

Business, Energy and Industrial Strategy Committee

Oral evidence: Decarbonisation of the power sector, HC 283

Tuesday 24 January 2023

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Members present: Darren Jones (Chair); Alan Brown; Ruth Edwards; Jane Hunt; Mark Jenkinson; Andy McDonald; Charlotte Nichols; Mark Pawsey.

Questions 196 to 227

Witnesses

I: Sarah Honan, Policy Manager, Association for Decentralised Energy; Merlin Hyman, Chief Executive, Regen (Electricity Storage Network); Will Mezzullo, Head of Hydrogen, Centrica; Dr Jonathan Radcliffe, Reader in Energy Systems and Policy, University of Birmingham.



Examination of witnesses

Witnesses: Sarah Honan, Merlin Hyman, Will Mezzullo and Dr Jonathan Radcliffe.

Q196 **Chair:** Welcome to this morning's session of the Business, Energy and Industrial Strategy Select Committee for our latest hearing of our inquiry on the decarbonisation of the power sector. We have two panels today. Our first is on flexibility and storage and our second is on nuclear.

In the first panel, we are delighted to welcome Sarah Honan, who is the policy manager from the Association for Decentralised Energy; Will Mezzullo, who is the head of hydrogen at Centrica; Merlin Hyman, who is the chief executive of Regen, which is associated with the Electricity Storage Network; and Dr Jonathan Radcliffe, who is a reader in energy systems and policy at the University of Birmingham. Good morning to all of you. The first question that we should answer for everybody watching is what on earth we mean by flexibility.

Sarah Honan: System flexibility, when we talk about it, generally means how we match electricity supply and demand on a week-by-week, hour-by-hour, minute-by-minute basis in order to keep everything moving around the system nice and safely and within the proper parameters. In the past and present, the way that we have made sure that the system is flexible, i.e. supply and demand are matched at all times, is generally by the electricity system operator, the ESO, contracting with gas and coal plants to either generate more electricity or less electricity, depending on how much need is in the system.

We all hear about big football events and things like that. There will be a spike in demand and we use gas and coal to meet that spike. In the future, of course, we are going to need to decarbonise that flexibility. About two-thirds of it last year was gas and coal. In the future, this is expected to be completely decarbonised.

My area of flexibility is demand-side flexibility or demand-side response, which is, essentially, when users at home change how much electricity they use in response to some kind of a signal. This can be a signal that there is not enough generation on the system, that it is not sunny enough or the wind is not blowing hard enough. There could be a grid issue, so there is something technical on the grid that needs to be fixed. It could simply be a financial incentive that it is cheaper to use electricity at different times of the day.

At its core, flexibility as a whole, including demand-side response, is about how we make best use of all this brilliant renewable generation we are building and how we make sure that we do not build too much of it that we do not need, or that we dig up roads to lay more cables or construct extra pylons in our beautiful landscapes to get electricity from point A to point B. It is projected that flexibility will bring somewhere in the region of £10 billion a year in system savings by 2050.



Q197 **Chair:** Merlin Hyman, this is not just about consumers, is it? It is also about industrial commercial clients, public sector clients. Are they able to play an effective role in demand-side response and flexibility?

Merlin Hyman: Yes, absolutely. In fact, they have done for a long time. We used to have a system called Triads, which was a very high cost for the grid three times a year. In many cases, they are huge users of power and have the scale to respond. They can respond by using less, potentially, power, such as a water company turning down its treatment works a little bit for a while. There is particular talk around storage and batteries. They can install their own storage on site.

Turning to your overall question, we have covered a real good insight into what flex is. It might be worth bringing out the levels you have. It begins to change in the net-zero power system. Regen did a report called "A day in the life of 2035" with the electricity system operator last year. We looked at a difficult day and went through, hour by hour, in 2035, with lots of renewables, what is actually happening at 4 pm and 6 pm, how consumers are responding and the like. That is online. It shows you quite graphically and easily the importance of being able to be flexible.

There are three broad areas. Sub-second flexibility is the ability to respond very quickly to an issue on the grid that might threaten frequency, such as a power station going down or something. That is what batteries are now starting to do a lot, provide a lot of that. The quicker you respond, the less you have to respond, so speed of response is very important there. That becomes more important in a high-renewable system.

There is the inter-day balancing, which, again, batteries are doing quite a lot of, in terms of demand-side response. We have been seeing that in the last few days, doing quite a lot of that, moving power around during the day.

Then perhaps there is the bigger long-term challenge of the period of a few days or a week or more of a cold, low-wind snap, sometimes known as dunkelflaute. I am sure that others have mentioned the dunkelflaute effect, where we have perhaps a bigger challenge in thinking about how to store power for that kind of challenge.

Q198 **Chair:** Dr Radcliffe, I suspect a lot of people think that being asked or incentivised to reduce their energy is a bad thing. There has been a lot of press coverage recently about the system that has just been put in place to try to make sure that we do not end up in a situation where there are electricity blackouts. People think that we are not in a good situation if we are asking people to be flexible. Am I right in thinking that, in the net zero power sector world, being flexible with your energy use is actually a good thing and will be more normal?

Dr Radcliffe: Yes, I agree. In a net zero world, essentially, we are going through an entire system transformation. That is moving away from our



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equilibrium that we have at the moment, where generation can meet demand on that very predictable basis. That is enabled by the massive amounts of stored energy that we have in fossil fuels, whether that is natural gas that is stored in pipelines, through linepack or underground, or petrol that comes in and is stored in bunkers or petrol stations. We have this full supply chain of storage that allows us to have that flexibility in the entire energy system.

