

Science and Technology Committee

Oral evidence: [Technologies for meeting clean growth emissions reduction targets](#), HC 1454

Tuesday 2 April 2019

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[Watch the meeting](#)

Members present: Norman Lamb (Chair); Vicky Ford; Bill Grant; Stephen Metcalfe; Damien Moore; Graham Stringer; Martin Whitfield.

Questions 230 - 356

Witnesses

I: Professor Keith Bell, University of Strathclyde; Dr Robert Gross, Imperial College London; Dr Nina Skorupska, Chief Executive, Renewable Energy Association; and Tom Greatrex, Chief Executive, Nuclear Industry Association.

II: Professor Nick Eyre, Director, Centre for Research into Energy Demand Solutions; Professor Tim Green, Co-Director, Imperial College Energy Futures Lab; Randolph Brazier, Head of Innovation and Development, Energy Networks Association; and Duncan Burt, Director of Operations, National Grid System Operator.

Written evidence from witnesses:

- [Renewable Energy Association](#)
- [Nuclear Industry Association](#)
- [Centre for Research into Energy Demand Solutions](#)
- [Energy Networks Association](#)
- [National Grid](#)



Examination of witnesses

Witnesses: Professor Keith Bell, Dr Robert Gross, Dr Nina Skorupska and Tom Greatrex.

In the absence of the Chair, Stephen Metcalfe took the Chair.

Q230 **Chair:** Good morning. Thank you for joining us for our latest evidence session on technology for clean growth. First, may I ask you to declare any interests that you may have that we should place on record?

Professor Bell: I have done work as a researcher with various parties involved in the industry and given advice to other people as an academic, providing independent, objective advice.

Q231 **Chair:** Thank you for that, Professor Bell. I invite each of you briefly to say who you are and whom you are representing here today.

Professor Bell: I am Keith Bell. I am based at the University of Strathclyde. I am also involved with the UK Energy Research Centre, where I am one of the co-directors. I have a power systems background.

Dr Gross: I am Robert Gross. I work on energy policy, economics and systems at Imperial College. I am also involved with the UK Energy Research Centre.

Dr Skorupska: Good morning. I am Nina Skorupska. I am chief executive of the Renewable Energy Association. I am also on the board of Transport for London. My other interest is that I am the deputy chair of WISE, the Women in Science and Engineering Campaign.

Tom Greatrex: I am Tom Greatrex, chief executive of the Nuclear Industry Association.

Q232 **Chair:** Welcome. If the UK wants to meet its fourth and fifth carbon budgets, it will have to deploy quite a lot of low-carbon generation, to build on that capacity. How likely is it that the UK will be able to deploy that low-carbon capacity?

Professor Bell: I think that it is entirely credible. We are well on the way. The progress that the UK has made in that respect over the last number of years has been excellent. I am trying to remember exactly what the parliamentary advice was that the CCC gave last year. Based on what exists now and the plant that already has contracts, is under construction or is scheduled to come along, we are getting well on the way there. When you factor in what the offshore sector deal is talking about, with 30 GW of offshore wind—I have not worked out exactly what the 30 GW would add to what is already there—you get the picture that we are getting close. I think that the CCC said that we might be 50 to 60 TWh short of what its carbon budget is suggesting by 2030, out of a total of somewhere between 250 and 270 TWh. There is a proportion that is



not already contracted, but, with the offshore sector deal, it seems to me that we could be well on the way there.

Dr Gross: We have something of the order of 40 GW of renewables installed and something of the order of 100 TWh coming from that sector. We would need to double both of those statistics over the period to about 2030. We will also need to ensure that we get at least one nuclear station away if we are to be on track to meet those targets. If you just think about that, you see that we need roughly to double the amount of renewables capacity and to make sure that we at least replace the nuclear stations that are going to close—or that we do something else. If we do not replace the closing AGRs, we will need to go even further with renewables or to do something with CCS, which we are currently doing absolutely nothing with.

On the renewables front, the only really big show in town between now and 2030 is the offshore wind sector deal, which promises 30 GW of new capacity. I completely agree with Keith that that is perfectly achievable, but we are very largely putting all of our eggs in that basket. At the moment, for example, the Government are not running any pot 1 auctions—auctions for cheaper technologies like onshore wind. Some capacity is still coming through, because there is a pipeline of existing projects. A small amount of solar and wind onshore is being contracted purely merchant, without any support, but I do not think that we can expect it to come through that route in very large numbers. We could well be on track in the power sector, but we are putting a lot of reliance on the offshore wind sector deal to deliver that.

Dr Skorupska: I agree with my two colleagues about whether or not we are on track to meet the fourth and fifth carbon budgets. To be absolutely correct, we are not on track. That is because we have not yet seen any new, fully funded supports or policies being introduced. All the policies stop at the end of this decade, but with a view to further CfD funding, as we have heard, for offshore wind, maybe from pot 2. We will talk about pots later.

We have seen the amazing things that can be achieved when there is clear policy and direction. Renewables' share of electricity generation has trebled since 2011. We are at around 33.3% in its delivery. It has been a mix of wind, solar and other technologies. The missing technology, which is referred to less, is bio-energy forms. The concerns about renewable power—I am anticipating that we may go down this track—are about the definitions of "base-load", "dispatchable", "secure" and "reliable". There is a whole range of renewable technologies that can deliver that.

The last point I would make is that, given where we want to go with the resource and waste strategy, there is a chance that we may have a view of lining up what we do with our waste, and how that resource can be used in various different guises.

Q233 **Chair:** Tom, do you want to add anything?



Tom Greatrex: The point that the Committee needs to bear in mind is that the budgets are around carbon, not just renewables. Therefore, they are around low-carbon generation, for the electricity part of meeting those budgets. If you are looking at a 2030 timeframe, all but one of the current nuclear fleet will have reached the end of their operating lives by 2030, after lifetime extensions. From time to time, you hear Secretaries of State and others talk about an abundance of power. They may be talking about the current point, but, looking forward to 2030, I think that that is a dangerously complacent position to take.

Q234 **Chair:** I think that the point you are collectively making is that there is the capacity, in terms of will in the sector to sort this out, but you need certainty of policy from Government and an indicator of where their thinking is moving forward. Is that correct?

Dr Skorupska: I think so. In the past, renewables have been identified as always looking for a subsidy to get them away. Support mechanisms have definitely seen the massive deployment of various technologies. With volume, the costs have come down. But we have no clarity going forward around any sort of mechanism or framework by which we can not only enable the cheaper, more commercial technologies to deliver, but bring on those technologies that were supposed to be brought on through the levy control framework, such as marine and other areas, so that they get the same depth of attention.

Q235 **Norman Lamb:** I have a very simple question. How urgent is the need for Government to provide the lead you are calling for?

Dr Skorupska: An illustration is around things that have stopped happening, even in the most recent times. We saw the closure of the RO a couple of years ago. The RHI is coming to an end. The feed-in tariff for smaller-scale renewables closed at the end of March. There is really nothing to enable it. Market is a wonderful thing to enable and attract investment, but at this moment in time it is not certain enough to kick-start new entrants.

I take marine, in particular. Marine—tidal—has always potentially been viewed as the real thing the UK could get its teeth into. It has been the Cinderella here. If it had got the same attention as offshore wind, we might have seen it going already. The CCC's view is that perhaps 10 GW could be installed. That is 50% of what Europe could do all together. It is quite the majority.

Professor Bell: As Rob said, it is not just about wind or offshore wind. The point about the pot 1 technologies is very well made. We are in a period of uncertainty there. I speak to various people in the sector. Some of them are optimistic about being able to get merchant investment away, but others are very sceptical about it. It is not a question of subsidy any more, I think—it is a question of the right contractual framework that allows the cost of capital to be reduced and allows the



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investment to be unlocked. It is not about a net subsidy, relative to the alternative generation technologies.

That is one dimension of the urgency of action. For another, we have a window of five years or so. Looking to 2030 and beyond, things like carbon capture and storage technologies start to become really important. We have to be able to build up confidence in that as an at-scale source of electrical energy, and to look at how it meshes with the possible production of hydrogen, as another mechanism by which our heating demand, which is extremely significant and is dependent on natural gas, will be met. Those things have to be considered together.

To be able to understand what these options mean and what the infrastructure requirements would be, we really have to be doing stuff very soon. Some of the clean growth strategy points towards that, but we will have to see that working effectively as a means of learning, where the learning is properly built on and disseminated and is done in a coherent way.

Norman Lamb took the Chair.

Q236 **Graham Stringer:** Can you explain what you mean when you say that it is not a question of subsidy?

Professor Bell: Subsidy, in my interpretation, means that some extra money is being given, over and above what would be the market-based investment. Regardless of what the technology or the energy source was, something extra would be needed, to come out of taxpayers' or consumers' pockets. We can look at the last auction round for CfDs for offshore wind. I think that it was in 2012 prices. I do not know what the inflation scaling would be, but the price was £57.50 per megawatt-hour for a couple of the new offshore wind farms. Depending on what you assume about gas prices, that is pretty much commensurate with the levelised cost of energy for a new combined-cycle gas turbine. That is what the market was building in the 1990s, and a little bit since then. Is low carbon more expensive than that? On that basis, no, so subsidy is not the subject—it is a matter of the contractual arrangements.

Q237 **Graham Stringer:** Until you put nuclear or some new technology into the system: then you will need subsidy.

Professor Bell: Based on the contracts that were struck, nuclear seems to be significantly more expensive than that. Then you have to look more deeply into the energy system. Nina mentioned the definitions of base-load and so on. What mixture of technologies allows the system to be operable, given the wide variation in demand through the year and through a day?

Q238 **Vicky Ford:** Tom, you spoke about older nuclear coming to the end of its life by 2030. How important are the various new nuclear stations that are planned to come online? I have a declaration of interest—Bradwell is just down the road from my constituency.



Tom Greatrex: It refers back to the Chairman's previous question about urgency where there is a requirement for Government to take a view on a number of different things. In relation to large-scale nuclear, such as Bradwell and Sizewell—those beyond Hinkley—that is determined largely by how much progress is made on adopting a more appropriate financing model or mechanism for that type of large-scale infrastructure, which has a very long construction period and then a long repayment period. That is quite different from a number of other sources of power generation. To be able to maintain the broad proportion of nuclear in the mix, which brings to it a range of different features that help to get you to a mix that is as low carbon as possible, there are a number of policy interventions that need to be determined. They are all there in BEIS and are being thought about and considered, but there is a real urgency on time, because of the time it takes to build the power stations.

Q239 **Vicky Ford:** May I be more specific? To replace old nuclear that is running off, which of the new power stations definitely needs to happen?

Tom Greatrex: The complication with this is that it depends on what you think overall power demand in the period ahead is going to be. You have a certain amount of capacity now that, on output—

Q240 **Vicky Ford:** Just to replace existing capacity.

Tom Greatrex: Do you mean by a proportion—

Q241 **Vicky Ford:** Nuclear for nuclear.

Tom Greatrex: In terms of the amount of capacity from current nuclear, or taking into account the likely increase in demand?

Q242 **Vicky Ford:** To replace the ones that are switching off, which ones do you need to switch on?

