



Science and Technology Committee

Corrected oral evidence: Long-duration energy storage

Tuesday 21 November 2023

10.10 am

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Members present: Baroness Brown of Cambridge (The Chair); Lord Borwick; Baroness Neuberger; Baroness Neville-Jones; Baroness Northover; Lord Sharkey; Viscount Stansgate; Lord Wei; Lord Winston.

Evidence Session No. 10

Heard in Public

Questions 83 - 98

Witnesses

Emily Bourne, Director of Energy Systems and Networks, Department for Energy Security and Net Zero (DESNZ); Stef Murphy, Co-Director of Hydrogen and Industrial Carbon Capture, DESNZ; Professor Paul Monks, Chief Scientific Adviser, DESNZ.

USE OF THE TRANSCRIPT

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

Examination of witness

Emily Bourne, Stef Murphy and Professor Paul Monks.

Q83 The Chair: I welcome our witnesses to the committee's 10th evidence session of our inquiry into long-duration energy storage. Today we are hearing from the Department for Energy Security and Net Zero. We are pleased to welcome Emily Bourne, director of energy systems and networks; Professor Paul Monks, the department's chief scientific adviser; and Stefanie Murphy, the co-director of hydrogen and industrial carbon capture. The session is being broadcast parliamentlive.tv and a full transcript will be made available to you shortly after the session for you to make small corrections if necessary.

We have a panel of three and quite a short time, so please keep your answers short. That would be helpful for us to make sure that we get through all the questions. Also, if there is one person who it is appropriate to lead on a question, we would be grateful if the others did not add things unless there were critical points that they felt needed to be made. If there is further evidence that you would like to submit to us after the session—I know that DESNZ has already submitted evidence, but there might be data that you think of that might be helpful to us—we would be delighted to receive that as formal evidence after the session.

We have heard about a range of energy storage technologies appropriate for different durations of storage, and we are interested to know whether DESNZ has a firm idea of the need for these different types of storage by 2035. We have also heard that some of these projects will take time to plan, to get planning permission and to implement, so we are interested to know how confident you are that we will be able to deliver what we need in long-duration energy storage by 2035. Are we on course, and what are the major milestones going to be?

The Committee on Climate Change suggested that the Government could identify some key no-regrets investments. How close are you to deciding on those?

Professor Paul Monks: Thank you for those three questions. I will kick off with the range of storage technologies. Our modelling agrees with that of the CCC, the National Infrastructure Commission and the Royal Society that we will need more interday and interseasonal storage. It will be in the order of terawatt hours to tens of terawatt hours in order to avoid reliance on abated gas to balance the network.

You asked about the specific amount of that long-duration energy storage in the future system. That is very sensitive to assumptions about the future generation mix alongside future demand for energy, particularly electricity—for example, the degree of electrification of heating. That is then balanced by the flex resources, including demand-side reduction, and interconnectors will be part of that system of the future.

We recognise that we will need that storage operating on intraday, interday, interseasonal and potentially interannual timescales. We will do that and put a low-carbon-emission system together at the lowest cost. That is a key feature of long-duration energy storage: we have an absolute need to give the consumer the lowest-cost energy and electricity available.

We will use a wide variety of storage technologies, from shorter-duration technologies such as lithium-ion batteries, flow batteries and the like, through to hydrogen storage, which can provide interannual duration and provide a sustained response when deployed.

The second question was on when those projects will be deployed. One of my colleagues may want to pick that up.

Emily Bourne: Certainly. For electricity storage, we have committed to putting in place an appropriate policy framework by the end of 2024 to enable investment in this long-duration electricity storage. We are talking about storage lasting for four hours plus. That is what we originally consulted on. Since we put that commitment in place, we have looked at the policy options in more detail and at interactions with the energy system as well as what the contribution could be from those different options.

We are planning to set out our proposed policy approach and a detailed consultation around the end of this year. That will then, during 2024, lead into more detailed design and probably further consultation on the detail. So we are proceeding at pace, but we want to get this right. There are a lot of complexities in the design to make sure that it delivers the investment that we need, that any costs are appropriate and that we understand what impact it will have on the system. That is the process over the next year.

Q84 The Chair: Can I push you a bit on that? You have told me that by the end of 2024 we might have got to the end of some consultations. That gives us 10 years until 2035. We have heard that the timescales for these projects can be 10 years plus. Is that not cutting it a bit fine? Should we not be looking at setting off some no-regrets projects now?

Emily Bourne: We very much take your point. We are trying to proceed at pace to develop the support mechanism. Pumped hydro storage, for example, takes about five to seven years to build, so we are looking at getting a mechanism in place as quickly as possible to enable that sort of investment to come forwards.

The Chair: Pumped hydro will not provide the scale of storage that we will need, from the evidence that we have been hearing, although it may make a useful contribution.

Emily Bourne: Certainly, so with this mechanism we are talking about that medium-duration electricity storage. Stef can talk about the hydrogen storage side, which is a longer duration.

