



Science and Technology Committee

Corrected oral evidence: Long-duration energy storage

Tuesday 24 October 2023

10.10 am

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

Evidence Session No. 7

Heard in Public

Questions 53 - 59

Witnesses

Nick Winser CBE, Electricity Networks Commissioner, National Infrastructure Commission; Claire Dykta, Head of Markets, Electricity System Operator.

USE OF THE TRANSCRIPT

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

Examination of witnesses

Nick Winser and Claire Dykta.

Q53 The Chair: I welcome the witnesses to the seventh session of our inquiry into long-duration energy storage. This morning we have Nick Winser CBE, the Electricity Networks Commissioner and a commissioner on the National Infrastructure Commission; and Claire Dykta, head of markets at the electricity system operator.

This session is being broadcast on parliamentlive.tv. Shortly after the session you will receive a transcript, and we would be very pleased to have that back from you as soon as possible. You can make minor alternations to it if you need to. If you think of anything that you would like to have said or if you have any other information or data that you think would be useful to us, we would be very pleased to receive that as formal evidence to the inquiry after this session.

If you are okay, we will get on with the first question. This is aimed at Nick Winser, so we will start off with you, Nick, and then ask you, Claire, if there is anything you would like to add. Nick, you have recently been closely involved with two very substantial reports that relate to long-duration energy storage—on the electricity transmission networks that enable it and on long-duration energy storage as a key national infrastructure project. Could you briefly outline the key findings of the two reports and what you are recommending, particularly as it relates to the issue of long-duration energy storage?

Nick Winser: Before I start, can I mention that I have a slightly uncomfortable number of hats that I might be wearing today? I will try to distinguish which organisation I am referring to, at which time.

I have tried to pull out of the two reports that you referred to things that are particularly relevant to long-term storage rather than the broader sweep of them. My report on strategic transmission and how to build it quicker had a number of points that relate to long-term energy storage. Of the 18 recommendations, about eight or nine relate to the need for a strategic spatial energy plan. That plan would need to represent all major components of the energy system and have some spatial element, for two reasons in terms of the networks, but it is also very relevant to storage. Having such a plan would allow us to anticipate where we need network capacity at a time when, at the moment, the build of networks is late. That is for two reasons: it takes a very long time and we have started late.

Part of the plan would be to model where we have long-term storage. To give a straightforward example, if you are to have long-term storage of, say, hydrogen in the north of Scotland in substantial amounts, it will have an impact on what size of hydrogen pipes you need going south, and what size electricity cables you need. A strategic plan is very important in that.

A strategic plan will also help projects, both on the network and on storage, to go through the planning process. One of the things I have heavily recommended is that the planning process will be eased by having much better discussion with communities, being much more open and more respectful and having much better political, economic and engineering context laid out to communities. What comes out of the Electricity Networks Commissioner report is that a strategic plan, including assumptions on long-term storage, is very important. It will also enable us to look at whether we think we have the right market and regulatory signals in place to get each part of the plan delivered, mainly by private investment.

In the National Infrastructure Commission assessment, a five-yearly document that was brought out last week, we made major references to storage in the sense that we recommended a long-term, flexible generation resource using hydrogen and gas with CCS. We have recommended 30 terawatt hours. I think an easier stat is to think of that as 12 gigawatts of electricity generation powered by hydrogen and gas with CCS. That is about 15 power stations or something like that.

We also suggested a strategic energy reserve, distinct from the long-term flexibility that I have just talked about. We speculated that, by 2040, we would expect the strategic energy reserve to be held mainly by hydrogen in store, but possibly, in the short term, hydrogen and natural gas in store. With the experience of the shock to the energy system coming from Ukraine, which was not the first such shock, we think that 25 terawatt hours should be held by 2040. That is about two months' worth of the non-renewable part of the system that we see in the future. To support that, we recommended that there should be 8 terawatt hours of hydrogen storage delivered by 2035. We believe that those sorts of facilities—the pipelines that we talk about in the report and the hydrogen storage—can take of the order of 10 years to deliver. We are in 2023; the facilities are needed for 2035, so there is cause for urgency.

The Chair: In our other sessions we seem to have assumed that this long-term energy storage will be in the form of hydrogen. Have you discounted other types of long-term storage—for example, things like flow batteries?

Nick Winser: No, we have not. The commission looked at long-term storage as a sector. We say that there needs to be detailed work as to exactly what that constitutes. Hydrogen is the easiest way to look at it at the moment, but compressed air and liquid air are interesting storage vectors, as are batteries. Hydrogen lends itself most easily to very large volumes but, of course, has a lower cycle efficiency than the other things I have mentioned. I certainly think, whatever mechanisms are put in place, it is worth being reasonably technology agnostic to allow the best combination to be discovered.