Tom Greatrex: Of the current projects that are in train, you will need Hinkley, Sizewell—which follows on from Hinkley—and Bradwell, plus at least one other. Of the others, one has been suspended, while NuGen has ceased to operate. Those sites may become more opportune in the future, depending on how the finance mechanism develops.

Q243 **Vicky Ford:** All three—and more—are needed, just to replace what is switching off.

Tom Greatrex: To provide the same proportion of power, with the likely demand that you will have.

Q244 **Vicky Ford:** Not to provide the same proportion of power—that was not my question. Which are needed just to replace the capacity that is coming off?

Dr Gross: My understanding is that you have about 4 GW of AGRs that are slated for closure by the mid-2020s. Hinkley is 3.2 GW. It would be operating at a higher load factor, because it is newer. Therefore, it would roughly replace those closing AGRs.



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Tom Greatrex: No. It would not replace all of those that are closing by 2030.

Professor Bell: In 2030, most of the AGRs will be gone.

Q245 **Chair:** May we have a note from you on that?

Dr Gross: Factually, we could very easily—

Q246 **Chair:** You also made the point that, because of rising demand, we are likely to need more.

Tom Greatrex: Yes.

Q247 **Chair:** Is that the point you were making?

Tom Greatrex: Yes. Even with all sorts of other developments in technology, if we are more successful in decarbonisation of transport and, potentially, heat and other things, the proportion of energy that comes from electricity is likely to increase overall.

Vicky Ford: A note would be helpful.

Q248 **Chair:** If the UK leaves the EU emissions trading system, what impact is that likely to have on the objective of decarbonising power generation?

Professor Bell: We have a carbon levy at the moment, so it will have some sort of effect. You could argue that, by the time the last GB coal stations have closed, that carbon levy will not be required.

Increasingly, we are making use of interconnections to the rest of Europe. We have a fair bit of capacity there now. Exactly how the market across the whole of Europe uses that will depend on the relative prices, of course. In that respect, it will be important that we do not introduce distortions in how carbon is priced here versus elsewhere. That can apply across other sectors as well. There is always a danger that, if we are too penal on it, all that we do is offshore the carbon.

My group has been doing some modelling, looking out to, say, 2025. It is a bit of an artificial scenario, because you might expect the carbon levy in GB to have reduced by then, but let us say that there is a difference in carbon price between GB and Europe. If we had a higher carbon price here, we would have lower carbon emissions from the electricity sector. We would be importing more energy overall, over the interconnections that we might expect to be built between now and then. However, the total emissions for the whole of Europe, including us—we will count ourselves geographically for that purpose—would be higher.

Chair: I understand.

Professor Bell: In other words, if we do not get the prices aligned, all that we will do is replace some of the more efficient gas with less efficient stuff in the rest of Europe.



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Dr Gross: The immediate impact on low-carbon generation support policy is relatively neutered. We already have a carbon price floor in the UK—an underwriting of the emissions trading scheme price, because some years ago a view was taken that that price was not sufficiently high to incentivise everything. We do not know anything, frankly, but it has been suggested that that would be sustained.

There is an accounting impact, which is to do with how we account for traded emissions under the Climate Change Act, but that is purely accounting. It does not build any power stations or change any of the carbon that is going into the atmosphere.

In the last few years, the carbon price floor has been very significant in the switching from coal to gas, because it has made it marginally less economic to burn coal. Coal-fired power stations have been closing for other reasons as well, mainly to do with their age and the acid gas regulations, which are also European regulations. In any case, the Government have said that they intend to ensure that all coal-fired power stations are closed by 2025.

If you are looking at the impact of carbon pricing on the power sector, and the only remaining fossil-fuel generation that you have is gas, it takes you back to the previous conversation about what forms of support you need and for which technologies, additional to, and over and above, a carbon price. Be very clear on that. A few renewables will get built with no subsidy at all, in the best sites—cheap solar and onshore wind. With offshore, we will continue to need some contractual de-risking, like a CfD, over a period of time, but that could be at zero subsidy or below. Nuclear is a special case, frankly, because it takes so long to build and costs so much. Therefore, it needs somebody—

Q249 **Chair:** I am conscious of the fact that we are tight on time. Could you try to keep your answers succinct? This is the final question from me. How attractive is the UK electricity sector for investment? Why has investment in low-carbon power generation fallen?

Dr Gross: It is less attractive relative to other countries than it used to be. We have a pipeline of investment that is still coming through for projects that were commissioned either under the renewables obligation or in the early years of the CfD. Some of those projects got quite high levels of subsidy. You would not want to continue that, because it is expensive for consumers. For the reasons Nina has already pointed to, we do not really know what is going to be happening after about 2021 or 2022. That is very soon. If you are planning a project—

Q250 **Chair:** We are lacking the mechanisms now to drive future investment.

Dr Gross: It is less likely that you will attract cheap investment into the UK. Pension funds and institutional investors like renewables globally, but they like renewables in a nice, low-risk environment, which does not mean a high-subsidy environment. That is too uncertain now in the UK.



Q251 **Chair:** Were you going to say something, Nina? Please do so very quickly.

Dr Skorupska: It is an unstable policy environment, as Robert has said. We have a finance forum within the Renewable Energy Association, because we look at all the forms of technology and help investors to understand technology risk. We also try to explain policy and regulatory risk to them. They have got to know solar and wind, but the general lack of a clear policy and framework beyond 2020 is stifling investment.

We have talked about the EU ETS and carbon pricing. That has a detrimental view of what will happen beyond 2020. The Committee will be aware that we are now rated eighth in the RECAI—the EY attractiveness index. We have been as low as 11th, just after the referendum, when everybody wondered what would be going on. We were seventh last year, so there is still money coming in.

I will give you a real illustration of what the uncertainty is doing. Our renewable generation increased by 0.9 GW in 2017, because of where we are with Brexit and uncertainty, compared with 2.4 GW that was built in 2016. Everything is slowing down.

Q252 **Damien Moore:** Should we be increasing the amount of onshore wind power and large-scale solar power as part of the UK's energy mix?

Dr Skorupska: I believe that we should. It is our cheapest form of renewable generation to date. It goes hand in hand with clean technologies, such as energy storage. This afternoon you will hear about decentralised energy and the interconnectedness of our smart systems. That is showing in an extraordinary way that we can both connect large-scale solar and onshore wind to transmission levels and continue to spur community-level generation. With on-roof solar and the built environment, we really are harnessing and delivering power close to where it is demanded and at all scales across the country.

Dr Gross: I will give you a non-partisan version of that.

Dr Skorupska: There is nothing wrong with being partisan.

Dr Gross: No—it is your job. There is no question but that, in the right location, onshore wind and large solar are the cheapest low-carbon options. We would all agree with that. At the moment, we are a long way from being in a position—apart from at a few pinch points—where there is such a lot of renewables on the grid that we cannot accept the power or huge system costs are being created. We need to be mindful of that in the long term.

Ultimately, it is a political choice. There was a manifesto commitment not to provide any more subsidy to onshore wind. Onshore wind and solar are controversial in some parts of the countryside, with some constituents. Therefore, we have decided that we prefer to do more expensive things further away that people cannot see. It is as simple as that.



Q253 **Damien Moore:** What are the main barriers to deploying onshore wind and large-scale solar, other than participation in contract for difference auctions?

Dr Skorupska: You mention the contract for difference auctions and the fact that the different technologies are put into three different pots. Pot 1 was defined as the most established technologies. Pot 2 is for the least established technologies. Pot 3, as the Committee may be aware, is for conversion of coal-fired power plants to biomass. Pot 1 has not been funded in the last two rounds of auctions, so solar and onshore wind have not been given a chance to participate, even to demonstrate how low the price could be, compared with pot 2 auctions.

When we have introduced auctions, as we have for pot 2, we have seen the startling reduction in prices that the different developers have offered. They were as low as £57.50 a megawatt-hour for 2022 delivery of offshore wind. Imagine if pot 1 had got away. I think that we could be looking at prices in the 30s.

Dr Gross is quite right. now, we can have these going away subsidy-free. Solar is still getting ahead subsidy-free, but onshore wind is not. That is linked to the manifesto pledge.

The pot 3 element is a really interesting aspect. The issue is whether we should have pots at all any more, because those definitions may not be useful. This mechanism was supposed to support less-established technologies, such as marine and advanced conversion technologies—gasification of organic waste and anaerobic digestion. We need a minimum. We need a little bit of ring-fencing. If it is in the same pot as offshore wind, it really cannot complete. Therefore, we need to look at this again.

Q254 **Chair:** I will take a quick contribution from Keith.

Professor Bell: I want to come back to the question. Rob pointed to one of the obstacles—public acceptability in particular locations. We are already seeing some network and system constraints in parts of the south of England, to do with solar PV. There is a lack of observability and controllability of it, so that the network operators can really know what it is doing. It does not mean that it cannot be connected, but there will be certain conditions when there is actually a surplus of it. There are technical and market means to optimise it.

Q255 **Chair:** How it is that many other European countries appear to have a much greater solar presence? It seems to be effective there. Do we have particular problems?

Professor Bell: It is about the nature of the system and the nature of the demand. In southern parts of Europe, it is sunnier, but there is also a fair bit of air-conditioning demand. The two come along together. At the time of day when the solar power is available, the demand is higher.



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Q256 **Chair:** Are there particular problems to do with our grid that make it more difficult than in, say, Germany?

Professor Bell: I think that we would see the same kinds of problems anywhere. It is very locational, in terms of what we see. You are dependent on what was built and developed in the past and on what has changed. In some cases, it is about adapting the infrastructure to the different circumstances that are there now. There are similar problems in parts of other countries as well. It is quite a regional/local sort of thing.

Dr Skorupska: May I say a little bit about the grid, which we might come to later? The grid codes and rules are being transformed as we speak. Currently, we are going through RIIO-2, the price control mechanism to be introduced. There is a commitment by distribution network operators through their association, the NEA, to make it open and enable the new smart technologies to be able to connect. Of course, there are constraints, but technology is now enabling things to become clearer and easier. Different business models are coming together where companies can see, if they want to develop solar or other forms of renewable technologies, what else can be connected alongside that, like a housing estate or industry.

Therefore, there are now means of balancing out and reducing those constraints, but the conversation is still going and it is happening at different paces by different distribution network operators. They want to become DSOs; they want to be able to support the system and see how they can buy these services. We are now moving towards providing services from our generation types rather than just thinking we need to be securing lots of base-load.

Q257 **Damien Moore:** You do not have to convince me of marine power. I have been arguing for a tidal lagoon in my own constituency. I will do so again by taking this opportunity.

Moving to wind power and going from onshore to offshore, do the wind sector deals and the pot 2 contracts provide the right support for offshore wind?

Dr Skorupska: Talking to my renewable UK colleagues—we represent all other renewable energies, except wind—the offshore wind deal that has been secured is an amazing one. It will not only ensure that the UK significantly increases its share of affordable renewable generation, which will cut carbon emissions, but will deliver about £48 billion of investment in the UK's infrastructure between now and the end of the next decade.

At the end of 2017 the renewable energy sector employed 127,000 people across all the different technologies. There was a growing number—another 20,000—in energy storage and electric vehicle infrastructure. Of those 127,000, 27,000 were employed in offshore wind.

