that our batteries are as likely to put out a fire as start one because of their fundamentally liquid nature.

The thing that has been most surprising to us, as we have gone down the path of commercialisation, is the degree to which interconnections on to the electric grid have been a significant challenge. Our batteries are designed fundamentally to alleviate the congestion constraints, the instabilities in voltage and frequency, and some of the challenges we see cropping up on the electric grid, as we get to a higher percentage of renewable generation.

The fact that interconnection queues have extended in the way they have is somewhat paradoxical. It means we are not able to do the work on the grid that would prevent some of those constraints from happening in the first place.

That has definitely been a challenge. I know there is a very big conversation across the renewables and energy industry about how to alleviate those interconnection constraints. Certainly, any work this committee could do to assist with that, knowing that energy storage can help with a lot of those grid challenges, would be greatly appreciated.

Lord Rees of Ludlow: The link with the grid is a generic problem, you are saying, for most of these technologies.

Matt Harper: The interconnections to the grid are, yes.

David Surplus: Our scale-up scheme would be to start at 20 megawatts and to look at the skills, supply chain, health and safety aspects, and all the other regulatory things that we need to do for project development.

The next step would be 100 megawatts because that is the scale we need to be at, if we are going to dewater the salt caverns during the commissioning phase. We would need to run a 100-megawatt electrolyser on a 40% duty factor for about a year to commission one of the caverns. That is the second step.

The third step is to add an additional 300 megawatts of electrolysis. That would allow us to balance a reasonably sized offshore wind farm deployed in Northern Ireland waters.

That is what we want to do, and do quickly, but what do we do with all the hydrogen? That becomes a problem. With no actual legislation in place at the moment and no regulatory regime that allows us to apply for a licence to inject hydrogen into the gas network, that route to market is not open to us. There is also no obligation on power generators to burn green gases up to some percentage. They will be happy to carry on burning fossil fuels until somebody makes sure that they have to do otherwise.

As those routes to market are not available to us and since road transport is small and slow growing, we have put our attention now to the synthesis of e-methanol for the shipping industry, which has made a big statement recently that it wants to have a lot of green methanol for its vessels. It is backing that up with carbon taxation through emissions trading schemes, both in Europe and in the future in the UK.

We feel that there is going to be a ready-made market there, so we can go to our investors and say, "Here is the price per tonne we're going to get for this hydrogen". We should be able to move more rapidly towards financial close.

Lord Rees of Ludlow: Will the price be an acceptable one?

Matt Harper: Yes. The carbon taxation system will provide what we feel is a level playing field. It is a level playing field that does not exist in the wider world because we do not tax all the carbon that is emitted. Only a minority of emissions are actually taxed.

Jim Isherwood: For ACAES technology, there is no barrier with respect to the supply chain or the technology itself. There is no further development to do there.

One of the challenges we encountered in executing the LODES project was the grid connection. I will echo the comments made by Matt earlier. The grid connection offer for our project was November 2037. Clearly, that does not jibe very well with the aspirations of a decarbonised grid by 2035. We know that National Grid is working on this. We would encourage those reforms to be accelerated.

Notwithstanding that 2037 number, we also found that going down the pre-investment decision pathway, having to go through the DCO route for planning applications and things, would be a long-winded process. It would push our development timeframe to five to seven years before we would be ready to start and take an investment decision.

Of course, the big sticking point for us was the commercial pathway. I am sure we will have a specific question on that later, so I will hold fire.

Q35 **Viscount Stansgate:** This question has been raised, in effect, by some of your answers. How easy will it be to deploy long-duration energy storage, given the nature of the UK's grid infrastructure? Can you talk in a bit more detail about the problems you see with the current grid and the way in which the technologies you are talking about would connect to it?

Matt Harper: The number one issue to be solved is the one we are working to solve sitting here today: the co-ordination of regulation, markets, technologies and ultimately the manufacturing and engineering horsepower that will stand behind these solutions.

These technologies exist. They are reasonably well proven. We know we can go and build the batteries. The question is whether we can deploy them with the regulation and the market-based structures that are going to see the business actually accelerate towards delivering the needed capacity on to the electric grid.

We have been encouraged by some of the developments and potential options—for example, a low-carbon capacity market—for those market-based structures. Around the world, we have seen that the adoption of these technologies takes place only when we get rational and holistic views of how these technologies can be deployed at scale. When those structures get put in place, companies such as ours, alongside others, can go and do the work to install this kind of capacity.