The Chair: A strategic reserve that can generate 25 terawatt hours of electricity could be 50-plus terawatt hours equivalent of hydrogen. It is a considerably larger number for hydrogen.

Nick Winser: Yes, it is. To explain how that fits with the eight, we have said a minimum of 8 terawatt hours of hydrogen storage by 2035, but then we suggest a strategic reserve for 2040. That five years is quite critical. We are quite a bit further into the transition.

The Chair: But you are suggesting that, in addition to that, there is long-term flexibility that might involve hydrogen as well as natural gas.

Nick Winser: We specify that we think each of those needs to be held. We have not gone into detail on the 30 terawatt hours of week-by-week flexibility and the 25 terawatt hours of strategic reserve. It will not all be hydrogen, for a start, and we have not gone into whether discrete physical storage is needed for those two things. Obviously, it is possible to look at how the oil strategic reserve has been held in many countries and the extent to which you need segregated physical rather than segregated commercial arrangements.

The Chair: You talk about this needing perhaps at least 10 years to deliver. Do you have a sense of the scale of investment that will be needed to get it in place? I am interested to know whether you think we have a chance of making it happen, given that we have 12 years.

Nick Winser: I do not have a number at my fingertips on the cost of storage. I am not sure the commission put that out. To give you a sense, though, of the scale, we speculated that the two sets of pipelines—if we have a hydrogen pipeline and a CO₂ pipeline—will be between £10 billion and £22 billion. To give you the scale, it is in the tens of billions. It is that sort of size of infrastructure.

I am optimistic that there is enough time to do it. There is a need for real urgency, but we have seen extraordinary progress made in quite short periods of time over the last 20 years, once the right mechanisms get put in place. The progress on offshore wind is stunning, so I think that we still have time if we crack on.

The Chair: Claire, do you see the scale of the numbers from the NIC report and the timescales as being in the right ballpark?

Claire Dykta: Yes. At the electricity system operator, we create and publish each year something called our *Future Energy Scenarios* document, which looks at four possible pathways to 2050. In that document we have envisaged between 3 to 9 gigawatts of long-duration storage by 2030, rising to 12 to 17 by 2050. It is in the same ballpark as the NIC report.

It is worth noting that, at the end of last year, we published a piece of work we did with AFRY, which looked at resource adequacy in the mid-2030s and whether it was possible to operate a system dominated by weather-dependent generation. That stage of the modelling that we undertook said that a power system that is dominated by weather-dependent generation cannot be supported just by short-duration storage such as batteries, with the definition of them being up to six hours. You would need at least one other clean technology, such as hydrogen generation, CCUS, nuclear or long-duration storage.

To reinforce Nick's points, there is not much time. It is possible, and we have seen huge progress in offshore wind and in short-term batteries, but none of those technologies is able to operate in a commercially viable way at the minute. There needs to be more clarity on policy support for business models for those to be established.

- Q54 **Lord Krebs:** In the inquiry we have heard how many different stakeholders are involved in the energy system, including the future system operator, transmission owners, energy companies, Ofgem, DESNZ, the gas network and potentially future hydrogen networks. I notice that DESNZ refers to its consultation with the Hydrogen Delivery Council, the Transport and Storage Working Group et cetera. Are those different moving parts working sufficiently closely together to deliver what is, actually, a pretty urgent priority to get the whole system of long-term energy storage in place? Claire, maybe you would like to kick off with that.

Claire Dykta: The future system operator will hopefully be established with the Energy Bill passing any time now. It really addresses what you have very eloquently set out: there are lots of different bodies and, historically, the energy system has been quite siloed in how it thinks and how it operates. The Department for Energy Security and Net Zero recognises that and the future system operator is intended to fill the gap, to come away from any commercial interest and to provide independent advice to the Government on how government targets and ambitions can be translated into delivery.

There is an awful lot of work going on at the minute between us, the electricity system operator, the government department and the regulator Ofgem to define the lines of responsibility and how things will move forward. The intention is that the future system operator will be established by 1 July next year.

Lord Krebs: In the work that you are doing with the department, do you have a concept, an organogram, of how the different components that we have just been referring to fit together, who reports to whom and who has decision-making responsibility? I hear a lot of "we are advising" and "we are suggesting", but presumably the ultimate decision-maker is DESNZ. Under that, which is the lead organisation that feeds in the recommendations and checks that they are being implemented?

Claire Dykta: There are two routes. A formal framework is set out. We will be given statutory duties through the Energy Bill. The strategic policy statement that will be issued alongside that will also set out the formal framework for how the relationship works.