Dr Gross: At the moment we have a relatively small amount of money under what is called the levy control framework—the control for low-



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carbon levies—of £557 million. Strictly speaking, the cap on that runs out to 2025 and after that the Government have to rethink it, but that has been allocated as the additional money that will be spent to deliver 30 GW of offshore wind in the sector deal.

In the next auction they propose to run this spring they have already capped the price at £62.50 per megawatt hour, I think. That means they will not need to provide very much subsidy at all, which comes back to one of the earlier questions.

In some respects it is fortuitous that low prices have started to be bid for offshore wind at almost exactly the same time as the Government have signalled that they do not want to spend very much money on subsidising renewables any more. Not wanting to spend consumers' money on subsidising renewables is perfectly reasonable, but, to come back to the geeky stuff about the contracts for difference and what investors are looking for, at the moment the Government have not specified what the contractual terms will be looking further into the future. In my view they should stick with something that looks like a CfD—a 10 or 15-year contract that provides investors with some security that they will get their revenues, provided they build a wind farm that does not fall over and is in a windy place.

Q258 Chair: Therefore, it is security, not subsidy.

Dr Gross: Yes, but one also needs to try to introduce some additional incentives to respond to system conditions. At the moment, with a CfD you not have to worry about whether demand is high or low. You get some quite strange things happening, like people bidding negative prices and so on, which I am sure you have heard about, but you could keep the CfD at a base or floor level, below wholesale price, and allow renewables developers to come in and participate more in system balancing and try to get the best of both worlds. That would be a much more sensible and pragmatic way forward than the firm capacity auctions in the Helm review last year, which frankly would not work.

Q259 Vicky Ford: I go back to my theme about replacing existing capacity, I understand that a large number of onshore wind turbines will soon reach their end of life. Assuming that repowering existing sites is probably the easiest area to try to encourage a new generation of onshore wind, how are the auctions stopping that happening?

Chair: Perhaps you could give a succinct answer.

Dr Gross: There is no pot 1, so there is no contractual mechanism to get the cheap technologies built.

Professor Bell: To give a slightly different perspective, I honestly do not know the extent to which individual investors would take on and have the provision to set up power purchase agreements sufficiently well to de-risk those repowering projects. The costs of repowering should be lower. In principle, a lot of the risk in siting and grid connection is not there. You



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may be extending an existing connection. How that changes the financing arrangements, I am not sure. I have spoken to people, some of whom are optimistic and some of whom are pessimistic about what can get away on a merchant basis.

Dr Gross: What I think my colleague means is that you need to understand the price formation and the risk in the UK power market. Some markets around the world are quite monopoly-based and you can imagine building a wind farm with no subsidy at all and no intervention from the Government. The problem in the UK is that potentially there is quite a complicated and risky wholesale market price environment. That makes it more tricky. Even if wind was cheaper than gas, you still might build gas because of the risks in the marketplace.

Q260 **Vicky Ford:** Is that because there is no auction?

Dr Gross: Not necessarily; it is just the way prices fall within our wholesale market.

Q261 **Chair:** We are massively over time and we will not get through all the really important questions we have to ask you if we carry on as we are. May I ask you all, please, to try to be as succinct as possible in the answers you give?

Dr Skorupska: The answer is that it depends.

Chair: That is very good.

Dr Skorupska: It does not help that each project is independent.

Q262 **Vicky Ford:** To be clear, I am not walking out of here feeling that restarting auctions is an important priority. Is it a priority?

Dr Gross: Pot 1 is essential.

Q263 **Vicky Ford:** Pot 1 auctions must start. Is that what you are saying?

Dr Skorupska: Yes.

Q264 **Graham Stringer:** Dr Gross, you started answering my first question about whether you accept the analysis and recommendations of the Helm review. You can expand on your earlier answer, but I would be interested in the views of the panel on that.

Dr Gross: Some of what Dieter had to say was very interesting. He had a specific proposition that we would effectively merge support for renewables with the capacity market. In my view, that will not work.

Q265 **Graham Stringer:** Essentially, he is saying that you do not just use the capacity market for back-up; you use it for the whole system.

Dr Gross: In a way, he was saying that the CfDs and the capacity market could be merged into an equivalent firm capacity auction, and that renewables could contract for their own back-up, effectively. The



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problem with that is that it is just not an efficient way of running the system.

Professor Bell: The idea that each individual market participant is self-balancing and promising at all times to produce an average amount of energy is not an efficient way of operating the whole market. In respect of what is called the balancing mechanism, you can see evidence of that even in the past when we did not have so many renewables. The way individual participants have to hedge their own risk arguably leads for many hours of the year to a surplus of available generation relative to what is needed in those hours. Arguably, a central procurement of those reserve services would be more efficient and has to take account of the different timescales over which that happens and the different uncertainties over different timescales. That is very difficult for the individual market participants to understand, and it is why almost every country in the world has a system operator to look after those things.

Dr Gross: It does not fix it for nuclear, either, and does not do anything for CCS. I do not see an awful lot to commend it.

Q266 **Graham Stringer:** What Helm identifies in his report is that the system as it is has cost us about £100 billion. That is a public policy catastrophe and means, according to Helm, 20% extra on everybody's energy bills by next year. Those are the figures he gives in the report. That is a pretty big catastrophe that needs a solution that you do not seem to be talking about.

Dr Gross: But his solution to what he calls the legacy costs is that you create a bad bank, as it were. You take those away from bill payers and put it into general taxation. If you have made a commitment to provide a contract for a certain period of time to a generation asset and that has already been built, it is very bad then to take that away and change the conditions. Those investors made that investment in good faith.

You have to distinguish between legacy costs and the costs going forward. In my view, you cannot do anything about the legacy costs. We could debate whether it is £100 billion or less, or whether it was well spent. If we had not made those investments—for example, in offshore wind—we would not now have cheap offshore wind and all those opportunities.

We have to have a conversation about what we do going forward and what would be the most effective policy mechanisms to get cheap low carbon built going forward. Helm has lots of interesting ideas, but the main idea on low-carbon generation does not really solve the problem.

Q267 **Graham Stringer:** Surely, his main idea is that you move back to the market with auctions and stop Government trying to pick winners, which he caricatures as saying it is not Government picking winners; it is businesses that need subsidy picking poor Government decisions.



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Dr Gross: I am aware that what Dieter writes tends to be seen as very compelling by lots of people. That does not necessarily mean that everything he writes is right, stacks up and makes sense.

Maybe the Committee could think about recommending this: why not just run a single pot auction? Stick a price on for any intermittency system cost for renewables and give them all 15 years and see what gets built. Set it at the wholesale price or below and see what comes. You will not get any nuclear and you will get a mix of onshore and offshore wind and some solar projects coming through. That would be a completely technology-neutral basis on which to run those auctions, but you would give investors contractual certainty over a period of time that would allow them to recover their investments. That is lacking in the equivalent firm capacity proposition from the Helm review. It is not based on those kinds of contractual terms, so it does not offer that kind of certainty.

Governments have been involved in the energy market since forever. I think the “picking winners” characterisation is a bit overly-simplistic and a bit stale. You need to think about it in a much more enlightened and sophisticated way. You do not want to be captured by lobbyists, but there is nothing wrong with taking strategic decisions in the energy system. If you are to transform the energy system completely, which is what we need to do, we are talking about electricity, but it is important in gas and transport. We need to be thinking about CCS, which we have not talked about this morning and we ought to. We have both mentioned it a bit, but you cannot avoid the need for strategic decisions.

Professor Bell: As for a solution, I would argue that we have seen the benefits of prior policy in the fall in costs. I do not think you have to think about most of the low-carbon technologies being subsidised any more. As Rob said, there are structures you can put in place to have a competitive structure to contract for the provision of electrical energy, but it is very important to think about what is required in the 2030s and 2040s where such a deep decarbonisation requires extra stuff. Where is that going to come from? The market? It does not look like it is developing on its own at the moment. R&D and innovation are required. Are you going to pick winners? Are you going to invest in options?

Dr Skorupska: I agree. The Helm review was pretty binary in its proposals for going forward. The auctions mean that the cheapest now will be successful and will be deployed. Everything else gets kicked into R&D and somehow something will materialise in the future. What we have seen that may have been a success of the CfD in pricing and linking it to a pseudo-market approach is the attempt to bring on the new technologies and get them to understand what it means to participate in a market.

You are all experienced enough to see that we usually face that valley of death between a pilot demonstration and it becoming a commercial project. That is where we see quite a few of the renewable technologies



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sitting at the moment. We need that ability from Government to create the right frameworks for other technologies to come forward and different types of energy from waste: biomass with CCS and marine.

Q268 **Graham Stringer:** You talked about the cost of offshore wind reducing. I have failed a number of times to get out of Government the maintenance and depreciation costs of offshore wind and the connection costs. Are all those separate costs put into it, or are you just talking about the up-front investment?

Dr Skorupska: I think they are factored into that price.

Graham Stringer: Could you send us a note on that, because I would be interested in it? The Government will not tell me.

Chair: There is some nodding going on. A note would be useful.

Q269 **Vicky Ford:** Regarding Robert's suggestion that we might recommend the Government run a technology-neutral auction, do you all agree that that would be an interesting proposal?

Chair: May we have yes or no answers?

Professor Bell: Yes.

Dr Skorupska: No.

Tom Greatrex: It might be interesting, but I do not think it would make much sense.

Graham Stringer: That is interesting.

Q270 **Martin Whitfield:** I follow Vicky and declare an interest that Torness, part of the EDF fleet, is in my constituency.

Tom, I turn to nuclear power. Am I right in thinking that, following the Intergovernmental Panel on Climate Change, where nuclear power sits with regard to carbon emissions, looking at the entire lifespan of both nuclear power and the fuel creation, is significantly lower than coal and gas, slightly less than solar power and comparable with wind power? Would you agree with that before we kick off?

Tom Greatrex: Yes.

Q271 **Martin Whitfield:** As we are dealing with costs, is there any scope for the cost of conventional nuclear power to fall? What is your view on that? If you do think it will fall, what gives you that confidence?

Tom Greatrex: I think there is significant scope for prices to fall. People often make comparisons with the Hinkley strike price with the lowest offshore wind achieved for two projects in the last auction, as opposed to looking at the average over the course of the period. You can see that, as more have developed, the price has come down. There is no reason why that would not be the case with nuclear Hinkley as the first of a new generation. We have not built any for a generation before Hinkley. That



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brings with it additional cost in re-stimulating the supply chain—equipment qualification and all the things that need to happen.

If you take Sizewell, which is potentially EDF's next project, and look effectively at replicating Hinkley, using the same technology, supply chain and equipment, it is confident about making quite a significant cost reduction. If you ally that with a different financing mechanism, which reduces the cost of capital—because of the nature of nuclear it is the cost of capital that has the biggest single impact on the ticket price people refer to—it will make a very significant difference in line with the nuclear sector deal, which has a commitment to a cost price reduction of 30%.

Interestingly, the first units for the Horizon project, which is currently suspended, were about £70 to £75. If you take into account the ceiling price for offshore wind, plus intermittency of £10, it is about the same figure. You can see that comparing the first of a kind with the nth of a kind of another technology does not give you a complete comparison, nor does the LCOE comparison because generally it takes into account different things and has different characteristics.

