



Economic Affairs Committee

Corrected oral evidence: The Economics of UK Energy Policy

Tuesday 11 October 2016

3.35 pm

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Members present: Lord Sharkey (The Chairman); Baroness Bowles of Berkhamsted; Lord Burns; Lord Forsyth of Drumlean; Lord Kerr of Kinlochard; Lord Lamont of Lerwick; Lord Layard; Lord Tugendhat; Lord Turnbull; Baroness Wheatcroft.

Evidence Session No. 3

Heard in Public

Questions 27 - 39

Witnesses

Professor Richard Green, Professor of Sustainable Energy Business, Imperial College London, Tony Lodge, Political and Energy Analyst, Centre for Policy Studies, and Jimmy Aldridge, Acting Associate Director for Energy, Transport & Climate, Institute for Public Policy Research

Examination of witnesses

Professor Richard Green, Tony Lodge and Jimmy Aldridge.

Q27 The Chairman: Professor Green, Mr Lodge and Mr Aldridge, welcome to the Economic Affairs Committee and our inquiry into the economics of UK energy policy. You may have noticed that I am not Lord Hollick. He is indisposed and I am standing in for him today. We may be interrupted by a Division or two in the course of the afternoon, which will cause a break of five minutes or so in the session. Perhaps I can start off with our first question. The present Government's four objectives for energy policy are to ensure the UK has a secure and resilient system; to keep energy bills as low as possible for households and businesses; to secure ambitious international action on climate change and reduce carbon emissions cost-effectively at home; and to manage the UK's energy legacy safely and responsibly. Do you think the current Government's energy policy strikes the right balance among those stated objectives? I should say that you do not all have to answer every question.

Tony Lodge: I think the current Government's energy policies do not fulfil those ambitions. The fact that we are having this meeting in October 2016, given what needs to happen before Christmas, which we will come to, is absolutely right. There used to be consistent chatter from some of us that there was an energy trilemma. It was a three-legged stool: the need to have security of supply, decarbonisation and cost-effectiveness. I have always argued there should be a fourth leg to the stool, which is diversity of energy and electricity supplies. There is a real problem in that far too many coal plants have closed too early and not enough gas-fired plants are coming in to replace them; there is a problem of picking winners, which is what we are doing with feed-in tariffs and contracts for difference; and there is a problem as to what we are hoping to do in the future to get us out of an issue. We do not have an electricity market any more. Anyone who uses that expression is either misunderstanding it or consciously accepting that it does not actually exist. We pick winners, and we have an issue where we subsidise certain technologies in the hope of meeting targets. That is at the root of the problem. In short, I do not think we are meeting our priorities and ambitions, and there are legacy issues that we will have problems with in the near future.

Professor Green: I am somewhat more optimistic. The capacity situation is not helpful, but it means that in an average winter there will be a few hours during which National Grid is offering money to large customers to use less power than they otherwise would, which is a rather different prospect from uncontrolled blackouts. There has been quite a lot of progress on decarbonisation, although it is perhaps unclear whether the next steps are quite as securely mapped out as they might be. Perhaps the fact that we are collecting the costs from both domestic customers and industrial customers is a problem, when parts of these costs incurred for public policy objectives are akin to a tax and a standard prescription in public economics is that you do not tax intermediate

production; in other words, you tax the final consumer rather than the industrial consumer. We may have got the balance wrong in where we are collecting the revenues.

Jimmy Aldridge: If I may, I will touch on a few different forces that I think are acting on the Government's ability to meet their objectives at the moment. The top-level themes in this discussion provide a useful context. At the moment, there is a large amount of electricity capacity that is retiring, or is about to retire. Many coal plants are reaching the end of their useful life, as are a number of gas plants and nuclear plants. The figure that has been put is that by 2030 we need the equivalent of 30 Hinkley Point Cs to be built across a number of different technology types.

We have decarbonisation targets not only at UK level but in the post-Paris agreement context. By around 2050 we need to get to the goal of net zero emissions. That is all occurring within the context of very rapid technological change. A large number of technologies have come on line very recently. Their costs are falling very fast, and it is difficult within that context to chart a course to say how we are going to reach 2030 and 2050, because the ground is moving very quickly. The characteristics of a large number of those technologies are very different from those that have underpinned the sector for a long time. They are generally smaller scale and are scattered around the country in a way that large-scale coal, gas and nuclear plants have not been, so that introduces a whole raft of additional challenges for balancing the network and ensuring that it meets our objectives going forward.

Within that context, the Government have an extremely challenging job to meet their objectives. It is inevitable within that context that there will be a degree of intervention. There are many different objectives that need to be met at the same time, so intervention is inevitable. We need to be careful that those interventions are very carefully chosen. Although I think the general energy policy framework is imperfect at the moment and there are some issues with it, generally we are in a good position to meet the carbon budgets going forward and to ensure secure supplies.

The Chairman: To speak plainly, do you think that the decarbonisation objective should be subordinate to the other objectives?

Professor Green: It would be wrong to ignore any of the objectives. If you lose political consensus for decarbonisation because you manage to do it in too expensive a way, or you do it in such a way that, coupled with bad luck or incompetence within the industry, it leads to significant blackouts, the political support for that will not happen. You need to balance all three.

Tony Lodge: Security of supply should override decarbonisation ambitions.

Jimmy Aldridge: I disagree with that view. I think that each of the elements of the trilemma should have equal weighting, and the

Government's job is to try to balance those three objectives as best they can.

Lord Forsyth of Drumlean: Can I ask Mr Aldridge how he thinks the electorate might react if they found themselves in the dark and priority was being given to decarbonisation? Is that really a practical policy?

Jimmy Aldridge: That is an important point. Security of supply is extremely important and must be maintained, but decarbonisation is tackling an issue that is very significant for future generations as well. It is extremely important not only that we balance the needs of current bill payers and householders but that we consider future generations. It is important that there is cross-generational balancing of those different objectives.

The Chairman: To be clear, when you say balancing, I assume you do not mean "give equal weight", or do you?

Jimmy Aldridge: I am arguing that they should be given equal weight. They are all extremely important and need to be the focus of government policy and given equal weight.

Professor Green: Perhaps I may respectfully suggest that Lord Forsyth's sharp dichotomy between security of supply and decarbonisation may be sharper than one needs. If you were decarbonising in such a way that you closed all fossil plants very quickly without thinking about what would replace them, there is obviously a conflict. If you do it more gradually, whereby you have demand response coming in and increasing amounts of energy storage, which has just been contracted for, you muck up security of supply if you get it wrong, but it can be done without creating that sharp dichotomy.

Q28 **Lord Turnbull:** We are only on track for the first of those. We are removing coal production very fast, and where "the market" is working it is not producing gas to replace it. That is exactly the scenario you say you want to avoid. You also seem to be saying that we will not actually have outages. We may not, but we may have paid an absolute ransom for things that prevent outages—the various back-up contracts, which can be very inefficient, even down to burning diesel, for example. That could add to the total costs of the system very substantially.