The more informal working arrangements will very much operate with the concept of an advisory role that sits within the FSO and takes some of the scenario work and things like that, and provides advice to the Government on the development of policy. It goes to the Government and they make the decisions. It comes back to the FSO in terms of delivery of some of the things that the NIC report identified, such as the strategic spatial plans and things like that.

One of the big intentions with the future system operator is that there would be clear plans that create a very clear intention for industry parties and others on how we move forward, rather where we are at the minute, which is to let the market decide and see what evolves from the ground up.

Nick Winser: I emphasise the role of the strategic special energy plan. There is a lot of good will in the industry and a lot of enthusiasm to move quickly through a complex set of interacting technologies and needs.

In addition to Claire's point, a plan that all those stakeholders can focus on, well defined in terms of the responsibilities for its delivery and endorsement, will provide a focal point for that discussion. At the moment we have a variety of different models, mostly not at all spatial. People are planning, and lots of organisations are coming forward with different sets of scenarios to have a plan that has clear input from DESNZ and is regulated in its production by Ofgem, so that stakeholders can understand that it can be a focal point for discussion and decision-making.

I would use it as an opportunity for Ofgem, probably, to look at everything that we expect to be delivered and at the set of regulatory and market arrangements for all those different things, and say, once a year perhaps when the plan comes out, "Yes, we think that the set of market mechanisms and regulatory mechanisms are likely to move us in this direction". Clearly, some parts of the plan will be speculative. Some parts will have decisions that we are not yet ready to make as a country. It is not that the plan will represent a definitive view of the future, but it is a rallying place for good decision-making and a sensible debate about the commercial and regulatory mechanisms.

The Chair: How soon could such a plan be produced? How challenging a thing is it? Is it a complicated thing to do?

Nick Winser: Well—you go first, Claire.

Claire Dykta: It is complicated. With these things the trick is not to make them too complicated because then you never get anywhere. We are looking at options to publish something late next year or early the year after.

The Chair: You are talking about early 2025.

Nick Winser: Yes, we are.

Claire Dykta: We are in discussions with the department at the minute as to when it would be practical to publish something that is meaningful that takes into account the real need for the plan to be there and finds the right balance between getting a useful plan and providing some of the benefits that Nick outlined, versus not taking too long to do so.

The Chair: But if we need such a plan for Ofgem to be able to check that the regulatory arrangements and things will work, and we have only 10 years to deliver the infrastructure we need for 2035, is that not too late?

Nick Winser: My view of the timescales on this absolutely reflects Claire's. To use a hackneyed phrase, we should not make perfect the enemy of good. We do not have a strategic spatial energy plan at the moment; we have a number of different parts to that. The mere process of starting to do it will help us tremendously in identifying what needs to be decided when, and indeed the implications of not deciding things, which may be legitimate in some cases. I would say: let us get on with it; let us model the big chunks as quickly as possible. I would certainly encourage the FSO to hit the timescales that Claire talked about. Starting to bring out something that is a high-level view of it would help an awful lot and could be done quite quickly, in my view.

Q55 **Baroness Neville-Jones:** I wanted to ask you more about the spatial energy planning, but we have nibbled into the subject already. From listening to what you are saying, am I right in understanding that, in your view, it is a framework for policy, with the various bits that need to be there related to each other but without, at this stage, being anything that is absolutely cast in concrete, because of, first, what we do not know and, secondly, what could happen? In your mind, is it a framework in which storage is one of the elements and where the relationship between the different parts is spelled out?

Nick Winser: I think framework is a good description of it. It does not seem to me that it would be useful, in all cases, to define volumes exactly and, of course, their position on the network, which is critical. If I may talk about the sorts of things that need to be in it—the big chunks—it is how much offshore wind and in which position around the coast, working with the Crown Estate as well, which the ESO is doing, and integrating that into the use of the seabed and what that might mean for volumes around the coast.

To give an example to show the breadth, it is about making some forecasts about domestic heating, how many heat pumps, where and how they will be distributed. Electric car charging should go into it, as well as the hydrogen network and hydrogen storage. Where are the nukes likely to be? Once you start to populate it with those big chunks, you start to find out quite a lot quite quickly. There is every opportunity to use it, as you say, as a framework for discussion and for seeing whether it all fits together.

It is even thinking about things like whether we have enough skilled engineers to deliver all those things. How do we relate it to the supply chain? You can use it as a framework to tease out all those things. That does not mean that it is a central plan. It is a framework for discussion and looking at decision-making, making sure that we know the consequences, in particular when we make decisions. One of the reasons why the grid is so late is that, in some sense, it has crept up on us. If we do not move the grid forward now, it will not get there in time.

Baroness Neville-Jones: When the system operator is trying to do the plan, where do you reckon our knowledge is reasonably hard and where are the soft patches on which we need to focus? It seems to me that our understanding and knowledge are not evenly distributed. Where are we

going to have problems? Where will we have to focus? Where do we have some reasonably firm ground?