While we think about the power grid, as we move towards net zero, we are thinking about more integration of transport and heat alongside power. We need to think about how all components of that provide us with the flexibility. Understanding how much storage there is already in the system that we need to replace with low carbon alternatives is really critical. Part of that is going to come from reducing our demand at key points as well.

Q199 Chair: Will Mezzullo, from a hydrogen perspective, I suppose a consumer might not interact with the services you are running in the same way as they might do with their energy supplier. What role do you think hydrogen will play in this area?

Will Mezzullo: Flexibility and storage come in different forms. We have talked about demand-side response, which is changing consumer behaviour around moving energy consumption from different times of the day. We have also talked about batteries. We own and operate grid-scale batteries. They sit there on a network and balance with the network within seconds. They are balancing things such as the frequency of the network. Those batteries are in megawatt-hour form.

We also need to look at something called long-duration storage, which is what happens in those longer periods of time when we have an abundant renewable energy resource but our demand is, over a period of time, quite low. At the moment, we have mechanisms such as curtailment. As an example, in the UK we curtailed around four terawatt hours of power last year. That is, effectively, paying to switch off generators.

When we talk about curtailment and terawatt hours, we have to recognise that we have to move away from things such as batteries. To put some numbers to this, the global demand for batteries by 2030 will be one terawatt hour, so when we talk about terawatt hours of curtailment we need something different. This is when we look at how you decarbonise the power system and around flexibility. This is where hydrogen potentially could come in.

It is about, "How do I store that energy for a long period of time using infrastructure assets that I have, the gas pipes, gas storage facilities, so that I can effectively have a super-large battery in the form of hydrogen?" Then there are those periods of time when renewables are not available. We have an elongated period of demand, such as the three weeks in December of really cold temperatures and quite low wind across



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Europe. That is a great example of where long-duration storage comes into play.

There was a really good report funded by BEIS last year; AFRY undertook it. It started looking at the role of long-duration storage. I think it showed that it would save around £13 billion to £24 billion, from a Government perspective, to try to achieve net zero if you look at long-duration storage. It is a family of things around flexibility.

Q200 Ruth Edwards: Merlin Hyman, I am quite interested in your view on what the role of the different types of energy storage should be. I am thinking about all the different ranges: hydrogen, hydro, compressed air. Also, how much do we have in the pipeline? Are we on track for the 2035 targets around energy storage?

Merlin Hyman: We have heard from my fellow panellists some quite eloquent descriptions of the different types of flexibility that we need and the different technologies that we will be employing. Very clearly, if you can shift demand efficiently, that is potentially very cheap, not necessarily easy but very effective. We have heard that battery storage plays an absolutely critical role in balancing the system. Then we need forms of long duration storage.

We can see the demand side, exactly how that is going to play out, how much it is price driven and how much it is response to a signal. Those are things that we need to explore. Batteries have been very successful. There is about 1.5 gigawatts now on the UK electricity system. That is world-leading and it has happened in a pretty short space of time. There is a very strong pipeline of projects. Depending in what number you take, there is 30 gigawatts to 40 gigawatts of pipeline of projects, which is probably as much as we are going to need.

The question of the long duration storage and the role of hydrogen or possibly other technologies, such as compressed air—there are quite a lot of runners and riders out there—is one that we are still very much exploring. BEIS is carrying out various studies, et cetera.

Perhaps the critical point, from a policy, regulatory and market point of view, is that, ideally, the design of the system should be to signal value—what the system values—whether that is the longer duration, the short term or the frequency support, and allow the market to then respond. We will see which technologies are able to provide that. We need to make sure that the system, particularly the electricity system operator, has the right markets to bring forward these services, provide the value, that market operators can respond to.

We need to get rid of any barriers. Ofgem sometimes uses a concept of full-chain flexibility, allowing any asset on the system to provide its full value. There may be barriers that stop it providing value up the system because the system is, essentially, designed in the way that we heard, around a few big power systems.



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That transition from operating system based on a few big operators that can ring up the phone to somebody in a power station and say, "Cup final is coming up. Can you ramp it up a bit?", to oversimplify, to a world of millions of decentralised assets and a control room that is able to operate those efficiently to manage the system is a massive transition. It is one that the electricity system operator is starting to go on, I would suggest.

Q201 Ruth Edwards: Do you think that we have an attractive model for mid to long-term energy storage? That has been flagged as a potential issue in some of the written evidence that the Committee has received. If you think that we have not, how do you think we could go around developing one? What would you be looking for?

Merlin Hyman: The answer is no. The value is not yet there from the system to bring forward those technologies. We are still in an investment phase, where we are funding innovation and technology development. There are quite a lot of consultations coming out of Government. There is a recognition of the importance of this longer-term storage, which we have heard eloquently described.

There are various models for bringing that forward. With shorter-term storage, there is no subsidy-type support for batteries. They are entirely built by the market, just like any other market. They think that they can earn revenue. They think that they have a valuable asset, so they build it and earn revenue from the services they provide.

In the longer term for this market, we will see that you certainly have that, but, because of the capital intensity of some of those projects, you will probably have to have a bit of a hybrid with the way that we support renewables, which is a long-term confidence in terms of the price to enable infrastructures to invest at low rates of return. People had talked about a cap and floor type model, but the exact design is still to be worked through.

Q202 Ruth Edwards: Dr Radcliffe, what is your view on the investment offer environment in the UK, as compared to other countries?