Stef Murphy: In the British Energy Security Strategy, we committed to having business models developed for hydrogen storage and

transportation by 2025. We are pushing ahead to meet that timescale. We took powers in the Energy Act, which received Royal Assent recently, to provide the legislative underpinning for those business models. We are working at pace on the next level of the design of the business models, working very closely with industry to ensure that what we develop is ultimately investable and will work. We estimate that purpose-built salt caverns for hydrogen will take five to ten years to develop, and a converted salt cavern could be ready in three to five years, so with business models ready to be allocated from 2025, that suggests that it is certainly possible to have hydrogen storage up and running by 2030, and even more so by 2035.

The Chair: Does that include the planning process? Our other witnesses have not been so optimistic about that.

Stef Murphy: That is certainly what we understand to be the case. The more advanced projects will obviously be well under way. We have talked to a number of projects that are already having those conversations about planning, so they are not waiting until 2025 to begin those discussions and submit TCPA or development consent.

The Chair: Even though they do not know what the funding arrangements will be?

Stef Murphy: We are working closely with the industry as we develop the funding arrangements. It is not quite co-creation, but it is close. It gives them the confidence to continue to develop their proposals in parallel to know that what is being developed is moving in the right direction. That is the nature of the conversations that we are having with industry at the moment.

The Chair: Should we have a Government who are committing to decarbonising the energy system by 2030, could you pull forward these plans?

Stef Murphy: We would have to take that away to consider. Certainly, if you are talking about converted salt caverns taking three to five years, with business model allocation available from 2025, that suggests that something is possible within that timeframe, but we would have to look at the detailed proposals.

Q85 **Baroness Neville-Jones:** I will take the question of the key decisions that have to be taken to get to the stage where we can take sensible decisions about the different types of storage that we need and how they could be supported. Nick Winser and others have recommended the creation of a strategic spatial energy plan. What is the department doing about this at the moment? Who will be responsible for creating such a plan, if that is your idea? Perhaps you could say something about the role of the future systems operator, compared with the department and Ofgem.

Emily Bourne: I am happy to speak to that. As the Prime Minister announced in September, the Government have committed to bringing forward a spatial plan for energy. We are working closely with the

electricity system operator, which will become the future system operator in due course, with Ofgem and with industry, to develop the options for how that plan will be produced. That includes the responsibilities for who would bring that forward.

We are planning to set out more information on this as part of the response to Nick Winser's report on transmission acceleration, which will be published in the coming days. That will contain a little more information about how we see that plan being developed and the roles and responsibilities within it. Obviously, we need to work closely with other government departments, and we have been, to look at alternative spatial considerations such as fishing and shipping. We are also engaging with the Devolved Administrations, given that planning is devolved in different parts of the country.

We anticipate that this will be produced through close working between ourselves and the future system operator, but, as I say, we will be setting out more on that as part of the response to Nick's report.

Baroness Neville-Jones: What is your timescale for producing that?

Emily Bourne: That, again, will be part of the response to Nick Winser's report. We have said that we will be developing a plan. We have not set out the timescales, but we will do so very shortly.

Baroness Neville-Jones: Does shortly mean before the end of the year?

Emily Bourne: As I say, we will be publishing that response in the coming days.

Baroness Neville-Jones: When and how can people take decisions on that basis? You may detect that the committee is worried about timescales in all of this and having sufficient public information in place so that investors and others can really act.

Emily Bourne: As I say, within the coming days, we will set out more information on that spatial plan and timescales going forward. The information is coming. We are conscious that there is a lot of interest. We have had a lot of engagement with industry and other stakeholders who are interested in how we take that forward. We want to communicate quickly.

Baroness Neville-Jones: When you say that you are setting out the plan, what level of detail are you thinking of?

Emily Bourne: In the publication coming out soon we want to set out more detail on roles, responsibilities and timescales going forward, and a bit more sense of the scope of the plan.

Baroness Neville-Jones: Perhaps we can explore that a bit further. Do you feel that, when you have set out the next stage of information, people will have a feel for the shape and the nature of the plan?

Emily Bourne: Our aim over the next stage is to work with stakeholders to get that information in place, but it is difficult when we have the information coming out very shortly. Off the back of that we hope that we can have those conversations and people will have comfort on the detail.

Professor Paul Monks: There is a lot out there already. If you look to the ESO, the Holistic Network Design is already out there, showing the broad shape of the future energy system. It looks at the delivery of a future electricity system in particular and the onshore and offshore elements of it. The HND is out there, it has been published, and the electricity system operator is looking to deliver that. This then overlays that spatial pattern with the HND and looks at the interactions around that and challenges it. I would not like you to leave with the idea that suddenly the slate is clean. You can look to the Holistic Network Design and say that we have that out there at the moment as a firm consultation and plan.

Baroness Neville-Jones: You have created such a plan, but people need a level of certainty. We have to move from the world of options to some real decisions. One of the anxieties is how quickly the shape of government policy will be definitively stated so that you can start to get action from the private sector and the regulation of everybody.