Nick Winser: I think that is right. To pick some examples, we will probably be in a position to be reasonably hard on offshore wind, solar volumes and the distribution thereof. There is obviously a big call to be made on domestic heating. The infrastructure commission had a lot to say on that this week. That is not what today is for, but, clearly, if at the moment that decision is forecast for 2026, you could leave it unmade in a plan. That does not mean that you could not have a plan, but you would have to have some assumptions in it that the Government—DESNZ—might not be prepared to endorse, and legitimately so if they felt there was still some discovery to be done.

The pieces that this committee is looking into in its investigation are incredibly important. What we will do on storage and hydrogen, and where, is pretty urgent in this plan. It really influences the transmission networks in electricity.

Baroness Neville-Jones: Is that the function of the views that you take on other things, such as how much of different kinds of energy you need? It seems to me that it would be.

Nick Winser: Yes, there is definitely a strong link between where you put the renewables and the solution for domestic heating. There is a very strong link there and with what your storage vector is, because the gas system currently eats up quite a lot of the volatility against temperature. Which way you decide to go on domestic heating, for example, will influence how much hydrogen storage you might need, although the NIC work is mopping up that volatility by using hydrogen to generate electricity on peak. You can do it either way, but it will make a big difference.

Claire Dykta: The system operator has a strong foundation in network planning and already thinks about things such as where it would be optimum to locate hydrogen electrolyzers, for instance, from a power system perspective. The big shift that we are already making, from where we are today to the future system operator, is to think about that from a whole-system perspective. We are already building capability into the organisation around different technologies and vectors.

There is a consultation at the minute on the concept of a regional system planner that would look at the problem from the other way. At the minute we are talking mainly about a top-down perspective and looking nationally at the big locations of generation, supply or flexibility. There is also a need to look bottom-up and see, from a regional perspective, working with local mayors, councils or authorities, what the characteristics of those regions are and what the right solutions are, particularly on heat but also on transport and other things.

The two aspects then come together and create the spatial plan. The way we are thinking about it is that it would give you the framework—I like that description—of 10 to 15 years. It would give you the big chunks, for want of a more technical description, that the regulator could use in its

regulatory decisions to understand the impacts of choices that the Government could use in policy decisions. While I agree with Nick that it does not create a definitive central plan, it allows you to remove any outliers and understand the consequences of decisions you might otherwise have made without that spatial plan being there.

Baroness Neville-Jones: I am asking a series of rather chicken-and-egg questions, but to what extent are we in a position to know what our consumption volumes are likely to be and, therefore, how much of different kinds of energy we need? In order to have the energy plan, do you have to have an industrial plan? Do you have to understand where the economy is going, and how much power and what kind of power that economy will need? It seems that some very big assumptions have to be made in this situation.

Nick Winser: You need to have those assumptions about the economy and industry. On a separate occasion we might talk about industrial clusters and the decarbonisation of industry, which is a very important issue that has urgency too. I think you need those.

In the industry a number of plans have already been produced by various organisations that actually take those macroeconomic assumptions or have to make them. To create the spatial energy plan we are talking about you do need to reach outside energy. You will reach outside to get your forecast, but it does not need to lead to a different approach to other sectors. We already forecast the economy; indeed, the ESO forecasts the economy and uses forecasts from other organisations in coming up with future energy scenarios. It seems to me that you would have to think very hard about, and have things in there about the degree of travel, what the solution is on domestic heat and what will happen in industry.

Claire Dykta: To add to that, Nick mentioned earlier that flexibility in the power system is largely provided by gas-fired generators. We have to replace that flexibility with different kinds, which will come from storage, domestic consumers and other routes. That flexibility is the key. We produce scenarios that look at a range of projections of demand, but ensure that we have flexibility in the system so that it can cope with both the demand and the supply side—variable weather-related generation. It also ensures that you do not end up with the network being overbuilt or with inefficient decisions in that just-in-case world.

Baroness Neville-Jones: Although whatever is produced will not be perfect, but do you conclude that we have enough collective understanding of what is needed by way of consumption of different kinds of energy that we can come up with a plan that has plausibility? It will need alteration, but it is somewhere to start. Do the Government need to do anything in particular that they have not been doing so far to ensure that, first, there is agreement and, secondly, it has a reasonable degree of credibility?

Nick Winser: We absolutely have enough information to create this. In fact, just the activity of bringing together what we know would narrow

down the universe of possible outcomes really quickly. We have lots to go into it.