Dr Radcliffe: It is important to recognise that the battery storage market has grown up so rapidly, mostly based on the innovation that has come from the auto sector that has driven down the prices of the technology, so there is this large consumer market that has pulled through that innovation. The problem is that we do not value storage, because we are used to having that in terms of the fossil fuel that we already have and have come to accept as being there. That is fairly common across a number of different countries.

The investment going into the UK is encouraging on an international basis. We can see some leaders, especially in the US through the Inflation Reduction Act, so we have some way to catch up there. The investment in the UK is going quite strongly into that R&D, the research, development and demonstration side of it. We need that strong market



pull to bring the private sector investment in to see that investment case that will allow us to scale up the longer-duration technologies especially.

Q203 Ruth Edwards: Aside from the US and the Inflation Reduction Act, are there any other international examples of really good practice that you would point to?

Dr Radcliffe: There have been some examples in Germany that have incentivised the use of home batteries alongside solar PV, so taking it down to that localised distribution level. There are some other examples that are more based around that local storage.

The UK is doing quite well at that early stage. Apart from that early-stage R&D, some of the market mechanisms as well are especially important in the US, where storage is mandated in some of the markets. That really incentivises the private sector to invest and put that on the grid. That is the area that we need to be concentrating on now.

Q204 Ruth Edwards: Will Mezzullo, the Government have floated a number of different potential policy mechanisms: CfD, cap and floor price and different things like that. In Centrica's view, which of those would be the most attractive? Do you have a view on that?

Will Mezzullo: This is for medium and long-term storage. Before I answer that, in terms of short-duration storage, which is grid-scale batteries, the business model or the investibility of that is well understood by the investor community. Investors are comfortable with that. Those revenues that were being discussed before are the indirect consequences of an intermittent renewable resource and a change in our consumer behaviour around electricity. Typically, an investment in a grid-scale battery is millions of pounds, tens of millions of pounds. That reflects how much storage is capable.

When we start looking at long-duration storage there are a few things. One is that the UK is fairly unique. There are countries that do not have the ability to say, "We are going to start investing significantly in long-duration storage", because they are not blessed with natural resources like geological storage or salt cavern storage. That starts shaping a little bit where Governments are going in terms of how they declare themselves.

You will have seen that some Governments are saying, "We are going to be a net importer of hydrogen and we are open for business. Come and speak to us and we would like to buy your hydrogen". The UK is slightly different. We are in a different position. The UK can strive to achieve becoming a net exporter of hydrogen because it has the ability for storage. Effectively, the UK could be selling long-duration storage to other countries and not just meeting our own demands.

To delve in a bit more around our Rough facility, Rough is a natural gas storage facility that has been historically used for storing natural gas. That very much met the fluctuating demand side and your storing of



fossil gas. If you look at Rough in the future, we see that it is not just balancing that demand. You are balancing that supply. It is actually having a two-part role.

We believe that the investment in Rough would be around £2 billion. The scale of that would need to be underpinned by a regulatory support model. I have been in renewables pretty much all my career, so I know no different. Positively, I have never seen investment as being an issue. Capital has always been available. It is getting that investor comfort and putting those boundaries around so investors can say, "I can deploy my capital". An infrastructure project such as Rough, to allow that long-duration storage, really needs that sort of support model.

We had the Chris Skidmore net zero review, which made a recommendation to the Government of bringing forward that decision about long-duration storage hydrogen business model from 2025 from 2023. That is really important. These projects take a long time and the earlier we have that visibility the earlier we can start planning.

Q205 Ruth Edwards: There are two quick follow-ups on that. We heard from SSE that, unless the decision was brought forward to 2023, the idea of having what we need in place by 2030 is not going to happen. I would be interested in your view on that. Secondly, what would give investors that confidence that you mentioned to invest in long-term storage?

Will Mezzullo: On the first point, SSE raises a valid concern. It is a concern that we have raised: that these projects for long-duration storage require such a ramp-up period of time, just because of the scale that we are talking about. We agree with Chris Skidmore's recommendation, which is to bring that decision forward.

BEIS did a great job last year. The consultation came out, asked all the right questions and working with industry to make sure it was addressing all the possible connotations. Now we are in the stage of coming out with discussions around, "What does the business model look like?" I am positive that we are on a good road, but we strongly recommend that that decision is brought forward to 2023.

I am so sorry. Forgive me; I have had a mind blank on the second question.

Q206 Ruth Edwards: You mentioned about investors needing that confidence. I was wondering what, in your view, would help deliver that.

Will Mezzullo: That is a good question. This is a lesson from renewables, long-duration storage and other types of storage. The model that you may set at the beginning will be different as time goes on. If we look at renewables, we started life with renewables obligation certificates. The uptake was a bit ropey, so then we introduced the feed-in tariff, which was a really simple scheme. Uptake was, arguably, a bit too much, so it was a really successful scheme. Then the CfD came in. You saw there a lifecycle of support schemes that addressed the market in that.



It is recognising that the model that may be needed today to underpin investment into long-duration storage may be different over time. The scheme that we see would be needed for something such as Rough would be a hydrogen business model support scheme, which has been in the consultation. Over the longer term, something like a cap and floor is more akin to what we see on an established market, such as interconnectors, nuclear and wind. A cap and floor model may be more preferable. It is being agile to understand where the sector is at the moment and what investors need.

Q207 Ruth Edwards: Sarah Honan, what is ADE's view on storage, where we are at the moment and how well are we doing at hitting where we need to be?