Emily Bourne: That is the reason for taking forward a spatial plan—to give that level of certainty, which does not exist at the moment. That is the rationale for taking it forward, but obviously we need to get the process in place to do that.

Baroness Neville-Jones: Obviously what will come out relatively shortly is an important stage forward.

Emily Bourne: It is, yes.

Baroness Neville-Jones: That is good to hear. You have created such a plan, so how do you envisage getting all the actors in the system to follow it and act accordingly? What is your next stage of building on?

Emily Bourne: Again, we will take that forward more in the next stage. But we are very conscious that it is industry that will be delivering all this investment, so we need to closely involve industry and other stakeholders, such as investors, in the development of the plan in order to make sure that what we develop works for them. Again, this is part of the consideration, but we are working with Ofgem, the system operator and other government departments to design that process.

Q86 **The Chair:** Can I press you on something? You have talked about the fact that there are all sorts of outline plans already in place, so it is not as if there is nothing. Does that not put it into a position where you could give us a clear idea of the minimum level of storage—the no-regrets level, kind of—that we really should kick off now?

Emily Bourne: As part of the consideration on the electricity side in the development of the support for long-duration electricity storage, that is one of the questions we will consider. But, at the moment, we do not have a “this is the no regrets” level. There are various estimates. As Paul said, we know that we will need all sorts of types of storage, so having the mechanisms to bring that forward is the important focus.

Professor Paul Monks: The hydrogen area—Stef can comment on this in more detail—is where we will move quite quickly. That is to support

not just long-duration energy storage but all the other uses of hydrogen that go with it. So, in a sense, the storage that we will require will come partly through that. I will hand over to Stef, because this is more her area of detail than mine. I think the answer to your question lies in that.

Stef Murphy: We announced in our hydrogen transport and storage infrastructure government response in August that we will publish a transport and storage networks pathway—hopefully shortly. This will set out our approach to enabling the build out of transport and storage infrastructure for hydrogen—as Paul said, to support the broader hydrogen economy and all the benefits that it can bring. The pathway will also help to identify and prioritise early strategically important transport and storage projects and inform the first allocation round of those transport and storage business models. That document, which hopefully will come out soon, will give a bit more information on how we intend to move towards and start to think about what strategically important options for hydrogen transport and storage infrastructure might look like.

The Chair: I am going to sound a bit rude here, but is this a normal person's "soon" or a government "soon"? We know that a government summer sometimes extends to November. Does "soon" extend into next year, or does it mean "before Christmas"?

Stef Murphy: I obviously cannot give you a definitive timeframe, but my best guess is that it is around the end of the year.

Lord Winston: This year or next year?

Stef Murphy: We will have to see. It is subject to all the usual grid processes.

Professor Paul Monks: I think he said, "This year or next year?"

Stef Murphy: Oh. Around the end of this year; I thought you meant "before or after Christmas?" That is not within my control at the moment, unfortunately.

The Chair: Well, good luck.

Stef Murphy: Thank you.

Q87 **Lord Sharkey:** My question is about hydrogen. It has five parts, so brief answers would be enormously appreciated. The Government recently doubled their 2030 target for green hydrogen production, I believe. Are the current policy measures sufficient to meet that target? Perhaps, Stef, you might like to answer that.

Stef Murphy: Sure. We think that 10 gigawatts is both stretching and credible for the UK. It would position us in the leading pack internationally and would enable us to support and develop our burgeoning hydrogen economy, which we think could support 12,000 jobs and up to £11 billion of private investment in the UK by 2030. We have seen the impact that setting a clear ambition can have when combined with a supportive policy framework; for example, we have seen the impact of that on renewables technology in the UK. That is why we think that setting that headline is really important.

The UK Hydrogen Strategy, which we published in August 2021, outlines a comprehensive road map for the development of a hydrogen economy during the 2020s to help us deliver that 2030 ambition. Obviously, when we published that hydrogen strategy, our ambition was 5 gigawatts, not 10. But we have since published regular updates to the market, providing detail on our policies, the policy framework and the regulatory interventions that we are making to help us deliver that 10 gigawatts.

Q88 Lord Sharkey: Do you think we need more clarity around the role that hydrogen will play in the entire energy system in future—how it will be used and in what quantities? In particular, what volume of green hydrogen do you see being produced in the UK in 2030?

Stef Murphy: Our approach is to promote every aspect of the hydrogen economy—production, demand, networks, storage, markets and regulation—to give industry maximum certainty about the UK Government’s support offer and to drive investment. It is really about getting hydrogen produced, ready to be used and in a position to be moved around.

In the British Energy Security Strategy, as you said, we doubled our ambition to 10 gigawatts, subject to affordability and value for money. We said that at least half of that will come from electrolytic hydrogen, drawing on the scale-up of UK offshore wind, other renewables and new nuclear. We do think it is important, though, to have cost-effective scale-up to promote a range of production technologies. We are supporting both CCUS-enabled (blue) and electrolytic (green) hydrogen production through the different competitions and programmes that we have in place. We think it is important to support security of supply and energy independence.