Professor Green: It will certainly make a few hours out of the 8,760 in the year quite expensive, averaged over the year as a whole. If you can avoid those costs and National Grid can find ways to persuade generators at risk of leaving the system to stay on, then that can be a more efficient way to do things.

Tony Lodge: On that point, I believe that last year this Committee held an inquiry into the resilience of the electricity system. The key word is resilience. On the question whether we are now in a better situation than we were three years ago, I think we are in a much worse situation. We have coal plant closing early. It has been forced to close by the carbon price floor and government policy. When it closes early, the Government

panic and give it £250 million in what is called supplementary balancing reserve subsidy to keep it on for this winter and next. I consider that a disastrous policy outcome.

Lord Forsyth of Drumlean: I understand the point about balancing, but ultimately, just as the first duty of government is to defend the nation, it is the first duty of government to ensure security of supply for industry and people's homes. I am puzzled as to why Mr Aldridge thinks that they can have equal weight. Whatever one's view on what needs to be done for future generations, they are some time away, but on a day-to-day basis surely it must be the absolute priority to maintain security of supply.

Jimmy Aldridge: I think that within that question is an assumption that to put focus on decarbonisation is implicitly to threaten security of supply. I would challenge that, because a number of technologies are coming forward that will be very useful for balancing supply in future. As Professor Green mentioned, in managing the demand side a lot of technologies are being developed very quickly on that side. We absolutely need a clear transition away from the high-carbon technologies we have at the moment to ensure that security of supply is maintained. I am not questioning that at all, but over time we need to ensure that all those different objectives are balanced at the same time.

Lord Layard: If you accept the decarbonisation objective and the different ways of achieving it, is the Government's mix for achieving it the optimum one at the moment?

Tony Lodge: One of the most important statistics on decarbonisation is the period between about 1992 and 2004 when the biggest collapse in British carbon emissions came about because we closed a lot of coal-fired power stations and replaced them with gas-fired power stations, known as the dash for gas. That was coupled with British Coal privatisation and the Electricity Act. There was a considerable collapse in UK carbon emissions, and it is a fact that nothing has come close to it since.

In our opinion, the priority has to be the swift replacement of what was coal-fired generation with gas-fired generation. There are some very high-efficiency combined cycle gas turbine power stations now available. They can be built relatively quickly. Of course, the key is that they get the right price in the capacity auction later this year, but at the moment there is only one gas-fired power station being built, near Manchester, yet we have five, six or seven coal plants coming off quite soon.

Q29 **Lord Lamont of Lerwick:** First, what view do you take of the most modern technology that can be used so that emissions from coal-fired stations are much less than they were in the past? Do you think that is unthinkable? Secondly, why is it that, while we are closing coal-fired power stations, Germany is opening them, as I understand it?

Tony Lodge: A new coal-fired power station in this country is illegal under the Government's emissions performance standard in the Energy

Act 2013. They are not allowed. You are quite right that in Germany advanced super-critical coal stations are being built. I believe 12 gigawatts have been built since 2000. They are high-efficiency plants. They emit more than a gas plant. E.ON had a plan to build one at Kingsnorth in Kent back in 2008. The then Labour Government refused to give it planning permission. The company said it would retrofit the plant so that it could be carbon capture and storage-ready, but it still did not get planning permission. We then had the ban in the legislation in 2011, which became the 2013 Act. Coal is cheap and plentiful, but Britain has turned its back on it.

Professor Green: The International Energy Agency did some work a few years ago looking at a plausible trajectory if global carbon emissions are to be consistent with a decent chance of meeting the 2 degree target. They were looking effectively at the emissions locked in from the infrastructure that the world already has. If that infrastructure stays operating for its expected economic life and then shuts, it leaves very little headroom, and in the period since that work was done more infrastructure has been added. In other words, were we to build even gas-fired stations at this stage, unless they were to replace coal stations closing sooner than the IEA had expected, or those gas stations in turn were to shut after a period when their owners would have hoped they were still running for longer, or they were to be retrofitted with carbon capture and storage, that would be part of our contribution to busting the carbon budget. New fossil plant without the possibility of retrofitting CCS may not be the best idea.

Q30 **Lord Layard:** It sounds to me as though you have given us a very important piece of information, but there is still the issue of how to increase the use of renewables. What is your comment on the mix of feed-in tariffs, renewables obligations and contracts for difference that we have at the moment as a way of trying to promote that?

Professor Green: The contract for difference is fundamental. It has the problem of picking winners. In a sense, any system picks winners. The market picks winners of the technologies that currently offer the best value, and the technologies somebody believes they can develop, using available resources from whatever source, to offer enough value within the time frame in which they are willing to invest. That leaves out the technologies that do not offer that prospect on the resources available to the people who might develop them.

Sometimes interventionist government policies can develop technologies that will take more resources than the private sector on its own is willing to commit at that stage. You could argue that that was the point, after the initial phase of the renewables obligation, of moving to a banded system where more support was given for things that were more expensive but might get cheaper in future. The contracts for difference do something similar. The great advantage of the contracts for difference system is that if you are going to decide to have a mix of technologies, some of which are more expensive—there is a question as to which ones are really worth it—doing so on an auction basis often means they turn

out a lot cheaper than you thought they would be. There is a dramatic contrast between prices of the order of £140 per megawatt hour that the Government had thought would be necessary for offshore wind projects being developed in the near future and the £120 per megawatt hour in the winning bids in the contract for differences auction. It is an odd market, but there is a little bit of competition in it, and that is probably better than trying to guess how many renewables obligation certificates everyone needs, which adds to the risk and therefore adds to the rates of return and the cost of capital. Although there is the problem of how on earth you decide which technologies deserve support, and the potential to get that wrong is high, once you have decided that that is what you want, the power of competition in an auction works well. The power of a government Minister to negotiate with the developer of a unique project may not be such brilliant value for money.

Tony Lodge: I may be controversial in saying this, but I think the priority is not to focus necessarily on renewables at this stage, but to get what we call our mid-merit plant rebuilt with the coal plant closing and not enough gas-fired power stations coming on. Some people used to use the term “base load”. We are not going to see Hinkley until the mid to late 2020s. A lot of the AGRs and other nuclear plants are coming off and will be gone, even with their life extensions. We have lost the peak; the oil-fired power stations—the peaking plants—have been demolished. Fawley, Littlebrook and Grain have gone.

If we are to have more renewables, we will need the spinning reserve to cover them, because many of them are intermittent. Gas is a very good cover for that kind of technology, but we are not getting it built. We can all talk about 2030, 2040 and 2050, but the priority for this country is the next 18 months to four years. If we get that wrong, we will have real problems, especially against Brexit where arguably we have to become more competitive, and industrial users need more competitive energy prices and the rest. That is the real issue.

As regards renewables, there should be a single unified technology-neutral auction and capacity market where renewables have to face the full costs of their transmission and location. With the carbon price involved, let us see what the real costs are. Then, as Amber Rudd said in November in her so-called reset speech, we can possibly get back to something like a market.