Sarah Honan: Everything that my fellow panellists have said is pretty extensive. A lot of the storage that we would deal with in companies is the shorter-duration storage. It is grid scale, but smaller-duration batteries. They are usually aggregated or combined into demand-side response portfolios, because they can boost the size of the portfolio and help other things come along. We are very supportive of some of the new markets that have been introduced by the ESO to bring in more batteries, because they are very fast-response.

Equally, at the moment the design of those services and those markets is very battery-focused. Adding in some more diversity there would be good because there actually are, as Merlin alluded to, a lot of industrial and commercial plants that can respond at a very quick pace and meet the parameters that the ESO is looking for in those markets.

Q208 Chair: Will, can I check two things? On the business case for long-term storage in the UK, I think you said about the UK being an exporter of energy. Can I check what you meant by that? Did you mean that we use the curtailment in the UK to produce hydrogen and then we export the power we can create from that, presumably through interconnectors to the continent, or are you saying that what we can do is provide a storage solution for excess energy created in the continent coming to us via the interconnectors, or is it both?

Will Mezzullo: I will address it first with our curtailment. If we look at what we have curtailed, that is fine. There are four terawatt hours and we think, "How do we manage that?" Actually, there are some really good independent studies, I think from Edinburgh University, but different sources, that estimate the level of curtailment. It is something like 30 terawatt hours by 2035, and that is equivalent to supplying 8 million homes with power for a whole year.

Forgetting the export part, you have an infrastructure and you build it to avoid those elements of curtailment. Because of things like curtailment—and this is where we welcome things such as the review of energy market arrangements, the REMA—we are in a more difficult phase to decarbonise the grid. It is fair to say that the last 20 years, although it did not feel



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easy at the time, was, "Let us connect renewables to the grid". That felt hard at the time, but now we have realised that that was probably the easy bit. The harder bit is how we balance and put more renewables to the grid.

When we assess, as a country, future energy scenarios for national grids, we look at, "How much renewable do I need just to meet my net zero?" If you look at the estimates from the Association For Renewable Energy and Clean Technology and RenewableUK about how much renewable potential the UK has, it could be an exporter.

We are the world leader in terms of offshore resource, but we will limit our growth of offshore resource to meet our own demand. We look at it in another way, thinking, "Imagine if you increased that offshore resource, created jobs and created the export of a commodity for countries that have already declared, 'I am sorry. I have no storage and no renewable resource. I am going to be a net importer'". That is where we see the role that could be played.

Q209 Chair: Secondly, you talked about needing a regulatory settlement to underpin the investment in Rough. Has Centrica done any modelling yet as to what it thinks that might look like in pounds and pence over what period of time from the Treasury?

Will Mezzullo: Centrica has been working closely with Government, along with other industry partners, around what the business model would look like. We have run our own scenario modelling, which has a number of assumptions. Ultimately, at this stage, with Government we are at the stage of underpinning the mechanism first and then going into the pounds, shillings and pence of what that mechanism needs to be.

It is fair to say that the industry is really quite nascent. That adds to the complication. One good thing to recognise is that storage goes hand in hand with production. I think BEIS is recognising this. The cost of storage is impacted by the success of how much production of hydrogen we have. If you build and invest in large amounts of storage but your production is lagging behind, it is not an efficient use of the mechanisms that you have put in place.

We are really pleased to see hydrogen production business models coming out. We hope to see a roll-out of hydrogen production facilities, namely to decarbonise industrial clusters. That also goes hand in hand with storage, so bringing that decision forward and having those conversations of what it looks like from a pounds, shillings and pence perspective.

Q210 Chair: If you want the decision to be made sooner, the Treasury is going to want to know how much money you want, so I suggest that you are going to need an answer to that. When do you think you might get to that?



Will Mezzullo: This year is critical. If we can have that response from a consultation response, saying, “Yes, we have made a decision. It will look like that”, that will open up those discussions. It is not just us in this. It is the rest of the industry that has other types of storage models.

Q211 **Andy McDonald:** Could I turn our attention back to the role of demand-side response? Sarah, when you gave written evidence you said that the energy security strategy did not include any new demand-side ambitions. I wondered, if that is the case, whether sufficient progress has been made in developing and deploying the tools and incentives needed for households and businesses to provide demand-side flexibility.

Sarah Honan: That is a really good question. Here, it is important to distinguish between something Merlin alluded to, domestic demand-side response, and industrial and commercial demand-side response. The propositions and the progress on both are very different.

With domestic, it is a very nascent industry. We have heard a lot about it this winter with the electricity system operators demand flexibility scheme. It will be heavily dependent on the roll-out of those low-carbon technologies, such as EV smart charge points, and EVs attached to them hopefully, heat pumps, heat stores and domestic batteries. It is only then, when there is more volume or more electricity for a house to move around their usage of, that the true value proposition will emerge.

That is not to say that there is not more that we can be doing now. We need the markets to be there. We cannot just say, “Let us wait until we have deployed all these technologies”. We have to have the markets there and ready in order to capitalise on that value and see its full potential.

With industrial and commercial, this is an industry that has been partaking in flexibility for years and years now. We have sugar plant and council-owned district heat networks, such as in Gateshead, partaking in the capacity market since its inception. We also then have things such as commercial cold stores and data centres partaking in those electricity system operator balancing markets.

The challenge there is really to make sure that those markets are accommodating and that barriers are removed. As was alluded to earlier, IT and how we move information around the system is essential to that. We are used to dealing with lots of big gas plants. We are not so used to dealing with lots of small megawatt assets all around the system participating in these services to help the grid. That needs to move at a much stronger pace.

Q212 **Andy McDonald:** How many gigawatts of demand-side response are we going to need to decarbonise power in raw numbers? Do you have any indication of how much of this is going to have to happen?