We hope to complete our first hydrogen electrolytic allocation round very soon. We will open the second round at the same time. We have previously committed to moving after that to annual allocation rounds to make sure that there is a very visible line of sight for industry of the opportunity to bring forward projects for production. We see that as our path to scaling up production for a range of end-uses, be it industry, power, transport or, potentially, heat.

Finally, we will publish our hydrogen production delivery road map—hopefully, again, around the end of the year—which will give a bit more information on what we think the pathway to 10 gigawatts by 2030 looks like.

Q89 Lord Sharkey: I want to follow that up by talking a little about production, and electrolyzers in particular. Given the global competition for hydrogen-producing technology, are you satisfied that we will be able to procure enough electrolyzers in time to meet the requirements of the plan? Is there any potential for UK industry to take a lead in the innovation and development of electrolyzers?

Stef Murphy: We are aware that developers are facing scheduling difficulties caused by lead times for electrolyzers and some other key

equipment, and we are working with industry on that issue. We are clear that there is the potential for the UK to take advantage of the growth of the hydrogen economy both in the UK and globally, seizing on opportunities presented by the UK's geology, geography and infrastructure expertise. Maximising the economic opportunities to the UK was a key flank of the hydrogen strategy, and we published a bit more detail on that in the sector development action plan last summer. Again, it came up in the report by our hydrogen champion, Jane Toogood, earlier this year.

We are working with Hydrogen UK at the moment to develop a supply chain strategy for hydrogen. That could include identifying where the UK's strengths are and where we could look to scale up so that UK companies can maximise the benefit from this hydrogen supply chain, which is growing. It could also include industry-led voluntary commitments to UK content in hydrogen supply chains.

I should note that, on Friday, the Government announced £4.5 billion of support for strategic manufacturing sectors, including £960 million earmarked for clean energy. That is part of the wider government support to ensure that the UK is the best place to start to grow and invest in manufacturing.

Professor Paul Monks: I will add one thing. You asked about the innovation pieces. We funded through the Net Zero Innovation Portfolio, which is worth over £1 billion, a long-duration energy storage demonstration programme, where we spent £69 million across two competition streams. Stream 1 was a sort of feed that is the front-end engineering design, and then a scale-up and down-selection among the bigger technologies as well. So we are doing the innovation piece across a range of storage technologies to deliver that and to make sure that it is ready for market.

Secondly, on the question of availability of minerals for electrolyzers, for example, we have a Critical Minerals Strategy that we launched as BEIS in 2021. We are just finishing an analysis of the Task and Finish Group with industry to look at the surety of our supply chains, and electrolyser supplies are part of that work to look at the availability of things like iridium-vanadium and so on.

Q90 **Lord Sharkey:** I turn to salt caverns. Do you see value in the Government commissioning the development of an initial set of salt caverns for hydrogen storage, as the Royal Society recommended, in order to de-risk the new technology, given that we seem to have cornered the world market in salt caverns?

Stef Murphy: With the Government playing the role of interim strategic planner for hydrogen storage infrastructure, we are keen to identify hydrogen storage projects that will provide the most strategic value to the hydrogen economy in the near term and in future. Again, more detail on this is coming in our transport and storage networks pathway, but I can say that salt caverns will likely play an important role in hydrogen storage. They are considered to be the most technologically mature form

of hydrogen storage out of the geological storage options. As a result, they are one of the types of storage that we propose to be eligible for support under our hydrogen storage business model that we set out in our minded-to position in the summer.

Lord Sharkey: Do we not need to get on with this, given what we know about the technology, about salt caverns and about what lies underneath Cheshire? Can we not simply get on with it?

Stef Murphy: We have moved at pace to develop these business models. Industry is telling us that it faces demand risk. It has demand uncertainty as this is a nascent industry. That is what the business models are trying to fix, alongside the large capital outlay for developing these stores.

We think that the best approach is to push hard to get those business models ready for allocation in 2025. As I say, we will be publishing more information in the T&S networks pathway, which will give more of a sense of what we think a set of early projects might look like so that we can work with developers in order that they are ready to submit applications as soon as the business models are ready to receive them.

Lord Sharkey: Does that extend to Rough? Centrica has told us that it is investigating repurposing Rough for hydrogen. Are the Government going to do anything special to support that?

Stef Murphy: We have been meeting regularly with hydrogen storage project developers as we have consulted on the design of the business models to make sure that those models are ultimately investable, and Centrica is certainly one of the key stakeholders that we have been talking to.

As I said, geological storage projects will be eligible for support under the hydrogen storage business model, but the technology readiness of depleted gas fields will need some improvement before they can be used commercially for hydrogen storage. We are considering how the Government can support the innovation required to raise the technology levels so that depleted gas fields can be used alongside salt caverns for hydrogen storage.

Lord Sharkey: I get the strong impression that there is a lot of considering going on at pace, but we do not have much time. Is there not a strong argument for saying that we ought to try to move faster than we are currently doing to at least de-risk salt cavern technology for future development?