Q272 Martin Whitfield: You mentioned the nuclear sector deal. Does that provide the support that is required, or does it need amendment, tinkering or what?

Tom Greatrex: The sector deal sets out a number of targets and ambitions for industry and Government to work towards, but to be able to achieve, for example, diversification of the workforce and the cost reduction in new build you need to have the programme to deliver it against. At the moment there are a number of issues in the Government's court, so to speak, to come to a view on, which will decide whether we have that programme in the future.

Q273 Martin Whitfield: Your view is that the Government should continue both to grow and maintain the UK's conventional nuclear provision. To what extent do you think the Government should focus on small modular reactors, SMRs, particularly when some of the other fleet comes off? Is this achievable quicker, more efficiently or economically?

Tom Greatrex: SMRs are used as a catch-all term for a whole range of different technologies. There is the nearer-term Rolls-Royce-led consortium, PWR, and there are other similar technologies. There are longer-term molten salt reactors and various other different technological developments that are a long way from fruition. That broader category would include micro-reactors, which are particularly applicable to very small, remote and rural communities in places like Canada.

It is a big umbrella term to use, but, if you are referring to the ones in the nearest markets, they provide a potential opportunity to have a complementary gigawatt-scale nuclear technology that can have some other features that could be useful in the longer-term mix. In particular, if we are successful in moving away from higher-carbon fuel sources for



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our energy uses and a greater reliance on electricity, they can potentially play quite a significant role in the future, but they will not be available in the next couple of years.

Q274 **Martin Whitfield:** They must be part of the jigsaw.

Tom Greatrex: Yes, but again there are outstanding issues with Government in relation to industrial challenge funding applications that have yet to be determined. A whole range of policy issues was highlighted by the expert finance working group, which reported last summer, that need to be implemented if we want to try to have the opportunity of SMR. There is also an important opportunity in being able to export that technology, because it is where the UK at the moment probably does have a significant lead. Therefore, it becomes an argument about economies of volume as opposed to economies of scale, and it is a different way of being able to make an economic contribution across the country.

Dr Gross: I can send you a paper on learning curves in the nuclear industry, if you are interested. I am in no way against nuclear. I think it is very difficult to envisage complete decarbonisation in the absence of it. You can take any option on the table, but the experience of cost reduction in nuclear is not great.

Q275 **Chair:** Is there any historical evidence of cost reductions in nuclear?

Dr Gross: Not outside east Asian countries.

Q276 **Chair:** Is there any evidence that leads us to believe—

Tom Greatrex: There is in France.

Dr Gross: No, there is not. The French programme gradually went through a cost escalation. That is the empirical position.

Tom Greatrex: That is wrong. In the UK, we have consistently changed the design each time.

Dr Gross: If everything was constant and you built a series of reactors, you would expect to get learning effects—provided the regulatory environment did not become more stringent, there was no accident and nothing changed. Real-life experience is that things have changed; environments have become more stringent and people get more concerned. The regulatory concern that this has to be so safe means that in any country like the UK you will get regulatory agencies crawling all over it and inspecting every weld.

Q277 **Chair:** Do you have a view about SMR?

Dr Gross: It is not licensed; we are not there yet with it; it will take some time. The thing that makes nuclear cheaper is that you have to have public involvement in finance.



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Professor Bell: Helm had a big thing about the system cost and keeping everything going. From the way he was putting it, it looked as if he had very much in mind variable renewables—wind and solar—but we should remember that there are potentially very significant system costs associated with the very large new nuclear stations. Nuclear should not be taken off the table as an option, but we should be conscious of the whole set of costs for all these technologies as well as the need to decarbonise.

Dr Gross: We have a weird situation where you need a Government entity to sit behind the finance phase, because it is very expensive and it takes a long time before you get any money in. It is very different from putting solar panels in a field, or even putting wind turbines in the North sea.

Q278 **Martin Whitfield:** We have discussed the complexities as much as the need for certainty of Government policy for the future. I think I am right in saying there is an understanding that nuclear needs to play a part. There are different arguments about how much. I want to home in a bit on timescale. The current operational fleet will effectively be finished by 2030, and that includes extensions plants have had. How much pressure is there on the nuclear industry to get a decision from Government, given we are 11 years from that date?

Tom Greatrex: In relation to the decision on the regulated asset-based model applicable to nuclear, there is a very important point at which you can maximise the cost reduction in relation to Sizewell following Hinkley. There is a point at which you can, in a relatively straightforward way, transfer the supply chain and use the same equipment while the supply chain is in place. That means EDF needs to make a final investment decision, probably in 2021-22, so that needs a policy framework in the next year or so to be able to be in a sufficiently strong position to deliver that project, get the maximum cost reduction and make that contribution to help replace the fleet, most of which is going off by 2030.

Q279 **Vicky Ford:** On building everything new in the south-east Asia model, how different is the Bradwell model, which is obviously a Chinese build?

Dr Gross: It is not so much about the difference in the technology; it is about the difference in the social and regulatory conditions and the expectations.

Tom Greatrex: The reactor design is relatively early in the general design process; it has not got to the point at which it has been approved yet. It is a reactor design that is being built in China. The EPR that is generating electricity is the one in China at the moment. It is the third one to start and the first one to finish of the three sites where that EPR is under construction. Hinkley is the fourth one. While accepting the point that it is a different environment and there are different factors, you can also learn from where that technology is deployed first. The first one will not be in Bradwell; it will be in China.



Q280 **Vicky Ford:** Therefore, it is not necessarily cheaper.

Tom Greatrex: Cheaper than?

Q281 **Vicky Ford:** Robert made the point that the cost of nuclear had come down in China. I was trying to ask whether the Bradwell power station, because it is a Chinese design, would be cheaper. I think you said that that is not necessarily the case.

Tom Greatrex: There are aspects of construction for large nuclear where it does not matter which technology you are using but you can benefit from supply chain development that has happened essentially for the first of a generation, which is Hinkley, and that will carry through to future projects regardless of which reactor design you are using. The reactor design difference is only one part of a much larger site that you need to use. There will not be a project with a strike price anything like Hinkley again.

Dr Gross: I think you could build it more cheaply than Hinkley. To be clear, it could be cheaper than Hinkley, but the thing to do to make it cheaper, if that is what you really want to do, is to take a public stake in the ownership, which is unique and completely different from any of the others.

Q282 **Vicky Ford:** I want to move to small-scale generation. I guess this question is for Nina. To what extent will the smart export guarantee successfully support a market for small-scale generation, and are there any particular details we must get right to succeed?

Dr Skorupska: It needs to be introduced as soon as possible because we have a policy gap between the feed-in tariff finishing and nothing to replace it. The market is responding quickly. Some players are already offering customers opportunities. They want to install solar on their homes, or do something slightly larger, such as Octopus. You may have seen it being launched yesterday. People who are generating power from their own small-scale generation need to be given a fair price, so it is not seen as retailers taking it for free. We are mandating a minimum index-linked safe tariff, which should be linked to the percentage of the system-in-balance price. We are trying to provide a framework that makes sense from a market perspective but also makes sense for a consumer or developer who wants to put this in.

Getting this in play should be done quickly, but the biggest challenge to small-scale renewables are the grid reforms. The total charges reform and forward code review have to be done in parallel in a sensible way. The current proposal by Ofgem and the Government is to change current understanding of the codes and introduce a new framework.

We have been lobbying hard or working closely with Ofgem to understand what all this means. We want more low-carbon generation in the system, but the signals we are getting from all these reforms show that it will stall the market.



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As for SEG, yes, please, we want it as soon as possible with the right framework, but the biggest thing to worry about is the massive targeted charging review of the grids.

Professor Bell: I think some kind of minimum export price would be extremely useful. There is a bit of work to do to define what that would be. Half-hourly metering gets a very bad press, but there are lots of useful things that come from it for smaller energy users. One of them would be measuring what is the export anyway.

As for the network charging review, how do you determine what network upgrades are really needed, and who pays for them? It is extremely important. I do not think there should be any free riders. What it should mean, coming back to our wider discussion about the cost of meeting our energy needs in a low-carbon way, is doing the right things in the right places. The network charges are important in signalling doing the right things in the right places relative to what the network impacts would be, or what the impacts would be in not being able to use all the energy because of where it is at certain times. It is a difficult, detailed exercise. I agree it has to be got right, but we should not be mixing up different kinds of policy instruments just because something looks nice. What we are interested in is the overall picture.

Q283 **Vicky Ford:** Should business rates for small-scale solar power and energy storage be reduced or removed? Somebody suggested that in evidence.

Dr Skorupska: It needs to be reduced, and in some areas where we want to see more rapid deployment it has been removed.

Q284 **Vicky Ford:** Is that for small-scale solar power or energy storage?

Dr Skorupska: On energy storage, we have been working with our members to show that it should not in any way enable business rates to be increased. We have already been arguing that it should benefit from reduced rates to encourage more businesses, commercial and industrial, to deploy it and be self-generators. We are working with them on the correct framework that suits the Treasury and supports local authorities going forward. We are working with them to understand the right framework, but it should not be seen as a windfall for local authorities to be able to penalise it; it would send the wrong message.

Q285 **Chair:** The Solar Trade Association said that some revision to the methodology by HM Revenue and Customs has led to a substantial increase in business rates for some solar power owners. Is that right? Have you observed that?

Dr Skorupska: That has been in the proposal and on the cards. Business rate reviews happen over periods of years and, all of a sudden, with the Government's view about enabling our business rates to revert to local authorities, they are reviewing how to value those buildings and the technologies in them. Are they part of deemed income, or part of the



business, or is it part of the infrastructure? We are working with them to clarify that. We should not be penalising forward-thinking businesses that want to install these technologies and are having to pay more for it.

Q286 Bill Grant: Touching on the potential support for domestic deployment and export of low-carbon technologies, we have heard this morning that when there is clear direction from Government you get the results. Following on from that, how should the Government support the development and deployment of the emerging and less mature low-carbon generation technologies? How should they push that forward?

Professor Bell: A colleague of mine, Matthew Hannon, completed a study a year or so ago. He did a specific review of wave energy and how the various schemes to try to support and develop that seemed to have gone. He came up with some useful conclusions. It was not a great story. Lots of companies were supported and then went out of business, and we do not see anything in commercial deployment as yet.

To summarise, his recommendations were that patient funding is really important. He felt there was a need for co-ordination across the innovation landscape as a whole. How does this fit in with other forms of support?

There was also a need to be realistic about what is possible. He felt there was overselling of the technology and its capability at the time. It was assumed it was just the last push to get to commercial deployment, when there were some fundamental issues to be resolved. It is an extremely challenging technology. There was a lack of support for the more fundamental R&D and too great a hurry into commercial deployment when it was not ready.

There were loads of different options and none of them was ready. There were other little bits and pieces about how to manage match funding with industry and what incentives that brings about.

There were some interesting things to learn about the nature of support for these kinds of technologies.

Q287 Bill Grant: Was your colleague hinting at more investment at the R&D end?

Professor Bell: It was basically: do not get ahead of yourself.

Q288 Bill Grant: Rather than a rush to deploy.