Sarah Honan: The ESO future energy net zero scenarios, the ones that get us there, estimate between 40 gigawatts and 70 gigawatts of



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demand-side response. For context, we have the 50 gigawatt offshore wind target. That is demand-side response and vehicle to grid technology combined, but that is the number given in the future energy scenario.

Q213 Andy McDonald: Colleagues, are there any further contributions to that discussion?

Merlin Hyman: Sarah has captured it very well. On the domestic side, you have to have your smart meters. I cannot have one in my house because I do not have a phone signal. There are still quite a lot of very basic barriers there. We need half-hourly settlement. At the moment, all of us here essentially go into the energy system as a profile class customer. None of us are going into the energy system based on what we actually use, so you cannot be very smart if it does not really mean anything in the energy system at the moment.

There is a lot of basic stuff, which is all in the process and all there, but that needs to accelerate. There is still quite a debate as to how much we will all be responding based on a fairly simple time of use tariff type process, or whether we will all be responding to a signal saying, "Quick, I had better cook my dinner before 5 pm because ESO needs something and we are going to get paid £2 for that". This is early stage. We are testing those kinds of things, trying to understand, with consumers, where we are going.

As Sarah was saying, domestic is quite early, but there are good players, such as Octopus, coming into that market and innovating. We will see where we get to, but it is clearly going to play a significant role. As we have heard, industrial and commercial is quite a well-established market.

Q214 Andy McDonald: Is there any concern about the equity that is built into this? I can remember super 7 and night storage heaters back in the day. The onus is on consumers to engage and be proactive about it. Are there any worries that this concentration on demand-side response is going to create some inequity in the system?

Dr Radcliffe: That is absolutely critical to understand. Those who have the ability to purchase smart devices will be the ones that could potentially benefit from their use. The scale of the demand-side response, or storage at that local level, could leave a lot of people behind that are suffering at the moment.

We need to take that into account and think about how that sort of market could be regulated as well from the side of the equity issues, but also how the market operates between small-scale consumers who are selling or buying electricity. There may be 20 million electric vehicles parked on driveways or outside homes that are trading on a market that is not visible to the network operators or the system operators. As well as the markets, we need to think about the regulation that is going to be appropriate for that level of consumer engagement.



Sarah Honan: Industry completely agrees with that and we are very supportive of the work being undertaken by BEIS, Martin's secure electricity systems team. At the moment, it is in the early stages of devising a regulatory framework for what it calls load controllers, which are the entities that are able to remotely give signals to assets in homes and control them.

That is the future of domestic flexibility, as opposed to where we are now, which is quite a rudimentary way of, "I am not going to cook my dinner at this time", or, "I am going to do this". In the future, we see much more that level of consumer effort being taken out of the equation. Similarly, at a faster pace, there is already a scheme, a code of conduct, called Flex Assure. It has just started a working group with industry and consumer representatives to draft a code of conduct for domestic customers and microbusinesses in this space.

Q215 **Andy McDonald:** I am curious as to how this is going to work through when people live their lives and they get on with it. Do they really want to construct their lives: "I will cook my dinner in about an hour's time, because it is going to be cheaper. I am not going to have a bath, because that is going to cost a fortune"? People do not live like that.

Merlin Hyman: Sarah's point has highlighted the point. If you have an electric vehicle, you set it up and say, "I would like it to be charged by the morning. If there is a signal saying that it is very expensive at the moment, that is fine. Charge it later", or, "Actually, I might need to go out tonight. I just want it charged and I am willing to pay whatever it takes". There has undoubtedly been a level of automation that can provide you with those services.

That comes back to your earlier point that this is all perhaps very well and good if you own a large EV, have a driveway to park it in and you are digi-savvy and have the app, the iPhone and all the rest of it. It could end up entrenching and excluding a lot of people. That is something we are going to have to think very hard about.

You already see, if you have an electric vehicle, if you charge at home it is about a third of the price as if you charge out. If you do not have a driveway, you are already paying three times the price of somebody who has a big home and a driveway. This is already being entrenched in the system. You are right that that kind of fairness and equity of this process is going to be critical. That really needs thinking about on the tariffs and supply side of the energy system.

Will Mezzullo: We have to be careful of pushing everything on to the consumer. That demand-side response, that short-duration balancing, is where grid-scale batteries are really effective. We heard that the UK so far has been rolling out successfully. At the moment, the grid is absolutely constrained. They physically can put hardly any more grid-scale batteries or renewables on the network.



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I have an example. We have a solar farm. It is not ours. We have been made aware of a solar farm with a 14 megawatt grid connection. It has been told of a grid connection date of 2033. When we look at how we help customers reach net zero and apply that demand-side response, how we help them balance the supply and demand, grid-scale batteries have a role to play.

It is not a lack of investment. The investment is there. It is not a lack of skills. We have the skills in the UK and the technology is there. It is physically the grid constraints. There is a role here for Government and Ofgem to work really closely with transmission network operators and distribution network operators to facilitate more batteries and more short-term balancing systems on the grid, as opposed to putting all that responsibility on to the customer.

Merlin Hyman: One key point I wanted to highlight today is the grid issue. I am quite impressed. We have got half an hour in and we have not talked about it yet. If you talk to anyone in the clean energy sector, that is all they want to talk to you about. The solar farm is quite lucky with 2033, because for most people it is 2036 or 2037 now. If you apply with a new solar farm, battery, hydrogen electrolyser, large-scale EV charger in most parts of the country, you will get a connection date in 15 years' plus time. Given our targets are rather earlier than that, that is clearly a huge problem now for the whole net zero transition.