Stef Murphy: We have laid out what we think is an ambitious programme to move quickly to be ready, as I said, to allocate business models for projects. It is also true that, under our hydrogen production business model, projects can bid to have small-scale storage projects included as part of production facilities, so that early projects that require smaller amounts of storage can get moving quicker. As I mentioned, we will be announcing the result of the first of those electrolytic allocation rounds fairly shortly and launching the second round. So there are opportunities for smaller-scale storage projects to get going more quickly, while the larger ones are developing in parallel with us being

ready to allocate business models to move forward at scale as quickly as possible.

The Chair: You have talked about 10 gigawatts of hydrogen production capacity, potentially half of that being electrolytic—many gigawatts from electrolyzers, which means a lot of electrolyzers—but how much hydrogen are you envisaging? The energy is not the gigawatts, it is the terawatt hours.

Professor Paul Monks: 10 gigawatts is 66 terawatt hours. From memory, that is a mixture of 60% green and 40% blue. That is what I remember.

The Chair: What about the assumptions about how long the electrolyzers will be running for, and things like that?

Professor Paul Monks: You get to this question with storage. The question is about the size of storage, and how fast you fill that storage versus how fast you empty it. You can have a small storage that you fill very often versus a large storage that you fill for much longer. On the question of how many terawatt hours that is, it is a balance. It is a steady-state equation of some variety— dx/dt .

The Chair: So 56 terawatt hours.

Professor Paul Monks: It is 66 terawatt hours, and from memory that was a 60% green-40% blue mixture of 10 gigawatts in 2030, approximately speaking.

Stef Murphy: You are right that load factors play an important role, and different uses will have different load factors according to the use case. We might expect that blue hydrogen production runs at a higher load factor than green, for example, so there are lots of variables within those calculations.

Q91 **Viscount Stansgate:** You recently set out the minded-to position for the business model for hydrogen storage and transport, which includes a revenue floor. Could you set out what that said and the thinking that went into it?

Stef Murphy: Of course. As I have said, we have consulted industry extensively to understand the key barriers to investment in hydrogen storage. Based on those discussions and the responses to the consultation that we held last year, we have had a very clear signal that the key market barrier is uncertain demand, which, when combined with the higher capital costs and lengthy deployment lead times, results in an uncertain financial investment return to storage providers in a very nascent hydrogen market.

We have reviewed all options for a commercial business model against that factor and discounted those that we do not believe will sufficiently reduce demand risk, such as contracts for difference and energy subsidies. Our minded-to position is intended to provide investors with the long-term revenue certainty needed to establish and scale up the deployment of hydrogen infrastructure.

Viscount Stansgate: Does that mean we can expect a similar business model to be set out for long-duration energy storage?

Emily Bourne: Electricity storage?

Viscount Stansgate: Energy storage. Can you give us an update on the business case for long-duration energy storage by 2024, which is a pledge that has been made?

Emily Bourne: Certainly. As I covered in the first question, we are bringing out our minded-to position on the support mechanism for long-duration electricity storage around the end of this year, with a consultation on the detail. As part of our earlier consultation on options, one option that was considered was the cap and floor model. That was considered by the consultation respondents to be the most favoured model. Obviously, we are considering those different options with Ministers at the moment, so, as I say, we will come out with something around the end of the year.

Q92 **Viscount Stansgate:** Okay. How important is it, in your view, that the business model supports a wide range of long-duration energy storage technologies and across a range of durations?

Emily Bourne: This is one of the considerations that we are looking at in deciding which model to come forward with and, particularly, what eligibility requirements we might have. The earlier consultation looked at anything over four hours duration and 100 megawatts of capacity. We are looking at eligibility as part of that, but yes, we would want to look at a range of different technologies with different durations.

Q93 **Viscount Stansgate:** Finally, do you have a sense of the scale of the funding that can be put into these business models to support the growth of these technologies, and will it be akin to that spent on offshore wind?

Emily Bourne: It is quite hard to talk about scale of funding absent the model design and questions on scope, eligibility and so on. That will be part of the considerations at the next stage. We know that there is a reasonably limited number of projects that might come forward under a long-duration electricity storage model. That limits how much you might see, but it will be part of the next stage to get a sense of that.

Viscount Stansgate: I am tempted to say that, listening to a lot of the questions and answers, you are appearing before us at not quite the right time.

Emily Bourne: Our Minister has been asked to appear at a later date, so that might be an option.

Baroness Northover: I wondered, listening to your answers, whether you had got to the stage of the Ministerial write-round. Is that what you are waiting for?

Stef Murphy: For us, we are heading towards that position.

Baroness Northover: So you have not yet put it into the Ministerial write-round.

Stef Murphy: It is something that we are discussing with our Ministers at the moment.

Emily Bourne: We are in the same position.

Q94 **Lord Borwick:** How does a subsidy regime with a floor ensure security of supply when the economic incentive for the storage operator is to flog the energy as soon as it gets over the floor? Will they not do that so that when it is actually needed, it is empty?