In my report on the transmission system, I suggested that the Government—DESNZ—would have a role in interacting formally with the FSO in coming up with a plan. Every year, in my suggestion, they would endorse the plan. There is a lot of debate to be had about what is meant by “endorse”, but it does not mean that the Government would have to predict everything. They would just have to say, “We’ve made assumptions. We’ll look at the assumption you have made on this. We see what you’ve said on that. In some areas we don’t think it’s appropriate to make a decision today and, therefore, a range of outcomes needs to be in there”. Just doing that would be very strong.

Baroness Neville-Jones: It has implications for investment, does it not?

Nick Winser: It would bring some much-needed certainty to the private sector in making investments right across the industry. It would help us in competing in the international space for resource, against the IRA in the States and the legislation passed by the European Commission and Parliament. It provides many things.

The Chair: Pressing on that a little, if delivering what we need for 2035 will take 10 years, does that not mean that we need a pretty clear picture of what the plan looks like now? It is not just a framework or an outline. We need to know what we are trying to raise capital to do and, indeed, in what ways people will be able to make money out of that infrastructure. If it will take 10 years to deliver, do we not need to know what the destination looks like in 10 years’ time?

Claire Dykta: Clarity is always helpful, particularly, as you say, in business models and commercial frameworks. Another area that would definitely benefit is reform to planning regimes. A lot of the things that we have spoken about are already in train. The electricity infrastructure plans are already published and are being taken through their various processes in their journey to being built. A big blocker in any infrastructure build over the next 10 years will be the planning laws. They need to be reformed, otherwise there is a big risk to the delivery of even existing technology, never mind new technologies, by the mid-2030s.

Nick Winser: How much the urgency drives absolute specificity in the plan varies from technology to technology. Last week, the commission—bravely, I thought—put a map in its report showing hydrogen and CO₂ networks as core networks and said, “These need to be built. They’re going to be very important, particularly for connecting up the industrial clusters”. It said that was urgent because of the timescale point that you are making, Chair.

There are some things like that which we need to get on with, and on other things there might be more time; time may not be so pressing. One of the great benefits of having a plan is that it allows us to understand which decisions are pressing and when. It allows optionality to remain open where it can remain open. Of course, that is very good in allowing

innovation, for example, to come into play and allowing broader competitive forces.

The Chair: What innovation are you expecting in a 10-year timescale?

Nick Winser: We see fantastic innovation at the moment on heat pumps. We are seeing quite rapid developments in different high-temperature heat pumps and solutions to hot water storage at home. We would need quite a lot of innovation in building new networks, which is in itself innovation, in hydrogen and CO₂. In other areas, offshore wind is now more incremental.

Q56 **Baroness Neuberger:** Slightly changing tack, there is an ongoing review of electricity market arrangements, REMA, and the possibility of introducing locational pricing for electricity. We would like to know what impact REMA could have, particularly from locational pricing, in supporting long-duration energy storage. What reforms should REMA include to encourage development and, indeed, appropriate use of long-duration storage?

Claire Dykta: We have been working closely with the department on REMA. At the minute, GB has a single national electricity price. It is a bit like the postage stamp system. Wherever you are in the country, or at whatever time of day you use electricity or generate electricity, you pay or receive the same price. That used to work just fine for the system that was designed at privatisation. Our current market arrangements have been in place for at least two decades—Nick might have been instrumental in designing them—but they are not appropriate for the world that we are moving into.

I have mentioned flexibility a few times. We need to send signals to anyone who is using the energy system, whether they are producing power or using power, about where it is optimal to locate on the network and when they can best use or generate power to benefit the system. For example, a very heavy, intensive industrial user might have the opportunity to change their processes so that they use power in the morning until mid-afternoon, but they do not use it between five and seven at night, which has a huge benefit to the system, and they get a financial benefit.

Moving to a different market arrangement that provides signals to market participants about where they could locate and when they could use or produce power leads to a more efficient system overall. There have been a number of different modelling exercises undertaken by various groups, all of which show variations in benefits. One was recently carried out by a company called FTI Consulting on behalf of Ofgem. It stated that there could be up to £26 billion-worth of benefits to consumers through moving to this type of arrangement. What it means for technologies and storage is that there is the opportunity to locate and operate in a way that is beneficial to those technologies from a commercial perspective and benefits the system. The idea is that you design a framework that ensures that those two sets of incentives are aligned.

We think it is important that REMA also looks at investment policies. We have something called the capacity market and the contracts for difference regime, which have different drivers. One is to stimulate investment in green generation technology and the other is to ensure security of supply. Those arrangements need further development to provide the appropriate support to new technologies and new factors coming through. Of course, everything that I have just said relates only to power at the minute. There is ongoing discussion within the department about similar arrangements for hydrogen. We strongly support a layered approach of long-term certainty of revenues through things like a capacity market, and then clear signals that, in a shorter to medium term, will allow investors certainty in the UK as an investment destination of the revenue streams that they can capture. That then allows for innovation in the technology because investors are prepared to put their money into the technology in that market.