Jimmy Aldridge: One point on which we agree is that in the short term there is a need for some new build combined cycle gas turbines. To get those built has been quite challenging, and despite the Government being fairly explicit that that was what they wanted to see and introducing a mechanism widely seen to be a driver for new gas plant, they have not been able to meet that objective. I think the reason for that is that there are split objectives within the capacity market, which was the mechanism I mentioned. It is not entirely clear whether it is about keeping old capacity online and ensuring that it has sufficient revenues to stay online or whether it is about incentivising new capacity to come forward.

That has created quite a problem within the capacity market, because effectively it is trying to drive two different things at the same time: one to remain and one to bring on new capacity. In previous work done by IPPR we recommended that the capacity market should be split so we can ensure that we have secure supplies going forward while new technologies are coming online. We have old capacity remaining online, but we are also starting to see some of the new capacity we are going to need, and that is gas turbine. We need some of that, although I take Professor Green's point that we need to ensure the capability is there so that we can fit carbon capture and storage technologies to it going forward. Other technologies can be used for the same role as gas turbines play in electricity storage and demand-side management. There is potential to use the capacity market far more effectively to bring forward those technologies as well.

Q31 Lord Tugendhat: Not only is there a considerable degree of state intervention in the market at the moment, but when I listen to your answers the word "ensure" comes up a great deal. You are conveying a general impression of managing a market. In those circumstances, do you feel that Professor Helm's suggestion that perhaps we should return to the Central Electricity Generating Board has some merit?

Jimmy Aldridge: Personally, I would not go that far. I am not sure Professor Helm would like to see that. I think he is being provocative and saying that we practically have it already. It is true that since 2011 no capacity in the UK has been constructed without some sort of state intervention. As I said in my opening remarks, because of the number of different objectives that we are trying to meet in the electricity sector at the same time, I think that situation is almost inevitable. Perhaps 20 years ago, when we were not trying to meet multiple objectives and it was a case of ensuring security of supply as cheaply as possible with no limitation on carbon, it was possible to focus in the way you suggest.

Tony Lodge: I think he is right. The Secretary of State at the moment has the power effectively in his auction to build new power stations. He picks winners with his feed-in tariffs and contracts for difference. He has the power, quite rightly, in the sense of where we are, to keep the lights on. He instructs National Grid and National Grid informs him. We have the Winter Outlook coming out next month, and that will be very interesting.

When we privatised electricity in 1989-90 we did the right thing. Many parts of the world copied us. We had the pool and a situation where competitive supplies of electricity were tendered. If Amber Rudd's reset speech last year is to be followed through, we have to have some return to the market quite soon, I hope. That has to be all technologies in a single unified capacity auction vying for purchase, and that includes renewables with their transmission and locational costs included. Then you return to something like we had all those years ago, but in many respects—Dieter Helm is quite right—the Secretary of State at the moment is very much operating in the same way as Walter Marshall used to in 1988.

Lord Tugendhat: The only thing is that in the case of Walter Marshall, whom I remember well, we could see what he was doing, and it is a great deal harder to see what the Secretary of State is doing.

The Chairman: Perhaps our witnesses will not want to comment on that.

Q32 **Baroness Wheatcroft:** I want to ask about Hinkley Point. Mr Lodge, you were quite outspoken in the evidence you sent us in your views on the scheme. Mr Aldridge talks about perhaps more public ownership of nuclear going forward. Professor Green, what is your attitude towards Hinkley?

Professor Green: The price is rather eye-watering. Even comparing it with a price depressed by lots of fast growth in renewables at the moment, which is not the price we would be seeing in 20 or 30 years' time. I think the Government missed a trick in going for only a 35-year contract; they should have done 50 or 60 years, with 35 years at a high price in order to get the capital investment repaid fast, in the same way as it is generally a good idea, if you are lucky enough, to pay off your mortgage, or make a contribution towards that. Then there should be a second phase, in which the customers, who have been nice enough, effectively, to buy EDF and its partners a 35 year-old nuclear station for free, pay a much lower price that is high enough to give EDF a full incentive to keep it running properly and a return for the risks it has taken on, but is perhaps not what the market price would otherwise be in 40 years' time. I think the Government missed a trick for our descendants.

The cost of capital seems amazingly high. If the construction contract could have been done in such a way as to make EDF carry 20% of the cost on a fixed-cost basis so that, if it mucked it up, people got sacked, I would be happy enough to pay my share of whatever the other 80% turned out to be, because I suspect the risk to my electricity bill of cost overruns on that part would be a rather cheaper insurance premium than needed by city investors and EDF, if it mucks up, betting the company and so demanding quite a high insurance premium.

Baroness Wheatcroft: The Government's argument is that by agreeing to this deal we offload any risk in the project. Do you think we are still left with the residual risk that it may not work?

Professor Green: I would be an awful lot happier if there was an operating European pressurised water reactor somewhere in the world. They have spent an awfully long time in France and Finland not finishing this technology. That does not mean it will not work. Sometimes you learn from your failures, but it would be more comfortable had they got one working.

Baroness Wheatcroft: Mr Lodge, I know your views on the cost of the project. What about the likelihood of its succeeding?

Tony Lodge: I cannot answer that. I hope it succeeds. My goodness me, we are paying enough for it. The problem with Hinkley is that it was

probably too far down the road for the Prime Minister to veto it. In years to come, we will, hopefully, learn more about what was going on at Treasury level when they negotiated the £92.50 per megawatt hour. The fundamental problem is that the Electricity Act 2013 was based on the premise that fossil fuel prices would keep going up and up, and of course they have not. We see more gas coming on around the world. The United States is about to start exporting gas. We have not even seen what the Australians are proposing to do with Western Australia. There is going to be an abundance of both ship-borne and land-borne gas production in the world in the future. Electricity prices will not be anywhere close to what would be £92.50 when this thing opens, and it will be one of those legacies we tell children about. I hope not, but I fear that will be the case.

Baroness Wheatcroft: But do you subscribe to the argument that in order to secure the base load capacity we will need nuclear in the future?

Tony Lodge: I certainly agree with that, but I am a supporter of small modular reactors. I think they allow you to be far more competitive in what you are offering in the locality where they are. Hinkley C is a very large plant, and that in itself is something that should concern people when one looks at Normandy and Finland. The fundamental point is that it was all built around a DECC forecast that fossil fuel prices would keep going up, and of course they have not.

Jimmy Aldridge: On Hinkley Point, the important way forward is to learn the lessons of going through that negotiation, its having been signed off. I do not think I would have chosen that technology or that price, but the Government eventually did well to see it through, and it took a lot of determination. However, there are lessons to learn from the process. One of them is that, if the state is to be involved in energy policy, it is important that it is used as intelligently as possible. If we are honest about Hinkley Point C, it is going to be delivered by a French state-backed company with Chinese state-backed finance. Potentially, British bill payers will be asking in 20 years' time why their money is going to foreign shareholders rather than using the state intelligently. If we have a very high risk capital-intensive project like a nuclear plant, can we not use the state more intelligently at the start to take out some of the risk and sell it back to the private sector for the private sector to manage and run it over time, and ensure that some of the revenues, returns and industrial opportunity in the project come back to British bill payers?