Stef Murphy: It is certainly true that the hydrogen storage business model has a floor and then a sales incentive to encourage the storage provider to maximise sales to reduce the amount of subsidy that is paid. The hydrogen storage business model is built that way, because that is what it will take to get this infrastructure built at the scale that is needed to support the hydrogen economy because of the demand risk and the high upfront costs.

The hydrogen storage business model is developed agnostic of the end use. It is about being able to store hydrogen for whatever use. If, ultimately, it is decided that there is a need for some kind of strategic reserve for security of supply reasons, it is certainly possible to layer other incentives or measures on to the hydrogen storage business model to deliver that outcome. However, in the first instance, the hydrogen storage business model is all about getting storage built, getting the infrastructure built, so that we have the capability to store hydrogen.

Lord Borwick: But you can predict with complete accuracy that you will need the second phase, the change, before this is working. Is that right?

Stef Murphy: We are certainly looking at what additional measures you would need to add to the hydrogen storage business model to use it in that way, because, as you said, the storage business model as currently conceived is there to support the hydrogen economy, which is to incentivise storing hydrogen and then selling it on for different purposes. That other potential use of the hydrogen storage is something that we are looking at.

Lord Borwick: When will we finish looking at this second phase, because I imagine that, as an investor, you would want to find that out before you invest?

Stef Murphy: That is tied in with broader discussions about the picture on long-term energy security.

Professor Paul Monks: This comes back to a slight contradiction that is coming up here. In a way, this is about building that capacity at speed. As Stef said, we are agnostic about what it would be used for, but we know that we will need it. That supports what you are pushing, that will we have enough hydrogen storage capacity to meet long-duration energy storage among the other different uses that we have.

Our answer is that this mechanism will allow us to build at speed that capacity. We can then layer business models above that to drive market conditions to make business models for long duration. It comes back to

the earlier point about whether we are moving fast enough in the build of this. Yes, we are, because this allows us to get that build and capacity moving quickly into the market.

Lord Borwick: That seems tremendously sensible but doomed the moment that it is finished, because the moment someone has filled it up, they will flog the hydrogen if the price goes up above the floor. Will you not constantly have to raise the floor to stop people selling as the price goes up?

Stef Murphy: Hydrogen storage is obviously a potential candidate for strategic energy reserves. There are other options available as well. The current business model is not designed to deliver hydrogen strategic storage reserves specifically. It is agnostic. If a decision is taken that we want to use hydrogen storage in that way, we will have to look at other amendments and changes that we would need to make to the hydrogen storage business model for future contracts that we would make for having hydrogen storage as a strategic reserve. It is not currently designed to do that, but we think that the mechanism could be adapted to do that in future if a decision is taken that we want hydrogen to play that role.

Lord Borwick: How often would you expect the floor level to be altered?

Stef Murphy: We are still working through the detail of that. My expectation is that the floor would be set in a private law contract that would last at least 15 years. That is the design of the model. That would be the floor that is set for the duration of those contracts, but we are still finalising this.

Lord Borwick: I understand that you cannot be absolute; it is just a matter of getting the architecture right. But no one has been able to predict energy prices over a 15-year period in the past. The price of oil has belted up and down over a 15-year period. Would it be easier to predict a floor for 15 years in hydrogen?

Stef Murphy: The floor is there to make sure that the storage provider can cover their costs. That is much more predictable.

Lord Borwick: Yes, the cost of producing it is fairly predictable.

Stef Murphy: The floor is there to make the cost of providing the storage effectively an economic prospect for them to build these facilities at a time when they have a high degree of uncertainty about the demand for people to use them—rather than trying to predict the future price of hydrogen, since at the moment there is no market price for hydrogen.

Lord Borwick: I understand.

The Chair: You say that a decision has not been taken yet on whether hydrogen might be an option for strategic energy storage. Do you have any sense of when a decision might be taken? What alternatives are being looked at, and do they include unabated natural gas?

Emily Bourne: This was covered in the review of electricity market arrangements consultation. Again, this is the second REMA consultation,

and we expect the forthcoming documents around the end of this year. That was one of its options, but I am afraid I do not have further information on what options they looked at. We can provide more information on that.

Professor Paul Monks: If you are asking whether there would be any unabated gas in the system in future, I can point you to one of the CCC's models.

The Chair: That was not the question. The question was: when might we get a decision about whether hydrogen will be used for long-term energy storage? Also, if other options being considered alongside hydrogen for energy storage in the very long term, do they include unabated gas?

Professor Paul Monks: On the second question, they have to include unabated gas, because, at the end of the day, we have to look at providing the cheapest energy system that we can. We might want to use very small amounts of unabated gas, which would not change our CO₂ emissions, as part of a peaking load sort of solution. The CCC put that in its March report as an option. You are going to talk to it next, so I suppose you can ask about that in detail.

The Chair: So the answer to my question about the options including unabated gas is yes?

Professor Paul Monks: Yes.

The Chair: I then asked about the timing of such a decision on long-term storage.

Emily Bourne: The second REMA consultation, which will be published later this year, will contain at least some further information on that.