Baroness Neuberger: If we went down the locational pricing route, what are the drawbacks and what should the Government be worried about?

Claire Dykta: You need to think about the design of what works from a pure point of view and then overlay interventions on top of it to make it realistic and workable. You need to think about investment certainty and how you maintain the UK as a credible and attractive market. That means predictability of pricing. It also means a smooth transition from the arrangements we have today to whatever new arrangements there might be. Do we need to think about the impacts on market participants who do not have the ability to move or flex?

There is no example in the world where domestic consumers are fully exposed to a wide range of prices. There is always some level of intervention. The same probably goes for industrial and commercial, or for technology that is reliant on a very fixed locational element such as salt caverns. You would need to put interventions in place to ensure that they were not disadvantaged by a shift to a different market arrangement that they had no ability to manage themselves.

Baroness Neuberger: You said that there is no system in the world that has sorted this out completely for consumers, but are there things we can learn internationally?

Claire Dykta: Yes, there are. Locational pricing is in operation in many markets across the world, primarily those dominated by renewables, such as California in the States. What I mean by their not exposing consumers is that there is recognition that it is unfair to fully expose consumers. There has always been some kind of governmental or state-level policy intervention to manage the impact on consumers to ensure that whatever market arrangements in place are fair.

Nick Winser: May I make some personal remarks on this? They go to my report on speeding up electricity transmission as well. I think there is a real tension between economic purity and the thing that we have talked about quite a lot in this hearing already, which is urgency.

On many components there is a real need for speed. The current electricity trading arrangements were set up 30 years ago, and I was there. For 30 years, I have been involved in discussions around locational marginal pricing. It has a lot to commend it in terms of economic purity, but it is tough for an existing market to transition from a wholesale price to locational marginal pricing. There is a worry in my mind that we will spend several years or more debating that, and that it creates a hiatus of investment because we are looking for so much private investment to come into it.

In my report I suggest something slightly different. I suggest keeping a postage stamp wholesale market and then overlaying it with a series of locational and temporal markets where we need to encourage particular behaviour from both the demand side and the generation side. It would not get to quite the same place, but it may get a substantial amount of the benefit of clearer locational and temporal pricing, without having to go through an enormous debate about the overall market structure and the consequence of delay while we do not know what we are going to do, as well as the danger that it makes investors feel that they do not have the certainty they need.

Q57 Lord Borwick: I have a quick question, Mr Winser. You mentioned the big new grids for carbon dioxide and hydrogen. You said that the costs would be something between £10 billion and £22 billion. Was that each or together?

Nick Winser: That is together.

Lord Borwick: Could we talk about the connections between the new long-term energy storage and the existing grids? What will the problems be that occur out of those connections?

Nick Winser: The idea of getting on with building the hydrogen and carbon dioxide networks, or just skeleton networks, is to give clear signals to industry about their routes to decarbonisation, which I think is important. The way that we have thought about building those new networks has been to say, "We need to connect up the clusters". Once you have some skeleton networks, you tend to put your gas with CCS and your hydrogen power stations producing electricity on that network. It would be good to do that now and see how it fits together. Then you could deal with energy from waste facilities because you would try, gradually over time, to migrate those to the CO₂ networks and capture the CO₂. Indeed, you might well put your greenhouse gas removal facilities, sometime in the future, on those networks too.

It goes exactly into long-term storage because those networks—particularly the hydrogen network—need the capacity to feed electricity needs from the storage facilities that, in my mind, I always envisage a long way north, because that is probably where they will be. You may well put the electrolysis facilities, or a significant number of them, where you occasionally have significant, constrained off-wind power. I always think of that as working in a north-south way. I am sure it is more complicated than that, but that is how I have thought about it.

Lord Borwick: Most of those connections between the caverns will be underground, so they should not have effects on consumers, the planning system or anything like that. Is that correct?

Nick Winser: They will have to go through the planning system. I do not know enough to say exactly which bit of the planning system or whether they would go through the DCO process or not. They would have to go through the planning process, but they would be underground, yes.

Lord Borwick: Do we need a different planning system for that? It would not affect most consumers because they will not see them if they are underground. It will just be the process of building them that affects them.

Nick Winser: They would probably need to go through the DCO process, certainly the pipelines. My strong advice on that, as part of my report on electricity transmission, is that, although people find that planning process quite difficult, it is fundamentally sound. It needs to be fed with much better political, engineering and economic context to help to go through, in a more respectful and open way, discussion with the communities that would be affected, at least in the case of those assets, during the building of them. We are talking about significant linear assets.