David Surplus: The Northern Ireland grid is the one I am most familiar with, but I believe there are echoes in GB as well. It is not really fit for its present purpose, let alone any future purpose that you might ask it to do. There needs to be an awful amount of money spent to gradually move your way towards something like that. My only fear here is that we have these really good projects that can do all sorts of good things, but, if they have to be connected to the grid in a normal way, that just becomes something that will not allow us to deliver on time.

We would want the ability to have private wire connections from offshore wind farms to large electrolyser installations that allow us to operate the electrolyser on a generation-following mode, so we can guarantee immediately that it is 100% green energy that we are consuming. We would then have a reasonable price point that would be supported by all those various business models that are out there.

To be a good neighbour, though, we would then like to say, at teatime in the evening, when the energy price is really high, that we would switch the electrolyser off and feed that wind power, if it was available at that moment, on to the grid. That would be a good, neighbourly thing to do, but that flexibility in the grid connection is not really allowed in the regulations at the moment. We are forming a group in Northern Ireland now to begin looking at how that would work itself out.

Viscount Stansgate: Do you think it is a regulatory problem rather than a physical problem?

David Surplus: There are regulations and rules for the single electricity market that we have in Northern Ireland, which set out how you have to do things, and that is not allowable today. There needs to be a review and a change of that, and it is an ongoing process for the people who openly know that this is an issue. That is where we are trying to lend a hand.

Jim Isherwood: I can talk to specifics about our grid connection offer in the local area, because that is a good example of some of the wider

issues around the rest of the country. In Cheshire, our grid connection date is 2037 because of reinforcement requirements in that area, which are all scheduled and planned to be done in advance of that connection. This was something that we discussed and tried to understand with the National Grid. Our understanding of the way that it treats energy storage projects, certainly at the scale that we are looking at, is that it has designed the grid to accommodate us dispatching electricity when everybody else is producing electricity, and demanding electricity when everybody else is demanding electricity. Of course, the energy storage facility will be doing the precise opposite. It will be taking out energy when there is too much and putting it in when there is too little.

That holistic view of how the grid will need to operate, in order to take advantage of the fact that energy storage can help de-bottleneck the grid, perhaps defer investments and at least alleviate the constraints that National Grid has in rolling out all its upgrades, has some real benefit, but it requires a holistic view of the system. We understand that National Grid appreciates this and has reforms planned for it, but the quicker, the better, as far as we are concerned.

Q36 **Baroness Northover:** You have answered some of these questions in what you have said already. These projects often involve technologies that are not yet widely deployed. Is there an adequate regulatory framework for deploying these technologies—you have partially answered that—and what more needs to be in place to allow these technologies to scale up? I will add in the point about expertise, technical skill and manufacturing capacity, as well, and whether those are adequate in the UK to scale up these technologies. What should the Government do to support that?

Matt Harper: Those are excellent questions. Our manufacturing facility is in Bathgate, just outside Edinburgh, and we have been very fortunate to pull in a very talented pool of workers, engineers and assembly technicians from the oil and gas industry. That transition from that industry into green jobs has been very beneficial to us.

In terms of the overall capacity of that labour force, we see that there are great capabilities, not only in our factory in Bathgate, but across some of the sites where we are deploying these projects all over the UK.

What more needs to be done to speed the commercialisation? When we look at the projects we are deploying on to the electric grid today, the economic case for these batteries is being built around a market structured for lithium batteries. When we think about the incremental value that is accorded to a longer-duration battery over the one- to two-hour lithium batteries that are currently being installed, there is not an enormous amount of additional value that we can provide, given existing market structures.

We would want to see the evolution of those market structures so that there are incremental benefits to providing longer-duration storage, whether that is through capacity markets or similar mechanisms, but in any case to have a manner in which batteries that provide that longer-

duration capacity can be reliably and reasonably compensated over an extended period throughout their life. That would really accelerate our investment case and our ability to go and build those domestically produced batteries on the grid.

David Surplus: As Dr Armitage mentioned in the previous session, the 40% round-trip efficiency for these hydrogen storage projects is not as good as it might be. That is partly because they are PEM electrolyzers, but mostly because it is gas turbine combustion that you are using at the return end. There has been a lot of research about which devices would better be able to achieve a 70% round-trip efficiency, similar to pumped hydro and some battery schemes.