Broadly, it is two parts. There is longer-term asset investment, with more wires. The core infrastructure will still be critical to this transition. Then there is a short-term queue management system, where there are a lot of projects that are not proceeding that have the capacity. There are those that can proceed but are stuck in a queue. There are much better ways of managing that queue.

The ESO asked me to chair the challenge group for its GB connections reforms process, which it is starting at the moment. There is recognition of this issue but I do not think it is yet nearly a high enough priority. I am not sure that policymakers and politicians are very aware of this critical issue, the fact that it is blocking billions of pounds in investment and our progress towards net zero.

Specifically on storage, there are potentially quick wins here. Storage should be helping the system. At the moment, it is largely modelled as at maximum generation it will also be exporting, so it is an added problem, or at maximum demand it will also be importing. If it was modelled as zero or even positive, the network operators could allow it to connect and they clearly need some control process there.

They need the ability to switch some sort of non-firm connection, in the jargon, the ability to stop you generating in extremis if they need it to protect the network. The industry would accept that, providing it was sensibly done and did not affect their revenue models too much. There



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are some quick wins there, but this is definitely the number one barrier for storage.

Q216 Andy McDonald: That is fascinating. You took us into capacity and transmission, which I was not expecting to go into. We see it. Royal Mail has electrified a lot of its vehicles. It cannot charge them up quick enough because of the lack of transmission. We have ambitions to continue rail electrification. We have some challenges there.

Can I switch you back? I wanted to know whether you had any insights or lessons to be learned from the pilot that has just been run. Is it too early to tell or are there any little nuggets that we are picking up at this stage, anybody?

Sarah Honan: You mean from the demand flexibility scheme. It has been an amazing trial that has come out of a not very favourable context with the gas price crisis. At least before Christmas, from the results of the first six test events, we saw that customers were overperforming. Some of the fears around disengagement—that you would do it once and then stop doing it—did not really happen. We had our first real-world event last night at 5 pm to 6 pm and will again this evening. The level of engagement has been really impressive and the level of volume that has been procured is really impressive.

The next lesson to be learned before we have all the metrics in is that this was a contingency service. ESO was also warming up coal. It was because it had exhausted all of its normal balancing actions, the ones that it uses every day. The problem with that is that DSR, or demand-side response, needs to become part of the everyday, part of business as usual for National Grid ESO. At the moment, some of the IT struggles we have talked about will be somewhat of a barrier to that.

Next stage for the demand flexibility scheme looks to be trying to incorporate all the public engagement and increased public understanding of demand-side flexibility into a business-as-usual model.

Dr Radcliffe: We need to know who benefited as well. The impact has been, I hope, substantial, but who has got the benefits? Which members of the public have benefited? Is it the people who did not need the extra revenue so much compared to some more fuel-poor households?

Q217 Andy McDonald: Perhaps, for future reference, concentration should be on the fuel poor, or where they have intensively harvested those returns perhaps.

Dr Radcliffe: There is actually some work in Ireland that is looking at using excess renewables from wind, which is going into heating up the immersion tanks for the fuel poor specifically. That is a scheme that could be tried out here.

Q218 Mark Jenkinson: It is interesting that you say about who benefits. I feel like I should declare an interest here, because I have been taking part in



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Octopus demand-side trials. I do that because it is really easy. I do not make any changes. I am not even there, because they have been Mondays and Tuesdays to date. My family do not make any changes to their lifestyle, but, because it is based on the last 10 days' history and not last Monday, or an average of Mondays or Tuesdays or whatever it might be, it is effectively money for nothing for someone like me; it is just two clicks.

You said, Sarah, that uptake was good. I think you said about needing to understand who got involved. If we know we need power on a Monday or Tuesday night between 5 pm and 6 pm or 4.30 pm and 6 pm, how does averaging that out over 10 days, rather than Mondays and Tuesdays, work? Most people's lifestyles will be quite similar on a weekly basis. My kids have clubs, training and whatever else. Do we know?

Sarah Honan: It was a massive question when the scheme was being developed and we were part of the industry working group, about how you measure performance. It goes to wider issues in the electricity system. How we usually measure performance is that a gas plant will say, "This is what I am going to be doing in an hour", and then afterwards you check whether it did what it said it was going to do.

As you say, in our homes it is harder to measure something that did not happen, as opposed to measuring something that did. The 10-day profile was an approach that was originally envisaged for industrial and commercial sites. It has proved effective in some ways. As you say, in your case it might be better to do Mondays and Tuesdays, but, if you do the last five Mondays and Tuesdays, say when this scheme started, you might be talking about summer. You might not have the same routine that you are talking about in your case.

Another thing that we found with the baselining, and coming back to the comment about the fuel poor, is that we were trying to get this up at pace this winter. A real question was that people were reducing their energy use anyway this winter, so people were saying, "Why do we not do that 10 days to this time last year? That would be more indicative of what I would be doing if I was not afraid of my bills".

To round all that up, how we measure performance and develop a framework that is best suited for domestic customers is very much something that industry and the ESO are focused on for phase 2 and how this demand-flexibility scheme develops.

Q219 **Charlotte Nichols:** To declare an interest, I am a vice-president of the Association for Decentralised Energy. I am interested to know how the National Grid ESO and district network operators are making sufficient use of flexibility. What more could and should the system operator and DNOs do to drive the transition to a smarter, more flexible grid?