Professor Bell: You have to have the support all the way through to recognise where the technology is; give it the right support at the right stage; and, as Rob said earlier, do not be captured too much by the lobbyists.

Dr Gross: It is horses for courses, which sounds platitudinous, but we got renewables along their learning curve by providing them with feed-in tariffs internationally. It worked for that sector. If we are looking at



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things that will go into people's households, like heat pumps, it is more likely that we would be looking at building regulation and perhaps up-front capital subsidies so they can immediately reduce the cost of purchase.

As for the wider system, if we are talking about things that we need to do decarbonisation, it is about big infrastructure pieces. Are we going to roll out heat networks? What will be the network and how will it be financed for CO₂ transport and storage so that we can have decarbonised clusters, decarbonised industry, look at the hydrogen option and all those kinds of things? The form of support that they will need will be different. There is something else for storage and batteries that depends on the market.

To come back to your question about R&D versus deployment, we need deployment support. We have money going into R&D. It is great. I work at a university. We love R&D, but we are on a relatively short timeframe here to 2050. It is not that long. We need to get stuff deployed.

Professor Bell: A lot of technologies take a long time. You will have read a review on that. You have to get the things in the right way and be patient, and when you see the commercial opportunities find the right mechanism for deployment.

Q289 **Bill Grant:** Is there scope for tailored Government support for selected emerging low-carbon technologies?

Dr Gross: Yes.

Dr Skorupska: I make three small points. First, as the Committee will be aware, everything is becoming more connected. If we are talking about power and small low-carbon technologies being deployed, you cannot divorce it from thinking about the built environment and the work that has to be done in the construction industry. It is great to see the sector deal on construction, and we have members engaged in that.

Secondly, the demonstration projects under the industrial strategy are prospering from the energy revolution. This is a sharp three-year programme looking at the deployment of smart digitisation in technologies combining power, the built environment and transportation.

Q290 **Bill Grant:** There is a synergy between them.

Dr Skorupska: That is the message. The connectedness of the opportunities to get people's bills lower is extraordinary. Take a building that is itself low carbon. The old zero-carbon homes are now called the housing mission, with people being savvy about their tech. Everybody loves their Apple. They will be able to have greater control.

Tom Greatrex: The Government did the right thing in establishing the expert finance working group in relation to commercialising and deploying small modular reactors. They have had that report since last summer.



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They now need to act on the recommendations, and that will get the pathway to enable that technology to be deployed.

Q291 **Bill Grant:** Dr Skorupska, in the past you have highlighted the role for the Foreign and Commonwealth Office and the Department of Trade and Industry as a platform for exporting these new technologies. Are you suggesting that that is a missed opportunity? If that is the case, is the opportunity still there for the Government to step in and assist?

Dr Skorupska: We have been seeing a pick-up in being approached and being able to export our services, knowledge and know-how of combining the technologies and delivering them as solutions appropriate to the different countries. One I can speak of and have been involved in is consideration of how we can be engaged in supporting Indonesia. It does not want just large power plants; it wants decentralised micro-grid solar storage, with a push for cheaper electric vehicles. How do they power their communities and leap over the need to build hard fixed infrastructure? That is what is exciting about what the UK can help to deliver. We have those answers.

Q292 **Bill Grant:** Am I hearing from you that the two Departments mentioned are listening?

Dr Skorupska: They are beginning to.

Q293 **Bill Grant:** Of course, it is a matter of crawling before walking, but they are going in the right direction.

Dr Skorupska: Wind is one of our leading export technologies. A lot of effort has been made internationally. My colleagues at RenewableUK and the offshore wind sector deal are part and parcel of how we promote and champion offshore wind. For the other technologies we still have to do a lot more.

Q294 **Bill Grant:** Do you want to comment briefly?

Professor Bell: I think there are opportunities in other parts of the world to leapfrog the wired technologies. Micro-grids are extremely useful in parts of the world where there are very remote areas. Long connections to a conventional grid would be extremely expensive, so methods are coming about. It is great to see a different dimension to it. There are fantastic entrepreneurial developments coming out of student communities in this country. They are doing a lot to lead this development in parts of central Africa, for example.

Dr Gross: I see this kind of expertise as being of particular value internationally in Keith's area of system operation—clever operation of grids in a liberalised market environment and the integration of new technologies. It seems to me that that end of things is an area where we are very well respected internationally.

Chair: Thank you all very much indeed. We appreciate your time. I am sorry we have been tight on time, but with four of you it is quite a



challenge.

Examination of witnesses

Witnesses: Professor Nick Eyre, Professor Tim Green, Randolph Brazier and Duncan Burt.

Q295 **Chair:** Good morning, all of you; it is good to see you. Could you make very quick introductions? If you have any interests that you think you should declare, it would be good to do that now.

Randolph Brazier: My name is Randolph Brazier, head of innovation at the Energy Networks Association. We represent the transmission and distribution networks for gas and electricity in the UK.

Professor Green: My name is Tim Green. I lead the energy futures lab at Imperial College London. We are a cross-university institute and look at both energy technologies but also system modelling.

Q296 **Chair:** Professor Green, you don't rap.

Professor Eyre: I am Nick Eyre, professor of energy and climate policy at the University of Oxford, and I am director of the Centre for Research into Energy Demand Solutions.

Duncan Burt: I am Duncan Burt, director of operations at the National Grid System Operator, part of the wider National Grid group.

Q297 **Chair:** May I start by apologising? I have to leave at five past; I have a meeting with a Minister. My colleague Stephen will take the Chair for the final part of the session.

How much more renewable power generation can be added to the grid before intermittency becomes a significant problem?

Duncan Burt: It is very timely. Yesterday was the first day of the National Grid ESO as a legally separate system operator for GB. We announced an ambition to get to regular zero carbon operation by 2025. We think it is very easy to get to very high levels of renewable generation and to 100% zero carbon generation over the next six or seven years for regular periods of operation in GB. Typically, at the moment we operate comfortably up to about 80% renewables, and we know we can go further. How much we can do with completely low carbon, which the previous panel touched on, depends on how fast we grow the renewables build-out and how fast we decommission and potentially replace the existing nuclear fleet.

Q298 **Chair:** How important is nuclear in maintaining stability of supply of electricity?

Duncan Burt: As a large bit of rotational plant, it provides some stability to underpin the grid. It is not essential. Without it we would have to put other clever control devices on to the grid, but we know what those would be, and we can install them over the next five to 10 years.



Q299 **Chair:** Are there any other thoughts on that?

Professor Green: As Duncan said, there have been times when the gas component of electricity has been squeezed down to 20%. There are ways to go forward from there. We could run higher penetrations of renewables yet. The point is: what do you do when you have plentiful renewables? We have options. We have storage. We could be storing it during times when there is less available. We have interconnectors to Europe up to about 5 GW at the moment with plans to extend that. At times of surplus we could export it to regions. We are a particularly windy part of north-west Europe, and there are parts of Europe that are not blessed with wind but may have solar, so we can import it.

Q300 **Chair:** By extending the network across Europe you could level out where it is windy on any particular day.

Professor Green: Yes, weather systems are quite large, but when you look at it on a continental scale—

Q301 **Chair:** What happens if you have an anticyclone sitting over Europe stubbornly for two weeks?

Duncan Burt: Anticyclonic systems over the UK tend to be about 1,000 miles across. Obviously, Europe is much larger than that; it is 2,000 to 3,000 miles.

Q302 **Chair:** You still have somewhere where there is a lot of wind.

Duncan Burt: Yes. At a continental level, you can spread the load. That does not mean there is not a significant opportunity for seasonal storage, or some other storage mechanism, that can go beyond a few days and manage high levels of solar output across Europe in the summer versus quieter, less windy days in the winter.

As for weather systems, we should also think about large, cold masses of air coming from the east over Europe, such as the beast from the east that we saw last year, which can cover everything from Italy right up to Norway. We need to think about those continental-type weather systems in how we plan for energy networks over the next 20 years.

Randolph Brazier: I think Duncan has captured it well from a national level. At a local distribution network level, we have connected about 30 GW of distributed energy resources at the moment. Most of that is renewable—about 85%. To get more on to that system, which we think we can do, we need to enable a smart grid at that local level. We have kicked off something called the open networks project at ENA, working with National Grid, to enable that smart bid at that local level and get more renewables at that local level, including storage to support it.

Q303 **Chair:** As for the capacity market, there has been some criticism of the fact that diesel generators have won through. How could the market or an alternative better incentivise low-carbon solutions, and should an emissions intensity limit be introduced to create the right energy mix in



that market?

Duncan Burt: National Grid ESO is technology neutral, but we can see a significant rise in small-scale peaking diesel technology that has come about as part of a capacity market. That market is a niche running maybe for a few hundred hours a year—just when you need that little bit of extra power. The alternatives in that market would be growing flexible and demand side response, so the demand-side market managing demand away from those peak periods, whether it is heating, air-conditioning or cooling.

Q304 **Chair:** Are you saying we are perfectly capable of achieving that and not needing to bring in other generation such as diesel?

Duncan Burt: That is right. You also have other flexible technologies such as batteries or interconnection to other markets; they can also play a role. Across those three, there are a lot of other flexibility options that could compete against diesel.

Q305 **Chair:** What is stopping that happening? Why do we need these capacity markets?

Duncan Burt: You would have to ask particular players in that field for their view. My general view, talking to investors, would be that people are keen to see a very level playing field. Some of the issues in the capacity market relate to particular parties' complaints about whether that is a level playing field at the moment, but a field on which they are all competing equally and can claim the same level of contractual rights is what we hope would initiate that.

Professor Eyre: It is clear that the capacity market has not been constructed to be a level playing field; indeed, that is why it has had problems under European law. It would be sensible for a demand-side response to be able to get the same contract lengths, for example, as supply-side technologies. There is also no allowance for energy efficiency and energy demand reduction. That was pushed off into a small and badly designed pilot scheme. It is perfectly possible to have energy efficiency in capacity markets; it is done in a number of American markets.

Q306 **Chair:** Was this Government's design?

Professor Eyre: In this case, yes, because it was the Government that designed the overall framework. We know that saving energy is generally much cheaper than supplying new energy. Referring to some of the pounds per megawatt hour numbers colleagues gave in the previous session, we know from the carbon emissions reduction target programmes that electricity can be saved at £10 to £20 per megawatt hour. We really need to think about the scale of energy demand we have. From the point of view of this Committee, technology is not just supply-side technology; it is technology that allows us to reduce demand, to make demand more flexible and to decarbonise demand.



Professor Green: It is not just reduced demand—that is a vital part of what we are trying to do—but making demand flexible so that it plays into that few hundred hours a year that Duncan was dismissing.

Q307 **Vicky Ford:** Is the UK on track to deploy the scaled-up energy storage that it will need for the fourth and fifth carbon budgets?

Randolph Brazier: From a networks perspective, we are technology neutral, but we have seen quite a lot of storage, both battery and other types of storage, come on to the system.

Q308 **Vicky Ford:** Could we have a yes or no answer? Are we on track to deploy the energy storage we need for the fourth and fifth carbon budgets?

Randolph Brazier: For short-term storage, yes; for longer-term inter-seasonal storage, not yet.