The Chair: What does "further information" mean? What sort of thing will it tell us?

Emily Bourne: We will have to get back to you on the detail of that, but it will come in the next consultation.

The Chair: It would be helpful if you could. Lord Sharkey, do you want to come in quickly?

Lord Sharkey: Lord Borwick raised the points that I was going to make.

The Chair: Excellent.

Lord Winston: Paul, you talk about the speed of this a bit casually, it seems. Given that the development of caverns is quite complicated when you consider connections, safety, security and so on, are you sure that this can be done relatively quickly, as you suggest?

Professor Paul Monks: There are two parts to that question when you look at the innovation required. One is the repurposing of salt caverns that have already been used for gas storage, where we are more confident that the engineering is there. Undoubtedly, what you say about that is true. We are waiting for the Health and Safety Executive to provide further information, particularly on the safe handling of hydrogen at scale, which, of course, will drive many of the cost decisions here.

We are not starting from zero here. Hydrogen is regularly used in industry. Actually, using hydrogen outdoors in industry is a relatively well understood safety issue. There are different safety issues around using hydrogen indoors, which is subject to other considerations. My summary of that is that we can repurpose caverns relatively quickly. Moving that mid-term from 5 to 10 years for caverns that have not been previously used seems a reasonable timescale for the delivery of that.

- Q95 **Lord Winston:** I will come back to the question that I wanted to ask. The evidence that we have heard from developers of storage suggests that the full value of asset storage in terms of what it does for the grid, such as protecting grid stability and reducing curtailment, may not be fully and appropriately costed when these assets are considered. Are there plans, therefore, to consider changing the incentivisation regime to assist with this—for example, as part of the review of electricity market arrangements? Perhaps you, Emily, could tell me.

Emily Bourne: Certainly. This is part of the considerations that the review of electricity market arrangements consultation has been looking at. It has asked whether reform of the wholesale electricity market, the balancing mechanism or the ancillary services might be needed to help bring forward different types of low-carbon flexibility. Some of the things it has been looking at include locational signals such as locational marginal pricing, and temporal signals such as changes to the length of settlement periods or the gate closure time. It is about whether those sorts of changes to the market might help to give better incentives for low-carbon flexibility to participate in those markets. Again, the next steps here will be part of the forthcoming REMA publication later this year. Originally, it consulted on a wide range of options. The aim is to try to narrow that down.

- Q96 **Baroness Neuberger:** We have touched on planning issues a bit, but storage developers have regularly cited issues in the planning system and grid connection regime as barriers that prevent their projects getting off the ground. Are specific reforms being considered to fix this? Is this also part of what we might hear at the end of the year?

Emily Bourne: Both planning and grid connections are huge issues for government at the moment. On both of them, we hope that we will be able to give more information very shortly.

Baroness Neuberger: I have a feeling that will you need to come back.

Emily Bourne: On planning, we have been revising the energy national policy statements, which set out the policy framework for planning. We will shortly publish those revised documents and lay them in Parliament ahead of designation. This weekend, the Chancellor spoke about further changes to planning in order to speed up consent for all types of infrastructure. We expect that to be set out in more detail soon.

On the grid connection side, there has been an enormous amount of work among industry and Ofgem on trying to speed up a system that, in effect, will not be fit for purpose for the scale and pace of electrification going

forward. We have already seen industry take actions to reduce the connection timescales between, on average, 2 to 10 years for the majority of transmission connected projects. The Prime Minister has also announced that we will move from the current "first come, first served" approach, where you end up with projects getting backed up in the queue behind less viable projects, to a "first ready, first connect" position, where the project that is ready can connect ahead of those projects that are not meeting their timescales. With that in mind, Ofgem published its code modification decision last week. It will allow the system operator to insert milestones in connection agreements and, in effect, pull a project back if those milestones are not being met.

There is a lot going on. We know that more is needed. We and Ofgem will publish a connections action plan in the coming days that will set out more of what we will be doing.

Baroness Neuberger: So there are some proposals already on the table and you will give us more. Assuming that the proposals on the table go through and you give us some more, what impact do you think the total package will have?

Emily Bourne: We hope to set out more of the impact as part of that package. Specifically on storage, we are already starting to see network companies offer non-firm connections to storage projects. In effect, that allows them to connect earlier in return for them being constrained in when they can dispatch when particular network conditions are in place. We are seeing quite a lot of interest in that already. We are seeing some movement for projects now, but we want to tackle this problem on a larger scale.

The Chair: I want to follow up on what Lord Winston was getting at with the safety issues. Has any work been done to inform companies and help them to understand the public's opinion about living near a hydrogen storage facility in a salt cavern?

Stef Murphy: I do not know what public opinion work has been done. I do know that developers will do lots of local consultation as part of the statutory planning processes. The Health and Safety Executive is certainly doing a lot of work on the safe use of hydrogen, as well as its transportation and storage, in different contexts. We are working closely with it as we go through those processes.