Lord Lamont of Lerwick: How do you do that? How do you take the risk out of it? You are saying that the state should take the risk out of it. We no longer have the capacity to build them.

Jimmy Aldridge: One of the major risks and key drivers of the cost of capital within all energy projects is regulatory and policy risk. If the state is involved in a project as large as something like Hinkley Point C, at least there is some visibility and certainty about the fact that there will be a framework that ultimately follows through. Another example of a different technology is the way offshore wind is procured in Denmark. At the

moment in the UK, the way we procure offshore wind is that there is an open bidding process, and a commercial developer must secure all the permissions and the up-front risky decisions early on. At that point, they can try to get the project built and they face the construction costs. They also have to bid into the CFD. There is a danger that they get planning fairly late and do not secure their CFD. In Denmark, the state identifies where it wants offshore wind to be built and gets the permissions in place for that, thereby removing the risk in securing permission to develop the project. Commercial developers then bid for a chance to develop in that space. That has reduced the cost of developing offshore wind in Denmark below the cost of doing it in the UK. I want to make it clear that I do not think there is always a role for the state in energy projects, but where it is involved it is important that we use it intelligently.

Lord Turnbull: On Hinkley, you are rather implying that the problems are regulatory. As I understand it, the project has achieved generic design approval; in other words, one set of nuclear engineers designed it and another set said it is okay to build it. The problem is that the people who are building it cannot build it, and that risk is still there. That is why I would never have signed the deal. Until they have demonstrated that they can see this project through to completion, as a pure construction project, it is we, not they, who are taking a risk. The risk to us is that instead of now coming on stream in 2027—we budget on that basis—when we get there we find this thing is three, four or five years late, or even longer, and we have not adequately prepared for it. That seems to me to be a problem. People think that Hinkley is the nuclear future. Other consortia are pursuing it on a less ambitious basis—not modular but smaller—with less advance on what went before. The construction risk is still there and it will fall on us, just as much as it will fall on the company.

Jimmy Aldridge: In the case of Hinkley, I do not disagree at all. There is only a role for the state to step in if the market is not delivering, so that is my only argument. The reason Hinkley Point ended up being so expensive was that it was extremely difficult for the market to deliver it, so the costs started to ratchet up for the strike price that was required. If further nuclear plant can be delivered without that same level of support, that is fine.

Q33 **Lord Forsyth of Drumlean:** I am not a great exponent of the state taking on projects, but the theory was always that, if there was a genuine transfer of risk to the private sector, you would pay a premium for that. The biggest risk is not regulatory risk, as Lord Turnbull has pointed out, but that the thing does not work. All the evidence is that that is highly likely to be the case. If it turns out that it does not work, what will be the consequences for our country and energy policy? In other words, how much of a risk are the Government carrying if this thing does not work?

Tony Lodge: The key point is that, if a future Government are sitting in Whitehall in 2023 looking out of the window and praying and hoping Hinkley C is open by 2026, it would be a very bad idea. They have to take the next two to three to four years to get enough gas built as possible. If we have the 3 gigawatts from Hinkley on by 2025-26, that is good, but I

do not think it should be seen as the main aim of British energy policy for the next 10 years. The fundamental problem about Hinkley will be that if we incur any of the delays they have seen in Normandy and Finland, and we have structured some of our grid around it coming on in 2026-27, which would be very late, that again is very bad planning.

Lord Forsyth of Drumlean: You have not really answered my question. Perhaps I did not put it terribly clearly. Let us assume that it does not work. Then the premium we are paying has clearly been wasted and there has not been a transfer of risk. It seems to me that the Government will still have responsibility for maintaining adequacy of supply. If we assume that it does not work and the gas-fired stations you advocate—I agree with you—are not built meanwhile, which seems likely at the moment, what would be the position? What is the scale of the difficulty?

Tony Lodge: I understand. In my opinion, that means we will have to have much bigger spare capacity margins available on the grid. As the Winter Outlook report will tell us next month, we are down to record low margins at the moment. We have had some mild winters; we also had a recent recession in 2007-08 when output collapsed, which basically saved the electricity system. We need a much bigger and safer margin in case the circumstances that you are talking about occur.

Lord Forsyth of Drumlean: If we do not do any of these things, what is the consequence?

Tony Lodge: I hate the word blackout, but you would certainly be looking at spikes in the price as we bring in emergency supplies. We pay industry to stop operating and we seek to close industry at certain times of peak demand to ration electricity. In any major industrial economy, that is a disaster.

Lord Forsyth of Drumlean: Do you agree with that, Professor Green?

Professor Green: I think it depends on the stage at which we learn it is not going to work. The latest plan—there have been many—is that Olkiluoto and Flamanville are meant to be coming online in a couple of years' time. If by 2020 neither of those is working, and if, as I suspect, the contract says that if the plant does not get built EDF does not get any money, it might decide that that was the point to stop pouring good money after bad. That would be five years before it was expected, which gives enough time to build most other types of power station, so that gap could be filled. If in 2024 we were suddenly to discover that some welds had been done incorrectly by the people at Hinkley, even though by that stage the reactors elsewhere were running, and it was suddenly pushed back, or worse, things are a lot trickier. Very often, you adjust the capacity margin in electricity not by building new plants, because it is too late, but deciding what you close. It is conceivable that there will be coal plant sitting around with a sentence of closure in 2025. With a certain amount of embarrassment, that could be kept open for a couple of years longer and would probably not do much to emissions because it would

not be used that much to fill the capacity gap. It is still very undesirable, but those are possible situations.

Baroness Wheatcroft: Mr Lodge, you mentioned smaller modular reactors. If we take the optimistic view that Hinkley will work, would it have any advantage over a suite of smaller modular reactors? You would certainly lower the security risk.

Tony Lodge: The smaller modular reactors enjoy three advantages. One is location. Many of you may know that we have had these things in universities and military establishments around the country for years. Many members of the public did not realise they were living next to one. They are, and will be, cheaper than Hinkley. They can react better than a 3-gigawatt power station to peaks in demand, unlike Hinkley, which is very much less flexible. I think there is an opportunity with an R&D perspective to rebuild a British nuclear sector around them. In my opinion, the sale of Westinghouse by Gordon Brown to Toshiba was an absolute scandal and is part of the problem of why we are where we are, but that is another matter. There are huge advantages in some of our key cities and university establishments.

Baroness Wheatcroft: Would either of the other witnesses like to add to that?

Professor Green: I happen to know that Imperial College is one of the institutions that had a nuclear reactor at one stage, although it is not on a campus I have ever visited.

Tony Lodge: I do not think there will be any coal-fired power stations post-2023. You might have Drax co-firing with biomass, but I think they will all be gone. They will be forced off by the carbon price floor and a tightening emissions performance standard. I do not think they will be available.