Q309 **Vicky Ford:** Are there any other comments on that?

Professor Eyre: I agree that long-term storage is going to be the key problem for decarbonisation.

Professor Green: Pace is important. We need to pick up the pace. The evidence is that the longer you delay investment in storage the more you build out other technologies and lock yourself into pathways which are not good in the long run.

Q310 **Vicky Ford:** Do viable large-scale energy storage technologies exist, and how do the Government balance the support for that long-term storage between development and deployment support?

Randolph Brazier: The technologies do exist—for example, one could be hydrogen—but they have not been tested at scale. We need innovation and support from Government to roll out these trials at scale.

Q311 **Vicky Ford:** Are there any other thoughts?

Duncan Burt: These days you have to think about the electricity and gas markets as one working together. We very much see them as joined. Most of the flexibility in the electricity market to manage variation in output, particularly from renewables, is driven by gas and interconnection. The gas plant provides a lot of flexibility in electricity. There is time to develop and roll out larger alternative inter-seasonal storage, but it is only part of the answer.

The UK is one of the leading markets in the world for short-term storage. We had a very successful roll-out through National Grid ESO services of an enhanced frequency response, a 200 MW battery tender, which is already saving a lot of money in the day-to-day operation of the grid. A number of markets in the UK are driving additional battery and storage capacity in UK markets. Investors are also seeing the pairing of batteries with solar and wind as a way to clear those solar and wind projects as subsidy free, which is an excellent development in the UK.



Q312 **Stephen Metcalfe:** Can you put a figure on building large-scale demonstrators? Is it simply a question of the Government setting up a fund of X amount and saying, "Please put in a bid to demonstrate that your technology works"? How much would that fund be?

Randolph Brazier: I do not think we have a figure at the moment. A lot of our members, particularly our gas ones, are looking at feasibility studies into that, but we do not have a fixed figure yet.

Professor Green: Part of the problem is uncertainty about what the costs are for inter-seasonal heat storage, whether it is hydrogen, ammonia or some other sort of fuel. It looks like it is molecules, but it could be compressed air. We have to do some learning and start to resolve some of these uncertainties, and have a clear view of what the pathway is.

Duncan Burt: I would not put a figure on it, but I would see it as intrinsically linked to the need for a very clear pathway for decarbonised heat to be established over the next five years, because to decarbonise the heat sector is such a large project. I advise the Committee to look at the development of inter-seasonal storage alongside decarbonisation of the heat market. The two go intrinsically together. We need to establish a clear decarbonisation pathway for heat in the UK. The amount of effort that storage needs to play in that will depend on the particular mix of pathways that emerges or is considered the best fit for Government policy. That would be a combination of electrification through heat pumps, decarbonised gas, hydrogen and district heat networks. You can see that, depending on the balance of those, you will need more or less intra-seasonal storage.

Q313 **Stephen Metcalfe:** The point I am trying to get to is: if we want to see that happen, someone has to put in the funding to start with. In order to frame a recommendation, should there be a fund of £100 million, £1 billion or £10 billion to try to get some of these demonstrators built?

Professor Green: You would need demonstration at scale, and that is why it is going to be expensive. I think it is north of £100 million. We would have to put on our thinking caps and come up with a better figure.

Randolph Brazier: It is certainly in the hundreds of millions.

Professor Eyre: That is because it is important to recognise it is not just demonstration of a stand-alone technology. If we are to decarbonise heating, it means decarbonising supply; it means a different network infrastructure, potentially storage, and different technologies at the point of use, and they will have to be demonstrated together ultimately as a system.

Q314 **Stephen Metcalfe:** But if a fund was available it might well stimulate that demonstration.

Professor Eyre: Yes.



Q315 **Vicky Ford:** Let me be very clear. That is funding for an inter-seasonal storage project in order to enable decarbonisation of heat. Therefore, I am assuming it is a question of how you store extra electricity in the summer months.

Professor Green: It is demonstrating that you can produce the hydrogen, ammonia or whatever from surplus electricity or natural gas, store it and then have the technology to use it.

Q316 **Vicky Ford:** For short-term energy storage, how important is the mass deployment of electric vehicles?

Randolph Brazier: I would say it is very important. One thing we are looking to do within the distribution networks, which our members committed to last year, is to take a flexibility approach. Rather than building more network to accommodate transportation or heat, we look to the market to provide flexibility solutions to minimise that cost of reinforcement. In particular, vehicle-to-grid technology that would come with electric vehicles could very much play into that flexibility market to help us reduce our costs, so we think it is critical. It also helps to demonstrate the technology of the batteries themselves within the vehicles, so it is critical.

Q317 **Vicky Ford:** Is that to manage peaks within the day?

Randolph Brazier: Localised peaks, essentially, which could happen on your street or in your neighbourhood.

Duncan Burt: There is a role EVs can play at a national level as well. The vast amount of power stored in those EV batteries is not going to be used most of the time; most people will need to charge up only every few days. The ability to choose when to charge over, say, a five or 10-day period will for many people deliver a huge amount of flexibility into the energy market as a whole.

Q318 **Vicky Ford:** That technology can be put in the charging points to switch on the charger at a time when there is excess power.

Duncan Burt: Yes. At a very simple level, you can choose to charge manually over that period, but you already have technology arriving in the UK from a number of suppliers, without quoting names, that provide the ability either to charge flexibly based on price or when power is greenest.

Q319 **Vicky Ford:** How important are smart homes and smart appliances so your freezer is not running at a peak time? How important are those things?

Duncan Burt: The roll-out of smart metering and the development of smart use of power and energy in the home are fundamental to going to a smart energy system. If you do not have the ability to reward people and enable people to choose when they take their power and see the



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financial benefits of that, then there is a huge hole in the middle of a smart grid.

Q320 **Vicky Ford:** Are the Government doing enough in that area?

Duncan Burt: It is taking time in terms of the smart grid roll-out, but we can take a lot of learning from that as well into the roll-out of heat. These things will be difficult and will take time. We still think the strategy will deliver.

Q321 **Vicky Ford:** What more needs to be done to encourage the market for energy storage?

Professor Eyre: I add one point on smart appliances. We can learn from experience in energy efficiency. Why have we regulated to have stronger appliance standards? We probably also need to make it mandatory for those appliances to be smart. Now is probably not a good week to be talking about that because the framework in which those appliance regulations would be made is probably in your hands rather than others, but it is crucially important that we have that sort of regulation, wherever it is done.

Professor Green: Part of it is about encouraging imaginative offerings from energy retailers. You start to see some of that already. It is about being able to charge your electric vehicle on your home tariff wherever you are and being able to charge at better times of the day and get better-price deals, which are quite eye-catching but may signal the future—for example, cook for free at Sunday lunch time. I am talking about things that engage the consumer and show them that where and when they consume is at least as important in future as how much they consume. Starting that conversation is important, so it is about encouraging innovation in that sector and what it brings to consumers.

Duncan Burt: On the point the previous panel posed, we have some fantastic energy companies emerging in the UK providing interesting products and innovation, which are looked at internationally, in putting very simple offers in front of consumers. As that evolves we need to trade that off. There are some big questions around data and we will need to take important cyber-security measures as well, but that can be done in the background as long as we have simple, innovative and engaging products in front of consumers that deliver low bills. That is what we are all trying to work at.

Randolph Brazier: Electric vehicles will definitely help in understanding how you use energy in the home and use your appliances, because ultimately people care about their cars. They like cars; they think they are cool; they know how much it is to top up their cars, whereas they are probably less interested in how much energy their fridge uses.

Professor Green: Small-scale generation helps. When people have photovoltaics on their roof they become more engaged; they are very



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interested in self-consumption and timing consumption to meet what is available, and that is something to build on.

Randolph Brazier: I agree.

In the absence of the Chair, Stephen Metcalfe took the Chair.

Q322 **Vicky Ford:** Does energy storage need a new legal definition beyond being a subset of generation?

Duncan Burt: It is going to be an important enough technology that it should absolutely have its own definition to avoid lots of potential traps along the way. I think that goes without saying. As Nina said, all the codes are being revised, but, until that is clear at a policy and regulatory level and in all of the industry codes, we risk tripping ourselves up along what can be quite a complicated path.

Q323 **Chair:** No one varies from that view; it is a view across the sector.

Randolph Brazier: Definitely. You need technology and it needs its own definition.

Q324 **Graham Stringer:** Following Vicky's question, do you think we are at the limit of where physics will allow us to go in battery technology, or can there be a breakthrough?

Professor Green: We are certainly on a very impressive cost reduction curve that does not look like stalling.

Q325 **Graham Stringer:** I am not talking about costs but about capacity and whether, just because of the number of electrons you can store in a particular place, we are at a limit.

Professor Green: To some extent they go together. Using less material in the battery is one way you drive out cost; you are trying to drive out cost in the manufacturing process as well, but refinements in technology are being well supported through the Faraday Institute. I do not think there is a fundamental block any time soon.

Professor Eyre: For example, bivalence metals are being looked at that have twice as much charge per atom.

Q326 **Graham Stringer:** That is very interesting. You have talked about the potential benefits of knowing the cost of energy at a particular time and reducing your costs. You do not put the reciprocal case that at certain times energy will be more expensive. Do you expect that, because sometimes people need to use energy when they need to do so, there will be consumer resistance?

Duncan Burt: It needs to be considered very carefully. There are two points. Peak periods of electricity use tend to be during the working day, particularly on winter evenings when people get home and turn on their lights, and factories and shops are still running. That needs to be looked at from a public policy perspective. There are other agencies and



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organisations that are much more conversant in that than me, but there is a real risk—which we worry about—that, if we get it wrong, it could be regressive and we could place additional costs on those who are at home and use power during the day and are less technologically enabled.

We also need to design much of these structures in a way that takes into account that, although the panel in front of you today finds technology really interesting and engaging, the vast majority of the population of the UK see energy as just a cost and need that cost to be as low as it possibly can be. That is what we all need to work towards.

Professor Eyre: I largely agree with that. You should always be cautious about saying what consumers want because there are lots of different types of consumers. Some people will respond positively to half-hourly tariffs; others will not want them. I suspect we will end up with a market that is separated in that way, even if retailers face half-hourly tariffs. We just need to be careful in designing the system to make sure that all consumer needs are catered for.

Q327 **Graham Stringer:** Is the Government's roll-out of smart meters going to deliver the smart energy system as you envisage it?

Professor Green: It is one of the enablers, is it not, but it is not sufficient? As we discussed a moment ago, the imagination of new offerings to consumers has to be part of it. It rests on various forms of flexibility: demand-side flexibility; storage, which has been touched on; the role of interconnections elsewhere; and a freeing up of the data peak. System operators have to have good visibility of what is happening in the system, as do people trying to offer services, so we have to open up data as well.

Randolph Brazier: From a network perspective, getting access to aggregated smart meter data will help us to run the networks, particularly at a low voltage level, a lot more efficiently and give us a lot more visibility of what is happening. It means that we will be able to pass those benefits back to customers. That will give them more choice, but it will also ultimately help to reduce their bills.