One promising option is the solid oxide electrolysis cell, which can be a reversible machine and become a solid oxide fuel cell. The important thing here is that you get much better utilisation of the capital plant because it is one machine working in both directions rather than having two machines, but because they run at very high temperatures their efficiencies are right up at the highest of fuel cells and electrolyzers. That is worth spending quite a bit of time and effort on, so that, if it is not yet possible, we can discount it now and then move on.

Jim Isherwood: The ACAES technology relies on equipment that is from a very mature supply chain. The UK's capability would be able to contribute to that, as it would to any process industry-type project. We have the skills and capability to assist in fabrication and manufacturing. During our projects, Hydrostor and others, we have partnered with heat transfer specialists in the UK, so companies that provide these technologies. The UK certainly has the capability and capacity to support these projects on the equipment side, as well as the transferable skills from the oil and gas industry and other process industries that are directly applicable.

In terms of the framework, there are two parts to that question. The first is the operating plant. Again, it is a process industry. The existing safety regimes such as COMAH would apply equally to an ACAES facility and would be appropriate for that.

On the commercial side, it is an important point, which has been made before, that long duration is not short duration. It is different from batteries. The market they operate in is different, as is the value of that market. There is a difference between the medium, the eight to 24 hours, and the 24-plus hours. The way the commercial pathway needs to be developed will be different for those technologies.

One thing to remark with respect to round-trip efficiencies is that these technologies will almost be parasitic on each other. The highest round-trip efficiency gets first go at the market. If we had a business case that was purely arbitrage and trading, we would not be able to act in that market until after the batteries had had their go. That, of course, relies on volatility in the market, whereas energy storage, by its very nature, is there to stabilise the market and reduce volatility. The commercial framework needs to be cognisant that this cannot necessarily be driven by a pure contract for difference approach, where you are giving a

revenue per unit dispatched, because the volume side is a lot more uncertain than it would be on a wind farm, where they have been successfully deployed. Something that takes into account the availability and capacity of the technologies is probably more appropriate for a long-duration type technology.

The Chair: Can I pick up on the question of education and skills, and whether you think that we are up to it as a country yet or whether more needs to happen?

Matt Harper: We are absolutely up for it, both in the UK and over here in Canada, where I am sitting today. We have tremendous capabilities because both countries have been powerhouses in energy for a long time. We need to move quickly. We cannot afford to cede some of these capabilities to offshore, as has happened in the solar industry. We need to build a strong domestic battery industry and, if we are going to get there, we have to move quickly.

The Chair: We have the people who can do it and the skills.

Matt Harper: Yes, absolutely.

The Chair: Mr Isherwood, do you agree?

Jim Isherwood: I am an engineer myself, and I perhaps might like the scarcity of my skillset, but more engineers would be useful to help move these projects forward and do it more quickly.

David Surplus: From our experience working on the FEED study for the Ballylumford project, we found that the engineering disciplines you really need are the electrical power sector, the oil and gas sector, the chemical industry, and, funnily enough, the water industry, because of the way that they package the equipment. The skills are all there and the academic institutions are happy enough that the courses and curriculums can be put together for the people we would need.

For the just transition that we keep on talking about, we need to be reaching out to the people who currently work in those fossil fuel industries and saying to them, "Here's something that's very similar to what you're used to and we value your qualifications". I am sure that, when we go to the market, there will be dozens of them on the inbox.

Q37 **Lord Sharkey:** I have two short questions, the first of which you may have answered already. First, are the current electricity market arrangements sufficient to support scale-up of your technology? Secondly, do you have any views on which subsidies are likely to be most effective in supporting long-duration energy storage at scale?

Matt Harper: To the first question, no, and that is one of the biggest barriers we face: adapting technologies and the markets to come together in a way that drives the kind of flexibility that we know the future grid will need. The potential market architectures under which we can see real progress to net zero using longer-duration storage are many. I am a big fan of capacity schemes that rely exclusively on low-carbon, long-duration solutions, but there are a number of options out there.

Focusing on low-carbon capacity and building structures around that would be my preferred route.

Jim Isherwood: Echoing Matt, in the current market it is a clear no. We cannot make our projects viable in the current situation. In terms of changes to that, our consortium partners would say that carbon pricing would certainly put strong signals in the right direction and helps with all energy transition projects. Specifically, any mechanism based on availability, security of delivery and, therefore, capacity is probably more suited to energy storage than something about unit costs and guaranteeing revenue per unit. A capacity-based system or a regulated market might be the way to go there.

One thing is certain: Hydrostor's other projects that are moving in other parts of the world are using contract for difference type arrangements to make those happen. There are ways to make this happen; it just needs to be tuned suitably for the UK.