Q34 **Baroness Bowles of Berkhamsted:** This is an energy inquiry. There are other forms of energy. Why have we made less progress on heating and transportation than we have with electricity generation and decarbonising? A recent report from the Energy Transitions Commission said there was basically a steady state in those other sectors, whereas improvement had been made in the electricity sector.

Jimmy Aldridge: If I speak specifically to the heat sector, the reason there has been initial focus on decarbonising the power sector is that generally there is a small number of very large units. It is simpler to decarbonise those units in the heat sector than it is to go into individual homes to change over the technology. It is a far more dispersed and complicated issue. A lot of the decarbonisation within the heat sector is predicted to move over to electrification of heat. It is extremely important, as we move over to electrification in the heat sector, that it is not based on carbon-intensive electricity. It was important for there to be an initial focus on the power sector, and that was appropriate. The challenge within the heat sector is so significant that it almost dwarfs the

challenge of decarbonising within the power sector. It is extremely important that, although it is a long-running challenge up to 2050, we start to put some of the building blocks in place to do it now, to ensure that in 2025 we do not suddenly discover we need to develop a low-carbon heat sector that does not exist.

It is also worth mentioning that this is going to be a challenge for every country in the world, and there is an industrial opportunity that I do not think is quite as true within the power sector, where decarbonisation has already happened to a higher degree. There is an industrial opportunity within the heat sector to try to expand UK capacity and expertise within the sorts of technologies required in the heat sector. In the post-Brexit context, it is important to look at our decarbonisation and energy policy as also fitting into an industrial policy that ensures some of the benefits of that move start to be felt by people across the country, and certainly within the UK rather than outside.

Professor Green: In transport we have done a bit with biofuels, which you can do largely with the existing infrastructure, but the issues about how sustainable some biofuel sources may be are quite well known. There is a lot of research going on into a generation of biofuels that will not be using the food parts of plants and therefore will not have many of those side-effects, but they are not ready yet. Electric vehicles have taken time to take off. Some of them are now quite impressive, but to get them properly working you need quite a lot of change to the infrastructure, and literally millions of individual vehicle owners would be making the choice to change at some point. That will inevitably be quite slow.

Baroness Bowles of Berkhamsted: Are we doing enough at the moment, or could we be doing more?

Professor Green: It is not really my subsector. I suspect more could be done on preparing more charging points and doing additional work on second-generation biofuels, but I could not give you specifics.

Jimmy Aldridge: If I could answer your question in relation to heat, heat and energy efficiency are part of the same problem. For a long time, they have been seen as separate policy areas, but as far as I am concerned they are both warmth within the home. Energy efficiency delivery has gone a little further than low-carbon heat, but in the past year or two it has ratcheted back. Whatever your perspective, energy efficiency can be seen as very useful and important, whether it is decarbonising, reducing costs or decreasing our dependence on gas imports. There are many different advantages to energy efficiency. Infrastructure investment is an extremely useful thing to focus on, but at the moment policy on energy efficiency delivery has moved backwards.

When tackling decarbonisation in the heat sector, we should absolutely start by ensuring that the housing sector, which at the moment is in a fairly poor state, is upgraded as quickly as possible, because a large number of people in the UK are still in fuel poverty. There are many

different ways of doing that. There are different policies to drive it, but it takes a bit of commitment, which has not been shown recently. On other low-carbon heat, there is some useful work, particularly in urban areas, to drive district heating schemes, which could prove very useful, but they need to show a little more commitment so that we can see a long pipeline of work, such that an industry can develop around them to start reducing costs. At the moment, there is not the required level of commitment to drive that industrial capacity growth.

Baroness Bowles of Berkhamsted: When you say commitment, how much of it is money?

Jimmy Aldridge: It is not always money. In the case of district heating, there is a requirement to place some money up front to deal with the capital risk issues that arise early on in district heating schemes, similar to the offshore wind example I gave earlier. The Government have introduced a heat networks delivery unit that works with local authorities or commercial developers to help with the expertise. It is almost like a revolving fund of expertise. They have helped to develop a pipeline of projects for district heating in the sector. If you are Balfour Beatty wondering whether to commit to the UK, and there is a heat pipeline developed by the unit, which is helping local authorities that otherwise are very strapped and have very limited expertise, that shows commitment and it does not take the same level of money.

Q35 **Lord Turnbull:** I want to start with Professor Green's figures. I am finding it difficult to compare the different technologies. You mentioned the price for offshore wind. You thought it might be £140 and you seemed rather pleased that it was £120. The next number you mentioned was nuclear at about £97. Despite being 30% lower, that was described as eye-watering. Below that in the list is onshore wind presumably, and below that is gas and then coal. Can you rank them? Can you give me some order of magnitude? You can do that in two dimensions. One is the cost per kilowatt hour and the other is the cost per tonne of CO₂ avoided, which is a different measure. Start with the actual cost so that I can get an idea of just how different these things are.

Professor Green: Offshore wind in the latest auctions was coming in at about 12p per kilowatt hour and nuclear was 9p which is rather higher than--.

Lord Turnbull: You are using kilowatt hours. What about the figure of £140?

Professor Green: I possibly misheard kilowatt hour. If you multiply by 10 you get pounds per megawatt hour, if the Committee has a preference. I think the figures are £117 and £119 for the two recent offshore wind projects. I believe I gave the numbers in my evidence, which I forgot to print out. The projects mentioned earlier in Denmark and the Netherlands were done on a slightly different basis, with some of the project development risk taken out, and excluding transmission. The ballpark figures are £70, £80 or £90 per megawatt hour, because I am

guesstimating what the transmission cost would be. Hinkley is £92.50, or £89.50 if they build Sizewell C. It would be less than that if there is a cost underrun or financing is cheaper, because the European Commission negotiated a better deal than the British Government were able to. How much better it could get nobody knows, partly because we do not know how big any possible savings would be. They are potentially negative, but EDF gets to deal with that. We also do not know what the gain share is, but part of the state aid process gave a small chance of probably a small gain to customers.

For onshore wind, I think the numbers have been coming in at £70 to £80 recently. The consultants who did reports for the Government a few years back on the cost of building new coal and gas stations came in with fairly similar numbers to nuclear, by which I mean within £10 to £20 per megawatt hour either side. I am afraid I am working from memory. I have not looked at the numbers for a while. That was based partly on rising fossil fuel prices and partly on rising carbon prices.

Lord Turnbull: To clarify, you are saying that the new coal price would be pretty nearly the same as Hinkley.

Professor Green: Any time I have run models using those government numbers, coal is less attractive than nuclear.

Lord Turnbull: What about gas?

Professor Green: On the numbers PB Power provided for the Government a while back, gas is less attractive for running all the time, but you would certainly want to run it for between 2,000 and 6,000 hours a year to deal with the so-called mid-merit load.

Lord Turnbull: When you are dealing with renewables, what allowance is made for the fact that each gigawatt of renewable capacity needs some non-renewable to back it up?