The Chair: It is quite late to leave it until the planning process starts, because it may not be the absolute safety but the public's perception of whether you are doing something close to where the public live that they find a bit frightening.

Professor Paul Monks: We are doing some work. Hydrogen storage, for example, is associated with the risk of microbial activity in producing hydrogen sulphides in those caverns. We have done studies and mitigations together. We have been engaged with studies looking at how you would put criteria together to be able to select hydrogen stores with specific characteristics such as pH, temperature, salinity and depth. We are not starting again from ground zero on this. There are studies under

way to do that, and they are informing the work by the HSE that will assess that evidence of that safety. So we are working with developers along those sorts of lines for that and with the HSE as the competent body in this area.

Baroness Neuberger: It sounds more like the merits of the issue than public opinion about the issue.

Professor Paul Monks: On the public opinion question? Yes.

Lord Winston: When you talk to the general public about hydrogen, whether it is a taxi driver or whoever, the ignorance is very striking. You would only need one tiny accident to destroy what could be a very important issue. I wonder whether that needs to be thought about.

Baroness Neuberger: The one thing you find people know about is that hydrogen is highly explosive, and there is a fear there.

Lord Winston: It is.

Baroness Neuberger: Yes, but that is the one thing they know.

Stef Murphy: We certainly agree that safety is really important.

Professor Paul Monks: We take the sentiment of the committee here in respect of public engagement. We have always said that we will do hydrogen tests in given areas with the consent of the public. Public opinion and working with the public in areas are an important feature of all the parts of the energy transition, along with the infrastructure and the different technologies that we will bring to bear.

Lord Winston: Are you using the dialogue process?

Professor Paul Monks: I am not sure about that, to be honest.

Lord Winston: It is worth looking at. That is helpful.

Q97 **Lord Borwick:** Over the years there have been lots of examples of big energy projects going through local planning, and in most of them the local planners and the local councillors have been terrified of whatever the change is, because of their ignorance. Is there any example of a big energy project getting through planning in less than five years?

Professor Paul Monks: That is not my area of expertise, unfortunately.

Emily Bourne: We would have to come back to you on that question specifically.

The Chair: If you are able to, we would find that very interesting.

Lord Borwick: I noticed particularly that in the Rolls-Royce discussion of small modular reactors it put something like 90% of the total budget on the cost of going through the planning process.

Professor Paul Monks: Nuclear siting slightly different from energy infrastructure siting.

Lord Borwick: Indeed, but the power of ignorance and worry should still not be underestimated.

Q98 The Chair: If you can find out about the typical planning times, that would be really helpful.

We come to our last question. We have become increasingly confused during this inquiry about the relationships and responsibilities between the large number of actors that there are in the energy system: DESNZ, Ofgem, the ESO becoming the future system operator, the transmission and distribution owners and so on.

We would be interested to hear about what distinctive roles you see particularly DESNZ and the future system operator playing in the energy transition. In particular, do we have clarity yet about the roles, responsibilities and authority for each of the organisations in the system? Is that clear enough? For example, who will develop the strategic spatial energy plan? Who owns it? Is it owned by Ministers or the future system operator? Will plans be developed in DESNZ and developed by the FSO? We are a bit confused about all this, and we would like to hear where you think things are and who does what.

Emily Bourne: At the high level, the Government's role is to set the policy direction. Ofgem is the independent regulator, obviously, and it makes decisions on business and investment plans. We see the future system operator as the whole-system planner, the operator of the electricity system and an expert adviser to the Government and Ofgem as the key decision-makers.

The Chair: So they will produce the spatial plan?

Emily Bourne: Only relatively recently have the Government confirmed that we will develop a spatial plan. As I say, we will shortly set out more about the roles and responsibilities for that specifically, but that has not been fully unpacked. That is definitely part of the next phase of consideration.

The Chair: So we do not yet know whether they or you are producing it.

Emily Bourne: That is something that we are actively discussing at the moment. We will set out more details soon.

The Chair: When do we expect to know that?

Emily Bourne: We will be setting out more detail as part of the response to the Electricity Networks Commissioner very soon.

The Chair: Okay, so do you think that the roles, responsibilities and authority are sufficiently well clarified and defined, or do you think that, when we hear that response, they will be sufficiently well clarified and defined?

Emily Bourne: I think we see the roles and responsibilities as being very clear. As I say, the spatial plan is a new concept, so we need to think carefully about how we develop it and what roles are taken in its development. That needs to be set out. Hopefully, we can set it out very soon and give people clarity on that, but that is being worked through at the moment.

The Chair: Will it have some sort of force as a statutory plan, or will it be a kind of wishful plan that we hope we can persuade people to play their part in?

Emily Bourne: Again, that is part of the consideration going forward, so we do not have an answer on that yet. That is being actively considered.

The Chair: Will we have an answer soon?

Emily Bourne: We will have an answer soon, yes.

The Chair: Okay. Thank you very much. We have worked you very hard. We appreciate that you have helped us to keep well to time with your concise answers, which has been very helpful to us. At that point, this session is now formally concluded.