David Surplus: Looking at the whole premise of a revenue stack, you have to get revenues from lots of different people at different times for different purposes to make a holistic project work. The electricity sector has ancillary services that we can offer. Capacity market payments can come our way, as well as electricity sales. We do not think that we are likely to change that much, so we have to live with what we can get from that, and then we look to the other support mechanisms, both CapEx and revenue support, that would typically come from the contracts for difference, the hydrogen business model, the new hydrogen storage business model, the net-zero hydrogen fund. Because hydrogen is flexible for use in the transport sector, we can avail of renewable transport fuel obligation payments and things, where a project is eligible for that. Adding them all up, do we get across the line? I hope so, yes.

Baroness Northover: I just wondered whether Mr Isherwood could expand on which countries around the world might have useful models in this regard.

Jim Isherwood: The two most well-progressed projects in Hydrostor's portfolio are in California and in New South Wales, Australia. I forget the particular name of the commercial model they employ, but it is a contract for difference-type approach, as I understand it. Whether it is exactly similar to what has been rolled out in the UK for renewables, I do not rightly know, but I think a modified version of that is what we have had. China is doing these ACAES projects as well. Goodness knows what commercial framework it has applied to make these things happen—other than political will, perhaps.

Baroness Northover: Perhaps you might be able to send us some details about those two, as well as anybody else who has anything to feed in as to what countries or states are doing to try to encourage this, outside China.

The Chair: That would be hugely useful. If you have any material on what other people are doing, that would be great.

Matt Harper: If I could just make one more comment, the one theme you see in every jurisdiction, especially in projects in the United States and some in Australia, is the close coupling of storage with renewable generation where storage is, in effect, a gatekeeper to incremental renewable energy generation on the grid. We have seen that being very effective, where local regulators, for example, in South Australia, where we are just commissioning a project today, have said, "You're welcome to build more solar generation, but it has to have a certain amount of storage associated with it so that it does not add to the congestion and constraints on the electric grid". Close coupling of those two together can be very helpful because it puts the impetus for finding a holistic solution in the developer's hands. We have seen that that close coupling can be very effective.

Q38 **Baroness Neville-Jones:** To me, this is very interesting evidence. The report we will be writing, we hope, will help government shape its policy in long-duration energy storage. I would like to ask each of you, in light of your knowledge of your project and of your particular technology, what you would most want to see government doing to get things moving in your technology and in long-term storage generally. There may be a point you want to make that is relevant to your particular technology, but also, I would hope, to the broader issue of regulation, for instance, really to get things moving in this country.

Matt Harper: There is a unique opportunity in the UK right now. With our company in particular, we span the entire range of what needs to be done to get these technologies deployed, from the supply of materials through to the manufacturing of the batteries through to the deployment of the technologies themselves. At each one of those stages, government can have a significant role in setting the groundwork for where we can go and build those projects, figuratively and literally. We need policies that encourage industrial innovation and manufacturing, that facilitate the connection of these kinds of technologies on to the electric grid in a timescale that is commercially relevant to advancing our businesses, and that reform energy and electricity markets so that we can have the greatest impact for these British-built batteries on the net-zero grid in the future.

Baroness Neville-Jones: You have mentioned, and other witnesses have, too, the whole issue of actually getting your particular technology on to the grid. What is the problem with this? I imagine there will be slightly different answers for each technology, but what is the essential issue about the grid? Is it inadequately powered? Where is the difficulty?

Matt Harper: The difficulty is that the electric grid was constructed around a very centralised model with huge energy facilities. You had a big lever where you would push more power and more fuel into the boilers and get more energy out, and that was how you could control the sufficiency of the supply that was available. We are now in a world where the grid is more decentralised. More of the assets that are coming out of the grid are not available on command. What the grid operators are struggling with is to maintain that same level of absolute low-cost reliable

power in a world where they have less and less control over how those generating assets are operated.

In some ways, that is the remit for storage: how do we build the control back into the electric grid? The problem we need to solve for is how we make sure that we, as technology manufacturers, working alongside the developers who are taking our batteries and installing them on to the grid, can deliver capacity in a way that is incremental to that drive for higher reliability and lower cost. I believe we can do it, but it requires a co-ordinated approach.