Professor Green: There are various ways that can be done. One is to take an estimate of how much additional capacity you would need relative to the energy you would expect the wind farm to produce. That work was done by my colleague Rob Gross and his team for the UK Energy Research Centre about 10 years ago, and they are updating the work at the moment. Similar work was done by the Committee on Climate Change not so long ago. From my vague memory, you are talking about adding £5 or £10 per megawatt hour. I can go back to those reports and give you accurate numbers.

Lord Turnbull: Perhaps you could send in another note and possibly answer the question about the per kilowatt hour figures while you are at it. The only other question I have is about CCS. Back in 2008, which was the high point of the Climate Change Act, it was confidently expected that CCS would be available. The plan was that coal-fired power stations could be built but they had to be CCS-compatible. The Government have now dropped their CCS research projects. Where are we on this issue? Is it

one of those illusions, or are we simply relying on other countries to do the piece of research for us and then buy the technology, or what?

Professor Green: It is very hard to tell. It may be that people look back at the desire to save £1 billion to meet the balanced budget target in the last public spending review as one of the more disastrous policy decisions, because we were about three weeks away from getting bids in from the two companies developing projects, and we would have had much better information on what it would cost. Part of the idea of the projects was also to develop the network of contracts you would need. Nobody is going to finance a pipeline if they are not sure there is a power station ready to send something through it; nobody is going to finance the capture equipment if they are not sure there is going to be a pipeline to take the gas once you have captured it. Those projects would have got round that chicken-and-egg problem, but in order to save a small part of the margin of error of budgetary calculations it was decided that that information was not wanted.

We are now in something of a mess. I suspect that BP and Shell will be slightly reluctant to commit significant resources to the next competition the Government choose to run. We can buy CCS technology from elsewhere, but getting the bits and pieces to work together in a UK legal framework will probably take a bit of activity. Even if a mixture of nuclear, wind, solar and biomass can give very low-carbon electricity, to my knowledge people have not yet thought of a way of dealing with the fact that you make cement by driving off CO₂, and that things like air travel will be quite difficult to decarbonise. Having CCS and the option of going to negative emissions with biomass could prove very useful.

Lord Turnbull: Mr Lodge, do you share the view that this was probably a bad decision taken for the wrong reasons, or do you think Government saw that it was a lame duck and got out?

Tony Lodge: I think Government saw it was a lame duck and got out. In particular, I think the Treasury thought it was a lame duck and a potential blank cheque.

Lord Turnbull: Do you think they were right?

Tony Lodge: They were right in the present circumstances based on what was on the table. If the Committee is minded to do it, it would be interesting to look at the carbon capture and storage project going on at a power station called Boundary Dam in Saskatchewan, Canada. It is significantly smaller than was proposed at Drax—White Rose. For some reason, the organisation will not tell you the cost of the electricity they are producing. I have tried to find out; I have asked organisations to find out as well. The SaskPower plant in Canada was held up. It is quite a small one; I believe it is under 150 megawatts. Drax was planning a much larger one. The key question about CCS is quite literally what the price of the electricity is that this thing produces, before we even start to talk about exciting things like enhanced oil recovery and flushing out more oil and gas from the North Sea, which was the point. I saw Lord

Oxburgh's report; it is all very interesting. Potentially, it can do a lot for the Aire and Trent valleys where there are existing power stations and there will be new power stations. From what I could gather, CCS would represent a blank cheque, and would want a blank cheque, unless we had some guidance from the R&D that the Canadians have done, and I do not see that forthcoming.

- Q36 **Lord Lamont of Lerwick:** When Lord Turner was here he pointed out that with low-carbon technologies, whether nuclear or offshore wind, you have enormous up-front costs and very low—close to zero—marginal costs. He said that, if people are going to be charged only for the energy delivered, that would drive down the wholesale price, the marginal cost, and the system would never work; nobody would build anything because they would not see it as a sensible thing to do. The same point was taken up by Professor Helm who talked about the wholesale price gradually withering away. That is quite close to the point Professor Green made at the beginning—that the price paid might become a tax system, simply because the bills were fixed and there was lack of flexibility. Do you think there is a prospect of the wholesale price disappearing and the cost of generation becoming fixed, and what would be the implications?

Professor Green: Between 1996 and 1999, Norway and Sweden had a joint market where the mix was approximately 70% hydro, 20% nuclear and 10% fossil fuel, so about 90% of their energy was coming from sources with very low cash marginal costs. However, as there is so much water storage in Norway, if demand is high and they feel it is time to use fossil plant or imports instead of water, because they want to keep the water back—"run out" is the wrong expression—that moves the price up. If it is very wet and there is a lot of water around, that moves the price down, so there is a shadow value for the energy in storage. If we were to move to a system with a lot of renewables and nuclear, we too would need a lot of storage. We would also be trading with neighbours. I suspect that would be a system in which the value of energy and storage, or the value of energy next door, would give us positive prices.

Tony Lodge: I concur with that argument.

Lord Lamont of Lerwick: Lord Turner referred to the fact that some people were of the opinion that we could move to a 100% renewable system. He said that, although he did not agree with it, he did not think it was absurd. Is that the view of all three of you? Do you see a time when renewables will be completely devoid of subsidy or protection?

Tony Lodge: You could try to get there. The cost would be significant. The key question, which can only get you there, is whether you have a large degree of successful and economic renewable energy storage. That is the key issue. You must have dispatchable electricity supply to meet peaks and to meet demand. If you are overdependent on intermittent weather-dependent renewables you will have all sorts of grid management problems. That dream, if it is one, is a long time away and I do not foresee it by 2050.

Lord Lamont of Lerwick: What about the idea of prices falling so rapidly in all these technologies that subsidies via feed-in tariffs and other mechanisms will eventually go? Do you think that is realistic?

Tony Lodge: It could be realistic, but it is some time away. The fundamental is that if the Secretary of State was brave enough to have a single unified capacity market auction with everything in it, including the carbon price, where technologies competed inside the auction, with their location and transmission costs included, we would get to a situation where we could drum that out. At the moment there are still some technologies, even ones being proposed, that would not be competitive. They are not competitive, but they have a role at the moment because they enjoy a feed-in tariff CFD.

Professor Green: What would be competitive obviously depends partly on what the price of carbon would be. A bunch of German engineers have come up with the so-called Kombikraftwerk project, which does a full-scale simulation of Germany meeting quite a range of engineering constraints at a level of technical detail that is a bit beyond me. They have storage; they have biomass; they have trade to cope with dispatchability; and they have very large amounts of wind and solar and a bit of hydro. The total capacity is about three times peak demand. It would be doable but it would not be cheap.

One extra point on the cost of renewables coming down is that, because solar power tends to come all at the same time, as does wind to a lesser extent, when you have it there is often a glut that pushes down the price and, therefore, the value of the electricity also falls. Various people have worked on that: Lion Hirth at one of the Berlin universities, and Professor Thomas-Olivier Léautier of Toulouse and I have done models looking at the rate of technical improvement bringing down the cost and the rate of expansion bringing down the selling price. Depending on the parameters you plug in, the two curves do not necessarily meet in a helpful direction. As anything moves into a market, it will become less valuable because you are supplying more of it, but it could be a particular problem for some kinds of renewable generators.