Lord Borwick: So many of our big structures take 10 or more years to go through their planning process, and we have only 12 years to finish the entire thing, in your words.

Nick Winser: My report referenced that on electricity, as you know, and said that it currently seems to be 14 years. My view of that, at least at a glance, is that it should be translatable to other infrastructure types. We can drive it down to seven, so that would still fit into the timescales we have.

Claire Dykta: It would be fair to say that at the minute the entire energy infrastructure regime is designed to operate on a just-in-time basis. Planning is a huge blocker. The current arrangements are not fit for where we are. Having a spatial plan enables you to think ahead and show what is coming. You can more proactively go through the process, which helps you to drive down the timelines, as Nick said.

The other element, as Nick mentioned earlier, is some kind of endorsement of the plan. If there is some kind of endorsement or recognition, it will also help the planning process because there is some kind of visible, published national framework or plan that can be pointed to in the process. You are right that the current arrangements will not get us there in time. Planning reform as a whole is required.

Lord Borwick: In addition to the buildout of transmission, what other infrastructure changes and ancillary technologies need work in order to allow the grid to work flexibly? Are there completely new sections, other than planning, that we have to work on?

Claire Dykta: All the technologies that are needed exist today; it is just that the majority of the new technologies are not commercially viable.

We could not just create a market and expect those technologies to arrive. New nuclear technology, carbon capture and storage, hydrogen prediction for generation or for storage, and some of the storage technologies that have been mentioned all exist. A diverse mix of technology is needed to be able to operate the system.

It needs clear policy and clear business models, however you want to describe it. Whether they are cap-and-floor or RAB models, the commercial mechanisms need to be in place to allow continued innovation in the technologies, because they will continue to evolve and get better. It will allow them to grow at scale to a point where, maybe, they would be commercially viable or there needs to be recognition that, when you are talking about things such as strategic storage, it is unlikely ever to be commercially viable on its own because, by its nature, it does not operate all the time. It is, therefore, a rare event.

Lord Borwick: Yes, it looks like that.

Q58 Viscount Hanworth: The Government's document, entitled *Hydrogen transport and Storage Infrastructure: Minded to Positions*, makes no evident assumptions about the so-called "off-takers" from the hydrogen grid. It strikes me that we cannot have a clear idea of the commercial model affecting the transport and storage of hydrogen unless we know in detail how the gas will be used and in what quantities. Can you comment on that?

Claire Dykta: I would probably say the same as earlier. We look at scenarios of potential routes that may arise, which gives us an envelope of both production and usage of energy vectors. We know enough, as Nick said, to be able to make some decisions. As you progress, you are able to bring that information to enough certainty to make those decisions.

I agree that there are lots of scenarios that could lead to very different outcomes in infrastructure build at both ends of the spectrum, probably from purely a spine for hydrogen through to a very extensive hydrogen ecosystem. There will be a range of options on the table. The key is that those options need to be narrowed down at the right time and early enough to make the right decisions.

Viscount Hanworth: My impression of the document that I have just read is that it is utterly vacuous, as well as being quite lengthy. Is it possible to comprise the differing durations of hydrogen storage and other forms of storage within a single commercial model? Should there be a distinction between the production of storage for immediate use and the long-term storage designed to accommodate dearths of power arising from rare and extreme weather events? Can it all be fitted within the same framework, as the document that I have just read seems to imply, or do we need to make fundamental distinctions in that respect?

Nick Winser: It is likely that you will need a range of different financial mechanisms to encourage investment in the right things. I take your point. Last week, the commission recommended that there should be a strategic reserve. A strategic reserve, by its nature, is likely to be used

very infrequently, so, as you can imagine, you might need a different financial mechanism for securing it. Clearly, remunerating it on its use would not be much use. It is a capacity-payment type of product. Hydrogen storage for electricity generation that will flow every year might lend itself to a different mechanism that is more energy market-related. You might build the commercial storage itself under a cap-and-collar type of arrangement.

I think the commission said last week, "We know enough to venture a hydrogen and CO₂ core network. We've looked at the clusters, we've looked at electricity generation and we've specified volumes there. We've looked at the potential for energy from waste, and as a further thought we've added the idea that greenhouse gas removal might be located in those places". The commission's view is that we know enough to build a core network or to start it off now. That needs several different business models, as they are called, but they are really commercial mechanisms to encourage private finance to come into them.

Viscount Hanworth: Can we leave long-term storage to a capacity market or should there be an active government intervention actually commissioning the infrastructure?

Nick Winser: Personally, I am not inclined towards the Government picking individual facilities. I very much acknowledge the benefit of keeping a fair degree of technology and neutrality but, at the same time, as we come up with mechanisms that are technology-neutral, they need to be service-specific. You need to have a mechanism, I think, that says, "We need some storage of some form. We need some standby generation of some form". Then you can keep them technology-neutral. It is complicated, but there is no escaping that level of complication. We need to embrace it and work with it.