Will Mezzullo: The biggest challenge we see is allowing more grid-balancing assets on the network. Some of them will take the form of



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batteries. We have talked about the role that batteries can play. The biggest barrier is physically connecting those.

The other type of balancing service that we see is around gas peaking. We own gas peakers. These are engines that sit there, on the grid, and, for a very long period of time, just sit there quietly, not doing anything. Then, for those long periods of time when renewables are not available, they get called on.

We have heard about compressed air. We are also looking at other forms of medium-term duration storage. All of these things are grid-connected. You can try to force each individual consumer to have, potentially, their own battery and push that responsibility or balancing on to the consumer, but there is an absolutely fundamental role of being able to connect at the distribution network, which is the lower network that is closer to consumers. If I could come away with the most important point, it is around facilitating more balancing services on the network.

Q220 Charlotte Nichols: In terms of some of those medium-length storage technologies that you have referred to, could you be a bit more specific about what sorts of examples you are referring to there?

Will Mezzullo: Yes, sure. I will give a couple of examples of the batteries that we have. I think that they are in the 20 megawatt to 50 megawatt region and for two-hour duration. They will operate, carefully balancing the network.

For declaration, I have a battery at home. As you can imagine, I am a bit of an energy nerd, so I spend my time boring my children and wife about energy. I monitor what my battery is doing, but I also look at the cost of that battery. My battery is eight kilowatt hours at home and it was a substantial investment.

Then I look at the batteries that we have at our facilities and they are 50 megawatts. Then I understand that one of these could suffice for thousands and thousands of customers and, critically, the customers who may not be in a position to install a battery at home, due to space or funds. That is the bit I am quite passionate about, understanding that it is not all pushing down to the consumer around balancing the grid, but also how we decarbonise it.

Q221 Charlotte Nichols: How much of the balancing is or should be batteries versus load-following capacity from other sources of energy generation?

Will Mezzullo: That is a good question. I do not have those figures to hand, but the balancing market and grid connectivity will respond to the market conditions. We heard earlier on that investors will make an investment into a battery and look at what the market conditions are. In theory, if you are getting to the top end of how many batteries you have deployed, you start creating so much balancing in the market that it starts becoming un-investible. We are so far away from that. It is really



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difficult to tell when we have hit that point. It is a really valid point about being aware of how many we need.

Merlin Hyman: Specifically on how much, in a way, there are future energy scenarios. Regen does its own modelling and I mentioned “A day in the life of 2035”. The critical thing for us, as policymakers and regulators, is to signal the value that the system needs and let the market respond. If companies out there prove brilliant at persuading lots of people to respond very flexibly and quickly, that may form a bigger part of the system. If it turns out that it is quicker and more efficient to do it with large-scale grid batteries, that should come through the market, providing that the value is there and clearly signalled and there are not barriers to enabling people to provide that system.

To pick up on your question, I agree, again, that the most important thing for the networks to do is to enable people to connect batteries to the system. The second thing that you really want to know, if you are an investor, is that you will be able to access value for the service that you can provide. We have alluded to this point: that the electricity system operator particularly is running these market frequency responses— inertia, voltage balancing. They have been designed around a few large-scale assets and are going through this transition in terms of being able to use this much more decentralised portfolio of different sorts of assets.

They have strategies and we have a markets roadmap. There is positive progress and we engage between the electricity storage network and the electricity system operator very regularly and constructively. That is a critical transition that needs to go faster and there needs to be a lot more transparency. I hesitate to get into the world of skip rates in this institution, but, essentially, that is saying that people at the moment see that their battery looks like the cheapest way of meeting a demand on the system and then it is not called on. Maybe a gas-fired power station is called on instead and they do not really understand why.

That clarity and transparency is not quite there yet. That means that, as an investor, I have a bit of nervousness. I have this great asset. I know that it can provide a service that we really need in the system to balance the system or provide frequency support, whatever it might be. I am not quite clear yet whether I will actually be called on or whether I will not. I am not quite sure exactly what criteria there are and they do not quite seem completely transparent to me yet.

I mentioned connections as one key barrier. A second key barrier to unlocking this pipeline of projects that we have out there, when they can connect to the grid, is investor confidence that they can access the revenue from the value they can provide to the system and it is all clear, transparent and done quickly. That reform is still in relatively early stages.

There is a certain amount that can be done at the DNO level as well that, again, is about connections. There is potential. The district network



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operators now run flexibility markets, which are largely about overcoming local constraints. That, again, is progressing, but there is definitely room to move faster into the world of DSO, distribution system operation, where you are starting to think about the whole system in a more rounded way, rather than just maintaining the wires.

There has been good progress in the UK. We are a world leader in this area, but there are still a lot of barriers. We need to keep up that pressure and progress.

Dr Radcliffe: We need to move away from just thinking about batteries as well. They are providing a great service at the moment over the shorter timescales. We need to be thinking about inter and intraday markets as the amount of wind from offshore sources increases up to many tens of gigawatts over the next decade.

That is an area where different technologies might be much more appropriate from the point of view of the cost of installing new batteries to meet that, but also thinking about some of the environmental impacts of having a lot of electrochemical batteries. For storage of that sort, there are things like compressed air energy storage, liquid air energy storage that is being tested and flow batteries as well. That is where we need to be driving down those costs and understanding the value of that network connected storage that we have got used to.

Sarah Honan: I completely agree with everything that Merlin said there. For us, we consider two baskets of barriers for demand-side response. Those are the IT, how information moves around and the market barriers. They are very related.