Q328 **Bill Grant:** I am hearing that consuming electricity when demand is lower will be cheaper. I am wondering whether we have been there before. I am of an age—maybe nobody else recalls it—to remember white meter night storage heating. It was a great thing; it was going to be the future. It crashed and burned and I believe did not achieve the economy suggested. I know there are newer technologies. How do we guide or educate the public to get it right this time round? They need to know how the system works.

Professor Eyre: One thing we are doing reasonably well is the roll-out of smart meters, treating it not just as a technology problem but recognising that people's trust in this technology and their ability to use it effectively to reduce their costs is absolutely critical. One thing I worry



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about is that the time scales for smart meter roll-out might mean that that quality of installation and customer engagement falls. I would say it is much more important to do the smart meter roll-out well than to do it quickly.

Duncan Burt: The smart meter itself is really just a means to measure and charge on a half-hourly basis; it is not doing anything clever beyond that, although smart metering people will tell you that it is clever. The real intelligence and innovation in the industry will come from organisations and people in the background coding and developing software and optimisation that uses the fact you have a smart meter to do clever things with how you use energy in the home. That can be deployed very quickly.

Q329 **Bill Grant:** We can do better next time round.

Duncan Burt: Yes.

Q330 **Graham Stringer:** I do not think that anybody but the Energy Minister thinks the Government will hit the target next year for the roll-out of smart meters. The first generation of smart meters is dying or is dead when people change their supplier. Is that a problem in getting towards a smart energy system?

Randolph Brazier: From a network's perspective, the earlier SMETS1 meters do not provide as much information to networks. We can still make use of that.

Q331 **Graham Stringer:** They do not provide any information if you change supplier, do they?

Randolph Brazier: There is an issue with switching, but they do not provide as much data as the new ones. Although we can make use of it, from a network perspective we would much rather have the SMETS2 meters as we can get better data ultimately.

Q332 **Graham Stringer:** Those problems have been well discussed in the national press. Are they a problem in getting towards a smart energy system?

Randolph Brazier: They go some way to solving the problems, but creating a smart grid is not just about having smart meters. From a network's perspective, we are putting a lot more monitoring equipment on our network so we can get visibility, and other customer solutions are being put into homes by suppliers that do not necessarily need a smart meter. I do not think it is a complete blocker, but it would certainly help to enable it.

Professor Green: We have spent quite a bit of time discussing demand-side flexibility and response. It is a big part of what we think the future of not just the electricity but the wider energy system will be, but there is still huge uncertainty about how well people will want to engage with it. What benefits does it deliver? What is the materiality of the amount of



demand you can move, and is it the peak of the system demand when you really need it? Anything that stops us getting to those answers and stops us doing large-scale trials of demand-side response is a real problem. It has to resolve some of those uncertainties quickly, so getting SMETS2 meters and doing large-scale trials of demand-side flexibility is really important. We desperately need to crack on with that.

Q333 Graham Stringer: What should the RIIO-2 price control framework include to ensure that cost-effective flexibility solutions are pursued actively?

Duncan Burt: This is very close to my heart. At the moment, we are in the middle of our discussions with Ofgem about RIIO-2 for the ESO and for National Grid Gas. The key issues for us on the ESO are that we have a structure that effectively funds what we think will be a very big expansion of the activity to help to avoid investment by delivering smart control on to the network and integrating what we do with distribution system operators, as they emerge over the next 10 years, and that we put the level of information handling—of AI and optimisation—that we can into the grid, so that we match the pace of roll-out of EVs, which is already happening, and are ready for the decarbonisation of heat.

That is a big task. We need a balance of long-term funding and certainty to deliver some of those investments over years. At the same time, the structure has to be able to handle a certain inevitable level of uncertainty about how fast some of this will happen. It is a very constructive discussion with Ofgem. As you would expect, Ofgem is being very tough on us in looking at the costs and uncertainties of handling this effectively, but we really need that longer-term view and the ability to handle the uncertainty.

Randolph Brazier: I agree with that. I would add only a couple of things. One thing RIIO-1 has been very successful with is innovation. In fact, the UK is now a world leader on innovation in networks. We would advocate more support for innovation in RIIO-2, along the lines of what we have in RIIO-1. We also think that we need to take a more whole-systems approach in RIIO-2. That means understanding the interactions with other energy vectors more and allowing us to run new types of trials and to form new types of markets or commercial models with other energy vectors in RIIO-2. We think that that should be a focus as well.

Q334 Graham Stringer: To what extent does the smart systems and flexibility plan provide for what is needed to stimulate the development of flexibility in the energy system? Is progress being made quickly enough?

Randolph Brazier: ENA very much supports the smart systems and flexibility plan. We agree with the actions in it. From a networks perspective, we think that the actions make sense. We are helping to roll some of them out.



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You asked how well it is progressing. Of the original 29 actions, at least 15 have now been completed. We believe that it is making good progress and fully support it.

Duncan Burt: It is the right measure at the right time. It is very good to see. We see very strong engagement from the Department, both on that and on the clean growth strategy more generally. We welcome the ability it brings to drive investment, in and to the UK, and to allow us all to play a role in growing a very innovative and exciting ecosystem of companies and organisations in the UK that can then support the export of that, to help to fight climate change globally and to grow UK business.

Q335 **Chair:** I would like to change track and to talk a little about decarbonising our heating system. I assume that we thought that the renewable heat incentive was a good idea, but it has not really delivered what we wanted. What do you think should follow on from that to encourage more people to install low-carbon heating systems in their homes?

Professor Eyre: We need to start with an overall strategy. The renewable heat obligation has been reasonably good at stimulating the deployment of biomass. One of the things that we know is that the UK will not decarbonise by using biomass. We need to start from thinking about where we want to end up. That will be some mix of heat pumps, using electricity, hydrogen-based systems of various types and, perhaps, some biomass. Some of those may be connected through heat networks to improve their efficiency.

It is a complex geographical picture. There is a real risk of spending capital twice, rather than the “measure twice, cut once” principle. As the Committee on Climate Change says and the Government accept, we need to move quite quickly to an overall strategy for how the decarbonisation of heat is going to be done—not in a five-year-plan sense, but as an overall framework.

Q336 **Chair:** We need a strategy, and then a scheme that encourages the strategy to get done.

Professor Eyre: As we have discussed, this will then need some innovation, but more deployment and system-scale demonstration, in order to get off the ground. It will raise some very difficult questions, because it will make each unit of heat more expensive.

Therefore, I would say that we also need to think about how we reduce the demand for heat by improving building efficiency at the same time. That is probably one of the things that we could start doing now. In recent years, we have gone backwards on our building energy efficiency policy framework.

Professor Green: I would be slightly cautious about the developed strategy and then do trial deployments. There are some aspects of the strategy that we can see. There is not a single solution that suits all



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geographies, densities of development and so forth. We know that we need myriad solutions, but we have uncertainties about the costs and effectiveness of some of those solutions. There has to be some learning by doing. That will help to resolve some of those uncertainties and firm up the strategy.

There is an outline strategy, but the first plank of the strategy is that we have to try some of these things, such as inter-seasonal heat storage and hydrogen production. There are some key technologies that play to flexibility. Hybrid heat pumps will run on electricity for a lot of the year, but when it is particularly cold and the heat pumps work poorly, or when electricity is in short supply for some reason, you might switch to gas. Picking some technologies that look to be important, like a hybrid heat pump, and then finding out how effective they are will be key.

Randolph Brazier: I fully agree. Our analysis has shown that looking at all the options and taking a whole-systems approach, considering different options in different areas, will be the cheapest way of doing this.

Duncan Burt: I do not want to add or repeat any of that, but I think that this is the one big problem left to crack for the UK. Electric vehicles are pretty much on the go now. We consider that a done deal. Heat is the only thing left.

There are two important factors. First, we cannot necessarily lean on lots of international experience here. Many decarbonising economies have a more Mediterranean climate, where their peak demand aligns with air-conditioning and solar output in the summer. We have a different problem in the UK. We need to solve it ourselves.

Secondly, this really is the whole-system problem of whole-system problems, as it interacts with electricity and gas and with some very important factors around how people actually use heat in the home. It interacts with efficiency and how people feel about their home environment. There are lots of complex personal issues in here that need to be tackled on roll-out.

Chair: Martin has a brief question. I am very conscious of time.

Q337 **Martin Whitfield:** This follows on from what you were saying, Duncan. It is a question that we have been formulating for a while. Is this not the time when we need to stop looking at individual sectors and blocs and to start putting transport, heat and power together? All of that needs to come together in thinking. In some areas, answers lie elsewhere. Some areas have problems that other areas can address. We cannot actually review this until we look holistically at the whole group together. It is a big ask, but we will get the best savings if we do that, rather than tanking down individual routes.

Duncan Burt: I could not have put it better myself. You can bank all the uncertainties. We understand what is going on with electricity. We are



really beginning to understand what is going on with transport; it is just a question of speed. The way in which you charge your EV will interact with how you might use electric heat versus how you might use biogas versus how you might use hydrogen. The whole thing now comes together. For this last problem, we need to solve the whole chain.

Professor Eyre: It is particularly clear for hydrogen, which can be used in industrial processes, in heat and, potentially, in heavy transport. What we do in the power sector—for example, whether we deploy CCS or very large amounts of variable renewables—will influence whether that hydrogen is produced by electrolysis or by steam methane reformation, with CCS.

Q338 **Martin Whitfield:** Who is responsible? Who should do it?

Duncan Burt: There is some fantastic work going on with the Energy Systems Catapult. It has put a lot of its effort into heat. I think that that is the right thing. Guy Newey and all of the team there are working very hard on that. We want to see continued strong and growing involvement from a number of Government Departments, led by BEIS. As I said, we think that it really is the last big problem to solve when it comes to decarbonising the economy.

Q339 **Chair:** You mentioned the Government. The Government have said that they want to “lay the groundwork this Parliament” to enable decisions to be made in the early 2020s that will help to decarbonise our heating system. What do you think that those decisions should be now? Did you take any comfort from some of the announcements in the spring statement this year, which seemed to set a destination for us?

Randolph Brazier: We fully support the green gas obligation. On steps that could be taken now, I agree with what Nick said about starting to plan a strategy. We have started to look at that with a gas decarbonisation pathways project that we are running. You can also start looking at things like blending hydrogen into the existing gas networks. We believe that we can get up to 20% hydrogen into the gas networks without affecting consumer devices in the home. We can continue to support biomethane plants being connected, which the RHI helped with. We also believe that we can now start planning for some at-scale trials.

Duncan Burt: It is important to bear in mind that, by 2025, we need to be locked in, with significant roll-out of some of those low-carbon heating technologies commencing. By 2030, we really need to be in it. It needs to be working in tens of thousands of houses a week at that stage. If you roll back from there, we face an issue similar to the one that we faced in the electricity sector 15 or 20 years ago. You have three or four potential technologies: nuclear, offshore wind, onshore wind and solar. What do you do? We can see a way to take forward all those heating options, to a certain extent. If you test them at scale, you will start to see how that comes together, looking at the whole-system aspects of it as you go.



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Professor Green: The statements on new build were interesting as well. In the previous session, you talked about incentives versus regulation. I think that obliging new build to be off-gas and to have very good insulation standards drives a set of technologies forward that, hopefully, we can pick up and start to use in retrofit, too.