Viscount Hanworth: You touched on the matter of the collocation of hydrogen generation, hydrogen storage and electricity generation via hydrogen. I presume that you are assuming that most of the primary power comes from offshore wind. It has been asserted that by far the best way of doing it is to have a nuclear power station generating both the electricity and the hydrogen, of course located near the turbines that would produce the electricity and near a storage site. What is your assessment of the assertion that it should be nuclear, rather than offshore electricity carried a great distance?

Nick Winser: The commission's report last week states that the commission's position on this is that we should be moving forward with, broadly, one nuclear facility at a time. That is predicated on the idea that nuclear strike prices are still at £92. You would have to index them for time and I forget which year that was set, but it is quite expensive compared to renewables at £40 or £50. I accept that they provide different things and you have to deal with the intermittency, but £90 is still pretty expensive compared with a system based on renewables.

Viscount Hanworth: That offshore wind price does not comprise any of the adjunct things we are talking about for the storage and to overcome the intermittence. Is it not a bit illusory to make those comparisons?

Nick Winser: I do not believe so, no. I believe that that renewable system still comes in at levels that are below £90.

Viscount Hanworth: Is that even with all the adjuncts that we were discussing?

Nick Winser: Yes.

Q59 **Viscount Stansgate:** Thank you both for your very interesting testimony so far. This final question is in the region of a wrap-up question. We are soon to be questioning the Minister and issuing our own report and the recommendations to the department. In the light of everything you have said, can you summarise your key recommendations or take-home messages for the Minister, when he arrives, to ensure that we deploy the long-duration energy storage that we need? Perhaps you could divide it into two answers—one in the medium term in the 2030s and one by 2050.

Claire Dykta: In the immediate term, the 2030s, our path is primarily set. The 2030s are about building the foundations for us to move on. The establishment of the future system operator is critical. The department's publishing the market arrangements—the REMA document—and moving forward with that process in a way that maintains investor certainty in the market will ensure that the right things are taken forward to allow the infrastructure, in the widest sense of the word, to be invested in and deployed. That would include planning reform and the right policies and mechanisms to ensure that investors come in and invest in those technologies so that they start to deploy at scale. All of that being underpinned by the spatial plan should help to give an appropriate level of guidance to all those elements in understanding the implications of the decisions being made.

Viscount Stansgate: Could you add something about the nature of the reform of the planning process?

Claire Dykta: If there is recognition or endorsement, however you want to describe it, of spatial plans, or some form of plan in the planning regime, there would be something to point to. I think there should be consideration of whether the planning regime we have today appropriately balances the interests of communities that have to bear the burden of the infrastructure and the wider need to progress towards decarbonisation, both for carbon targets and to lower the cost to consumers overall.

Viscount Stansgate: Mr Winser, do you want to add anything?

Nick Winser: I come at it from a slightly different direction. The important thing is strategic planning, for all the reasons that we have discussed this morning, to allow us to embrace the complexity and start to unpick it.

The only other thing is that I think it is important to be bold. We need to make decisions. We need to be prepared to back assumptions about the future in a reasonable way, to some extent, and get on with some of the investments. The reason I emphasise that point is that there we look very

easily at the cost of doing things, but there is a real danger that we do not look, at the same time, at the cost of not doing things. Lurking out there is a very significant cost of delay, and ending up with both a system that will not work or will not hit our legally binding targets and a big cost of carbon if we cannot decarbonise quickly enough. I urge boldness in a reasonable way.

The Chair: I would like to ask one final, very quick question. We talked a lot about strategic spatial energy plans in our previous session as well. If the plan says that this is needed and that that is the best or the least-worst place to put it, who will take a lead in communicating that to the local communities that will be affected? Whose job is that?

Nick Winser: I would not change from the existing system. The job would be with the developer of each part of the infrastructure. It is their job to go into communities, as they do now, but they would go in with a lot of the political, economic and engineering context laid out, in my mind, in a plan in terms of electricity transmission, with design principles that explain to communities why particular routes have been chosen and why the particular blend of assets has been chosen. It would still formally lie with the developer of each bit of the network.

The Chair: The Government endorse the plan and then the developer has to go in and deal with the opposition to it.

Nick Winser: Yes, but in the context of DCO it would inform the Planning Inspectorate's view of the application and make sure that communities have been heard, and their views listened to, within the context of the broader political, economic and engineering rationale that is laid out. It would therefore help the Planning Inspectorate to make a quicker and more solid recommendation to the Secretary of State for approval or not.

The Chair: I give our great thanks to both of our witnesses in this session. It has been extremely informative.