If you cannot get into markets because of IT barriers, the market signal is not there for investment to be made, even though demand-side response is really cheap to deploy. That is one of the things that distinguishes it among sources of flexibility. It does not require a ton of investment, it can be used quite easily and it is just about using what we have better. If the IT systems are not there to, economically and efficiently, pick the cheapest, the lowest carbon, or whatever parameters you want to put on it, that come into the marketplace, the business case simply is not there.

One recent publication that tries to throw some light on this was Ofgem's commissioned independent review of electricity system operator investment plans. That highlights a lot of what industry has been saying for quite a long time.

Q222 **Charlotte Nichols:** How confident are you that, by 2025, the system operator will be able to successfully manage periods of 100% zero carbon electricity?

Sarah Honan: That fully depends on the transformation of the IT systems. They said that their plans for this price control period were that



the IT would be overhauled by 2025. That is now looking at 2027. A lot of people do not realise that this is a very manual process. How the system is balanced and kept safe is still a very manual process. That means that it is quite secure, but it also means that it is not necessarily going to be the way we do things in the future.

Merlin Hyman: I welcome the announcement a few years ago that the ESO made as a good example of leadership, that it was aiming to do that, to recognise positive progress. It may well be able to hit it for a short period of time, but, as we say, there is still a whole transformation programme.

The last policy point on that is if we can move on from the electricity system operator owned by National Grid to a future system operator, with the Energy Bill going through Parliament at the moment, as an independent public body, that should give them more authority, independence and clarity in their role to lead this kind of transformation. That is a very important takeaway for policymakers.

Q223 **Mark Pawsey:** We have heard lots about price mechanisms and batteries, but many of these things are being considered by the Government in their review of electricity market arrangements. I am wondering if each of you could tell us what you would like to see as an outcome from that and what should be avoided.

Dr Radcliffe: REMA does a good job in analysing a lot of the issues that are going to come up over the next 10 years. Maybe where we need to do more work is thinking more about the energy system, rather than just the electricity system, which has been the focus. Especially as we go through the 2030s, we will be decarbonising heat and transport, and REMA specifically excludes having that low-carbon heat element of the system, but that is going to be really critical to be part of the consideration.

Q224 **Mark Pawsey:** Do you think that having a system that can be implemented from the mid-2020s is a reasonable objective? We are not far away from the mid-2020s, are we?

Dr Radcliffe: The targets are to be having large-scale deployment of heat pumps by 2027 and later, so they are going to have a massive impact on the network. How we deploy those is going to be really critical. The other forms of low-carbon heat will be part of that system as well. It is not just about thinking about electricity but also that wider system impact.

Q225 **Mark Pawsey:** Merlin, what would you like to see from REMA and what should we avoid?

Merlin Hyman: We should avoid locational marginal pricing. Engaging in a major, highly complicated, economically theoretically reform at the moment that we need tens of billions of investment would not be a sensible approach. We should speed up, put rocket burners—green



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hydrogen rocket burners—behind the reforms that we have been talking about. I might call it radical evolution.

We need to reform the way the balancing system works, move to perhaps shorter settlement, closer to gate closure settlement periods, reform the way we do constraint management, reform the control room of the future, reform the capacity market to stop just valuing four-hour duration and perhaps value all the other types of services that can be provided to balance the system. This is a massive transition and there is going to be a lot of change required. It is not the basic market framework that is the problem. It is making that basic framework work for this transition.

Q226 **Mark Pawsey:** We heard a lot earlier about the constraints of the grid. Are they going to prevent any changes that Government might want to make?

Merlin Hyman: We had a session on REMA with our members, and BEIS came and talked to them. If I could paraphrase the response from 100-plus investors in the sector, it was, “The market is fine. The problem is that I cannot connect to the grid”. I am greatly oversimplifying and there is a lot to be done in market reform, but the burning platform is connections and enabling assets to connect. REMA does not directly address that.

Q227 **Mark Pawsey:** Will, what should we aim for from REMA and what should we avoid?

Will Mezzullo: This probably chimes with what has been said before, but really to look at holistically. That is not just looking at the power sector but looking at how a decarbonised gas sector, which includes biomethane and green hydrogen, helps, and aligning with other Government targets.

We have a Government target of 2026 for decisions on hydrogen for heat. You think, “Why are we looking at hydrogen for heat?” It is because of exactly what we have been talking about. At the moment, peak demand for heat is about 170 gigawatts of gas. If you use a heat pump, converted 28.5 million homes to heat pumps and had a good coefficient of performance, that is about 56 gigawatts of power that you would need.

Yesterday, the grid was providing 42 gigawatts of power. When REMA is being undertaken, we need to understand what the consequences are if we move to one single solution of electrification of heat or one single solution of this. It is those unintended consequences and that is why a really holistic approach is needed. Also, we need to understand why Government are looking at technology-agnostic solutions around heating and other forms. Those are the recommendations.

Sarah Honan: REMA is a really good opportunity to come up with a UK-specific market system to get us to net zero. Given we know what our generation profile will look like in 2050, as long as the right investment signals are there, the rest falls on flexibility and making sure that we can operate all that lovely renewable green energy. This will be the first time



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that we have ever done that in a very focused manner. Making sure that we come up with markets that truly value the demand side on an equal footing to the supply side is integral.

As far as what to avoid, the big thing is that, although we should be considering the current climate as context for REMA, the seeds of REMA were planted long before the present gas crisis. When we are thinking about energy sovereignty and how to get there, we should avoid treating the immediate climate as the impetus for this and focus on what is best for our future system.

Chair: Thank you very much everybody. I am sorry that we have kept you slightly longer than we had intended, but we are grateful to you.