Jimmy Aldridge: On the question about a 100% renewable system, technically it is possible, and some great academic work has gone on to investigate it. One of the key challenges is seasonal storage. There is a seasonal variation in renewable generation at certain parts of the year. There is an enormous amount of work going on in innovation and the technical capabilities of storage technologies, because a lot of people across the world can see that there will be a need to balance renewables.

The Chairman: I am sorry to interrupt, but there is a Division. We will adjourn for five or six minutes, or more.

Sitting suspended for a Division in the House.

Lord Lamont of Lerwick: If I may make a further point, Professor Helm thought that pricing carbon and auctioning capacity could get him back to

the market system he wants.

Tony Lodge: I think that is fair, if we have a future situation with a single unified capacity auction for all technologies with all their costs assumed. Lord Lamont has touched on a very important question with regard to where the carbon price is going in this country. George Osborne froze the carbon price floor for the electricity generating sector two years ago. With a fossil fuel power station, we are already paying four times more for carbon emissions than an equivalent power station in Holland, France or Belgium. We are four times more expensive than the European emissions trading scheme, so there needs to be some certainty on what the carbon price is in Britain. The carbon price floor was meant to be £30 per tonne in 2020 and £70 per tonne in 2030. At present, it is frozen at £18.08 per tonne. If anything, we need some clarity, and the Autumn Statement is the perfect opportunity to tell us where that tax is going. That is on top of the ETS price, which means it is about £24 or £25 per tonne of CO₂ emitted. The sector needs some certainty as to where that is going. Are they going to start escalating again, or are we going to get rid of it and have the same price as the rest of Europe?

Professor Green: I hesitate to contradict you, because I may be making a mistake. My strong impression was that the £30 and £70 was the total and it would be a top-up, such that the ETS price plus carbon price support level would be £30 and £70. I would not die in a ditch over that statement, and I suspect we need to check it.

Tony Lodge: With the ETS on top.

Professor Green: No. If the ETS was £20, a carbon price support of £50 would be charged to get you to £70.

Tony Lodge: Yes.

Professor Green: We are agreeing.

Jimmy Aldridge: On the carbon price, £70 is very politically challenging and I cannot see it being delivered, although I agree we need some certainty on what the carbon price floor is going to be going forward and the Autumn Statement is a sensible time to do that. I would argue that holding it frozen is a sensible approach, because to a large degree it has already been baked into a lot of the investment decisions in the sector generally. If you remove it, it has a number of different impacts affecting the economics of all types of generation, and keeping it frozen is a sensible way forward.

I was hoping to pick up a previous question about the impact new technologies coming into the market have on wholesale prices. We went through a very long and painful process of electricity market reform. It did many things, but it did not actually reform the electricity market as regards the trading arrangements and the way electricity was bought and sold. There has been a fundamental shift in the characteristics of electricity. It is important going forward that as we have new

technologies coming on to the system, particularly renewable ones, government and National Grid start to consider how the electricity market works. Unfortunately, I do not have an answer for what that market should look like, but it is an extremely important piece of work. The capacity market is almost a symptom of that much larger problem, as I explained earlier, and it is something that needs to be tackled.

Q37 Lord Forsyth of Drumlean: When Lord Turner came to see us, he told us he thought it was important for the Government not to ignore the measures on energy demand. Professor Helm told us that it was an illusion that energy efficiency reduced energy demand. Is he right?

Professor Green: No. He puts it too strongly. If you wanted to insulate this room there would be engineers' estimates of how much energy it would save. Occasionally, once the users got in here, a window might be left open, which would mean that the engineers' estimate would always be a bit too optimistic. Your Lordships might decide that if the room is better insulated you can have a more comfortable temperature, and that eats a little bit more into the expected gain.

There was a report a few years back by the UK Energy Research Centre—the name of the author escapes me—on the so-called rebound effect, which estimates that sort of behaviour. As a ballpark, you might lose a third of what you hoped to gain from the engineering estimate, but typically that is in the case of people who were in fuel poverty now being at more comfortable temperatures. To the extent that people have a bit of money saved, they spend some of it on other things. If other things are low carbon, it does not do much to harm emissions; if the other things are a foreign holiday, they are pretty emissions intensive. Estimating those other things is pretty difficult. Overall, the numbers seem to imply that, even after the indirect rebound effect, you end up saving and you also have a citizenry that is a bit more comfortable at home.

Jimmy Aldridge: In the past few years in the UK we have had what I describe as a structural decline in demand, which has been driven principally not by the financial crisis, which Mr Lodge referred to earlier, but by the European ecodesign directive introduced by the European Commission to improve the standards of electrical appliances. Although it sounds quite niche, and perhaps a little boring, it has had an enormous impact in reducing demand across the system. On many of the challenges we have discussed today, and the increasing costs associated with them, one of the key things you can do to stave them off is reduce demand, and in my view that should be the point you start from.

Lord Forsyth of Drumlean: But the point Professor Helm is making is that if you reduce the relative price of something, which is what energy efficiency does, it makes it cheaper to have a certain level of warmth. As quite a lot of domestic consumers are not always living with the level of warmth they would ideally like, it has a negative substitution effect. You do not agree with that.

Jimmy Aldridge: There is an issue with the rebound effect, but I agree with Professor Green's point on that: although there is an issue, it has been shown through evidence that it still produces a saving. There is an important distinction to make between energy efficiency and demand reduction. Demand reduction has been driven by the ecodesign directive and a number of different policy measures. Energy efficiency could result in its reducing the price, so you end up with further use. A number of different demand measures can be taken.

Tony Lodge: I would like to cover a slightly different area, which is the Government's attempts to encourage industry, particularly energy-intensive industry, to turn off at certain times to preserve the integrity of the grid. They do not necessarily call that energy efficiency, but on the demand side, new measures at times of high demand to ask energy-intensive industry either to switch off or manage its demand have been described by some people as energy efficiency. I do not think it is energy efficiency at all. It makes UK energy-intensive industry less competitive and leads to what we call carbon leakage, which is when industry decides to set up overseas. It emits as much overseas, if not more, but it never comes back to the United Kingdom, and that of course endangers jobs, competitiveness and the rest. It is of concern that people talk about energy efficiency and better demand-side management when actually we are prescribing against industry operating at its full capacity.

Lord Forsyth of Drumlean: When we passed the Climate Change Act in 2008, the assumption was that in 2009 there would be a global agreement at Copenhagen, which was not forthcoming. Because of the lack of global agreement on decarbonisation, has that not left us in an uncompetitive position on our industrial energy costs?

Professor Green: The agreement signed in Paris at the end of 2015, which a large number of countries have now ratified, has gone a long way to addressing that issue.