David Surplus: There was talk earlier on about repurposing the gas grids because their capacity is very much bigger than the electrical network, and so to utilise that as a way of storing and distributing the energy around a country seems a good idea. Technically, Northern Ireland has a very modern gas network, which needs little or no modification at all for 20% by volume hydrogen. Even when it subsequently goes to 100% hydrogen, it is still okay. That is a low-hanging fruit in being able to solve the problem of the grid by using the gas networks. If there is competition from bio-methane to continue with the gas grid as a methane grid, the parallel hydrogen one should then be built, certainly between the large industrial clusters and for large transport sector use. There is some interest in doing that.

Baroness Neville-Jones: Do you have any other key recommendations that you would like to see us pushing forward?

David Surplus: It is time, effort and money for project definitions. Developers are struggling with a very complicated scenario where you need 10 different things all to fall into place, and you can get nine of them, but what do you do about the other one? It is the organisation of change. The scale and the speed at which we have to do things is way beyond our experience. We are like rabbits staring into headlamps and not able to move forward much. We need assistance. We are an SME-based economy. Most of the people working in these industries are in small businesses. They do not have big resources. We need a lot of money and help to be able to wrestle all this to the ground.

Baroness Neville-Jones: Where should this assistance be coming from? Is this something the Government ought to be doing, being more active and taking an interest in the development of these technologies?

David Surplus: Yes, there are established routes to get these funds through the regional development agencies, the councils and the devolved Administrations. In Northern Ireland we have Invest Northern Ireland, for example. There is a lot of support from the Strategic Investment Board. They are all there as instruments to deliver assistance to the SME base, but I think, in turn, they are not finding they have sufficient funds with which to do it.

We have been looking across the Atlantic to America in recent months as part of the ongoing peace process in Northern Ireland to try to get some activity going, and there is a strong interest from America to invest in projects in Northern Ireland, which is very encouraging. We do have that

dual life now of being in the UK but also still in the single European market, so some of the supply chain players—and we desperately need capacity in the supply chains to build all this equipment out—are looking at Northern Ireland as a good place to set up businesses. A lot of this stuff is very encouraging but, next week and the week after, will we still be sitting here, short of money to actually get up and do something?

Baroness Neville-Jones: So it is an investor issue.

David Surplus: Yes.

Jim Isherwood: As I have mentioned, our technology is deployable and ready to go. The issues on which the Government can help are as we discussed before. The commercial pathways are paramount and once they are in place we think the funding will not be an issue. Certainly, funding is channelled to other projects that have a commercial pathway.

On the grid connection, to follow on from Matt's comments, there is also a tremendous queue of applications, and the sheer number of projects that have applied to get on to the grid has almost overwhelmed the process for National Grid to be able to respond to these in a timely way. Not that I would want to badmouth any projects, but not all of them can be real projects, although they will have to be treated as though they all are.

Thinking about the pace and being able to get these projects going through an investment decision as quickly as possible, we would love to have a single point of contact within the Government who would help us co-ordinate across all the stakeholders, because we touch on various departments, and navigate those issues. Fundamentally, if I had my wish list, we need it really urgently. For us to be able to put ACAES facilities on the grid in time for 2035, next year would be nice to get this sorted out.

Baroness Neville-Jones: I think I have heard this story before in other areas. Is there a scale-up problem?

Jim Isherwood: Not necessarily for our technology, but I think the scale-up problem is the grand problem of needing numerous projects to deliver on a similar timeframe to achieve a target for the 2035 decarbonised grid and then onwards from that. It requires regular projects coming through the pipeline. The pipeline has to be stacked and moving with many different technologies and projects.

Baroness Neville-Jones: Does anybody have any last thoughts on what we ought to be saying to the Government?

Jim Isherwood: My last thought was "urgently, please".

The Chair: I think we have got that.

Baroness Neville-Jones: "Get on with it".

Matt Harper: We have an opportunity on our doorstep for a just transition, for tremendously increased energy security and to build a real British battery success story and an energy storage success story. The path is relatively clear if we can all pull in the right direction.

David Surplus: My last thought would just be about levelling the playing field and having carbon priced appropriately for anyone and everyone who emits it. You cannot really go forward at this stage and have people having free emissions. That is not going to help.

Baroness Neville-Jones: Those were good points, thank you.

The Chair: I thank our witnesses, all three of you. Mr Harper, you must have got up very early this morning if you are in Canada, so we are exceptionally grateful. We are very grateful to the two of you who are here with us. This meeting is now ended. A full transcript has been taken, and you will get the chance to look at it and make any corrections if you wish to. Thank you very much indeed.