Professor Eyre: I agree with all that. I would just re-emphasise that our building energy efficiency policy framework fell apart in 2013 and has not been rebuilt. It urgently needs to be rebuilt.

Q340 **Chair:** That was a useful point to make. This is the final question from me. Should the levies on electricity and gas supplies be amended to reflect the carbon intensity of the way in which the energy is generated or supplied?

Duncan Burt: We see the carbon price as a very effective mechanism at the moment for driving lower-carbon supply of electricity. The conversation with the previous panel around how those levies are done and whether we need to adjust them effectively to allow prices not to go negative, but to go to zero, is an interesting idea. As the ESO, we can make either option work. To the general person who is not steeped in policy, there is probably a lot of common sense in saying, "Most of these prices should stop at zero, shouldn't they? Why should they go negative?" I could buy that.

Q341 **Chair:** Does anyone else want to comment?

Professor Green: A carbon price could be combined with tailored support mechanisms for those technologies whose cost girth still needs to come down. That certainly applies to electricity. Gas would be interesting. With the increasing injection into the gas grid of lower-carbon sources of gas, maybe some reflection there would be good.

Professor Eyre: Levies on electricity and, particularly, on gas are inevitably regressive. That needs to be borne in mind. Whether the costs should fall on consumers or on general taxation is, therefore, a highly political decision.

Q342 **Bill Grant:** It has been suggested to the Committee in written evidence that co-ordination between the different sectors of the UK energy system could be improved. Bearing in mind that we are on a journey to a decentralised system, how could a more whole-system approach be established or adopted?

Duncan Burt: There is a lot of work going on in this space. We already work very closely with the other network companies, through open networks. We have a very large engagement with distributed energy more generally called Power Responsive, which is stewarded by National Grid ESO but sits as a separate entity from us, with its own board.

We need more of that kind of activity. There is a role for Government and the regulator in pulling together some of these actors, but there is a role



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for the sector and for industry in being proactive in solving many of their own problems, particularly with the stretch on the policy landscape at the moment.

Professor Green: There are so many dimensions to the co-ordination. We talked earlier about the whole-system view across transport, heating and electricity. That has to be there. As we start to look at local systems providing more services into the national picture, there needs to be co-ordination between the transmission system operator and the distribution system operators.

I do not know to what extent we are on a journey to a fully decentralised system. There is still a compelling logic that says, "Build wind turbines or wind farms large." The decarbonisation of heating through the production of hydrogen will be large industrial processes. I come back to my earlier point—international interconnection is one of the ways in which we help to balance our system. There is clearly a move towards decentralising at least some parts of what we do, but the centre still matters.

Q343 **Bill Grant:** We still need that co-ordination. Do we still need to improve that?

Duncan Burt: Tim is saying that even a very decentralised system is still probably 50% decentralised versus 50% centralised and large scale. Given the evolution of offshore wind, with solar and smaller-scale generation, that looks about right.

Q344 **Bill Grant:** We should still go forward to adopting a better-co-ordinated system.

Duncan Burt: Absolutely.

Q345 **Bill Grant:** It is essential.

Randolph Brazier: Absolutely. As Duncan said, we represent the gas and electricity networks. We are already trying to bring our members a lot closer together, so that they work together, under the open networks project and other initiatives in the company.

Professor Eyre: One of the issues is that that co-ordination really ought to include functions like housing, land use planning, building regulations, transport planning and local economic development, all of which are not done by national Government, including devolved Government. There is a question about how local authorities should be brought into this. We are seeing some excellent initiatives coming out of local government, but, frankly, there is mixed enthusiasm and, in many cases, very limited capacity for local government to respond clearly. In the broader governance sense, people need to be thinking about the role of sub-UK Government actors as well, because there is a lot of work to be done there.



Randolph Brazier: I agree. What the Scottish Government have done with their energy vision is really forward thinking and progressive. We probably need that at a more local level in other places. We may even need that, or something similar, at a national level as well.

Q346 **Bill Grant:** Did you note the accent? [*Laughter.*]

I move on to the subject of hydrogen. The Committee on Climate Change has urged that we need to break “the cycle of inaction”. Have the Government begun to address that? I am aware that there are trials in Leeds and that there are the Hydrogen 100 projects. Are the concerns raised by the Committee on Climate Change being addressed by Government? In what direction do we need to go in relation to hydrogen?

Professor Green: We are still waiting for some big announcements on large-scale trials, aren't we? Some of what has happened is a shift on carbon capture and storage technology, which we thought was going to be an electricity-generating technology and looks more like it plays to hydrogen production. That plays into decarbonisation of industry, for process heat, but also decarbonisation in the heating sector. You need to get on with that sort of trial deployment.

Randolph Brazier: There are a couple of things that Government could do. One relates to regulation. I think that at the moment we are allowed only 0.1% hydrogen in the gas grid. Duncan will correct me if I am wrong. We would look to try to relax that. A lot of the components of the hydrogen system exist and have been tested in isolation. What we have not tested at scale is the end-to-end process. That is what we need to focus on.

Q347 **Bill Grant:** In the case of hydrogen, and then its deployment into other low-carbon—

Randolph Brazier: It is the generation, the transport and then the end appliances in the home and how they are going to burn it, basically.

Duncan Burt: I would absolutely compete it against the other options that you have to deliver that flexibility into the heat market—ammonia, flexibility more generally and hybrid boilers. There are lots of different options.

Q348 **Bill Grant:** Randolph, you touched on the introduction of hydrogen into the existing gas network. I understand that there is a small percentage. Are you suggesting that we have not reached the optimum? There must be an upper limit for introducing hydrogen if the existing boilers are to function. They will not like what is coming in as their fuel.

Randolph Brazier: We are running some trials on this, but we believe that it is up to 20%.

Q349 **Bill Grant:** Up to 20%.

Randolph Brazier: Yes.



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Q350 **Bill Grant:** You think that that would be the optimum.

Randolph Brazier: I do not know quite the technical details, but I think that, beyond that, it starts affecting the devices in people's homes. Up to 20%, there is no effect.

Q351 **Bill Grant:** And that is a worthwhile reduction in carbon.

Randolph Brazier: It is a significant reduction in carbon emissions.

Professor Green: It is a useful transition, isn't it?

Randolph Brazier: Absolutely.

Professor Green: It is a useful transition. It is something that we should do, because we can do it relatively easily. However, there is a break-point beyond which you have to start changing the appliances in people's homes, because hydrogen just does not burn the same as methane. Different types of gas boilers and cooking hobs are important points that we have to recognise. We have to think through that transition.

Professor Eyre: I would go further than Tim. I do not think that we should assume that hydrogen will be burned in boilers. We need hydrogen heat pumps and fuel cells. We really need an energy system that looks like we know what the second law of thermodynamics is, as well as the first law of thermodynamics.

Q352 **Bill Grant:** There is a lot to do in that regard. There is a long road to go.

Professor Eyre: Yes. These fuels are going to be more expensive. We have to look at how to use them as efficiently as possible. Burning them in a boiler is not necessarily the answer.

Professor Green: It has the attraction of being familiar. It is interesting. We have made great strides in decarbonising our electricity, because it has largely been upstream and thus far the consumer has hardly been affected. There has been some demand-side participation. Is it realistic to think that we can do that in gas use? Can we decarbonise it upstream, so that people see a familiar set of technologies? We are probably going to have to replace appliances anyway. Nick is quite correct to pick me up on that. That is the point at which you say, "Maybe a gas boiler is not the thing. It is a hybrid heat pump, or a heat network, with the hydrogen used at district level."

Randolph Brazier: We need to look at all the options, ultimately.

Q353 **Chair:** Do we need a scheme where it is old boilers for new technology?

Professor Green: Yes. Do you do it regionally? Do you change the concentration in the city of Leeds and then change all the appliances in Leeds, or do you creep the whole system forward together? There is a tricky set of transitions to plan.



Duncan Burt: There is a big component of national—in the case of Scotland and Wales—regional or local measures that could happen in conjunction here. As Tim said, it makes sense to do some of this in a planned local way. We have had previous schemes to replace less efficient boilers with more efficient boilers. We could absolutely see that kind of scheme working again. However, as Nick said, it is vital that it happens in tandem with energy efficiency and continued measures to improve energy use in the home.

Professor Eyre: It can be done. I am old enough to remember the last time we changed the gas network in Leeds. I hope to live to see the next change in the gas network in Leeds.

Q354 **Damien Moore:** How can decentralisation in the UK's energy system contribute to decarbonisation? How can the Government help that process?

Duncan Burt: It is already contributing tremendously. We have very large amounts of small-scale onshore wind operating at a distributed level, particularly in Scotland. On a windy day in Scotland, the north of Scotland is like hundreds of mini-power stations, all exporting on to the national grid and flowing south to supply demand centres in Edinburgh, Glasgow and even as far as Leeds.

The next stage is that there is a lot to be done at a smart control local level to enable EV charging right across the grid. Beyond that, once heat-load starts moving away from unabated gas burn, lots of different sources of distributed heat networks or local planning could play a huge role. All of that sits under the general umbrella of distributed energy.

Professor Eyre: From my point of view, as someone working on and researching energy demand, the energy system has always been decentralised. I always worry about people who think that there has never been any decentralised component. It is hugely decentralised. What is changing is that some of the supply technologies are becoming more decentralised. That makes it important to think about how individual householders, transport users and businesses interact with the energy system.

Professor Green: Localisation helps people to engage with that. Community energy schemes or domestically owned PV help the process of thinking about self-consumption or peer-to-peer trading—all the things that we think form part of the system's future.

Randolph Brazier: I agree. It is a win-win, because you are decarbonising, but also offering customers choice and enabling them to reduce their bills and make new types of revenue.

Q355 **Damien Moore:** Do you think that there is a role for local enterprise partnerships and combined authorities to promote this?



Randolph Brazier: Absolutely. As I mentioned earlier, there is definitely a big role for local authorities to play. They should come together and look at the whole energy system plan for their area. I know that Scotland has already started doing that. Some other local authorities have, too. The GLA in London is a good example, but we definitely think that there is a bigger role for the rest to play as well.

Q356 **Damien Moore:** You mentioned the Scottish system, but they tend to have bigger authority areas. Would you say that that is what we need to do in England as well?

Professor Eyre: The key difference in Scotland is that the Scottish Government have explicitly charged local authorities with planning for energy efficiency and heat decarbonisation, whereas the policy framework for local authorities in England is, shall we say, vaguer. There are no specific obligations. The role of local authorities in the energy system in England is not very well specified. I think that that needs to change.

Duncan Burt: Bear in mind that Scotland is one of the lowest-carbon economies in the world now, with the level of wind that it has on. You will find that not just these organisations but organisations across the sector are thinking about how they engage very differently. If you went back 10 years, we would have 20 to 50 people, all very familiar energy experts, at our conferences and engagement sessions. Now we regularly have 400 to 600 at similar conferences—everything from local authorities through to small entrepreneurs. That makes us think about both how we structure our business and—although we do not have a very diverse panel today—the diversity of backgrounds, genders and everything else that we have in the organisation, so that we reflect the society we work in and engage really effectively with it at all levels.

Chair: Thank you very much for your attendance and information today.