Lord Forsyth of Drumlean: But do you accept that since 2008 we have been in an uncompetitive position?

Jimmy Aldridge: There are many advantages in investing early in decarbonisation that can be realised internationally if you develop and build capacity here in technologies and industries that can be sold abroad. For the UK to move early has brought advantages as well as costs. It is true that under the Climate Change Act there is a higher level of ambition than can be seen in other countries across the world, but I suggest that puts us in a strong position for selling some of these services and technologies abroad.

Lord Forsyth of Drumlean: But have we been in an uncompetitive position as a result?

Jimmy Aldridge: My personal view is that the relative costs of the policies associated with targets to reduce carbon have been quite minimal compared with other drivers of those costs. One example is in the steel

sector: of the costs for a blast furnace, 6% are associated with policy and 80% are compensated through some of the revenues raised through mechanisms such as the carbon price floor. Those costs are far less a driver than other far bigger issues.

Lord Forsyth of Drumlean: How did we end up with the fourth highest industrial electricity prices of the International Energy Agency countries?

Jimmy Aldridge: I do not have an answer to that.

Professor Green: I think it relates back to the point I made quite early on that countries like Germany have chosen to put the policy costs of decarbonisation much more on to domestic than industrial users. Obviously, having high electricity prices does not help. For much of the British economy, the share of costs that is electricity is pretty small, and there are many other things that will affect the international success of firms. The exchange rate movements over the past few months will have boosted it, although figures I looked at recently on industrial electricity prices indicated that we would need more than a 15% depreciation to bring us down into the pack, but Lord Turnbull had some slightly different figures.

Lord Turnbull: The figures I have are the ones we were supplied with.

Professor Green: I think yours are more up to date than mine.

Lord Forsyth of Drumlean: These figures show that Germany is the third highest.

Professor Green: Germany is quite high. In the Ofgem figures I had, Germany was a little below us, but their domestic electricity prices are even worse than their industrial prices, comparatively.

Tony Lodge: I agree with Lord Forsyth. We have increasingly priced ourselves out of the game. As regards energy-intensive industry, as a consequence of having some of the highest prices in Europe—we used to have some of the lowest—we have lost sectors such as aluminium smelting; the chemical sector is under pressure; and we are seeing pressure in the cement and chlorine sectors and other key manufacturing areas. The Energy Intensive Users Group has been making that point for quite some time. I do not know whether you are seeing the group; if not, you should.

If the United Kingdom has decided to take a lead, fine, but the problem is that it has gone much further down the line than many other European countries with regard to carbon price floors. We have set our own carbon price unilaterally, and we have decided, I would argue prematurely, to remove some of the cheapest ways to generate electricity. Consequently, we now see spikes in the price because we do not have enough new capacity coming online in time. If we are to have a new Department for Business, Energy and Industrial Strategy, I hope that the industrial strategy is in line with the energy policy.

Q38 **Lord Turnbull:** Mr Aldridge's response to Lord Forsyth implied that because there was now a Paris agreement the degree of unilateralism by the UK was diminished. My answer is that the bits that are legally binding do not cover whatever are the nationally determined targets. The legal requirements apply only to reporting obligations, so the fact that we have very strict legal targets in our Climate Change Act stands out as much now as it did in 2009.

Jimmy Aldridge: There is still work to be done across the globe to work through the implications of the Paris agreement and set that into legislation within each country.

Lord Turnbull: Surely, the whole point of it is that the big emitters did not want to do that, and the compromise was that the legally binding part would not be about their emissions.

Professor Green: A number of countries did not want to be bound but none the less have started to take more action. In China in particular, the emissions could well have peaked now. The Chinese have been putting in very large amounts of renewables, not necessarily because carbon is yet at the top of the agenda but because their air quality certainly needs something to improve it. If the things they are doing happen to reduce carbon emissions, they are not going to object on that basis. President Obama has done what he can, given the situation in the United States. Who knows what the election will bring? I think some countries may be moving.

We now need to decide on a trade policy. Some work was done a while ago by a Cambridge team looking at the detail of the World Trade Organization agreements and on having a border tax adjustment, in the same way as a manufacturer can claim back any VAT they have been charged when exporting from the EU and importers pay the equivalent tax when they import. To do the formulae would not be straightforward, but you could do something similar for energy-intensive products on the basis of assumed carbon contents. People who could prove the actual carbon content could get a lower entry tax, and that would do something to redress the balance. That would be something our future trade policy could consider introducing. It might not end up being feasible, but it would certainly be well worth exploring.

The Chairman: Can I ask you briefly about research and development? I do not think we have mentioned that in detail. Do you think we are investing sufficiently in R&D for new energy technologies, and what about the trade-off? Would it be better to use some of the money we spend on renewables to invest in basic R&D?

Professor Green: Technology policy experts, which I am not, would say that typically there is a mix, in that some innovations come from people doing stuff in the lab, for example developing new materials for battery cathodes and anodes. I am on a project, including chemists, which is doing just that. Some innovations come from building the kit and working out how to do it more cheaply. You almost certainly need a mix of both

those activities. I suspect the balance may have gone too far towards installing other people's kit rather than developing the kit of the future, which is the aim of initiatives such as Mission Innovation, or the Global Apollo project as was. I forget whether or not the UK has signed up to that.

Lord Layard: We have, yes.

Professor Green: There is a pledge to spend significant amounts of money on developing low carbon. As far as I am aware, there is no physical law that says some of these technologies could not get cheaper; for example, that you could not get to the point where solar plus storage would be cheaper, if not in Lerwick, at least in some parts of the UK. I do not think there is a physical law that says that. There is a physical law that says carbon capture and storage would always be more expensive than not adding a chemicals plant to your power station and using up a quarter of the energy, but in principle some technologies could become cheaper.

Q39 **Lord Layard:** Through Mission Innovation, which we have joined, with the 20 other leading world countries, we have committed ourselves to doubling public spending on R&D for new energy technology. The question I would like to ask you is how we can make sure this money is effectively spent. I think it is true to say that at the moment our research in this area consists of lots of separate little parcels. In many cases, people do not even know what others are doing. Should there not be more co-ordination and focus? Should not the whole thing somehow be made more glamorous so that this area of research attracts top scientists in much greater abundance than it does at the moment?

Tony Lodge: One of the negatives about the way electricity was privatised—we are now going back a little—was that the R&D components in place at the time in various sectors were thrown overboard and done away with. I am going right back to the time when British Coal research led the world in what we still call clean coal technology, but that was effectively abandoned and bought by the Scandinavians. We also had designs for the first gas-fired power stations, which came in 1990, 1991 and 1992, but that went out of the window and the Americans effectively got the technology and sold it to us.

For what it is worth, a key R&D technology where I would like to see the United Kingdom seriously spend money and win is the electricity storage of intermittent weather-dependent renewable producers. That is absolutely huge. BIS—ex-DTI, or whatever it is now called—is quite rightly making it a priority. The key question will be the extent to which the Treasury is prepared to allocate resources and deliver them for that to happen, and whether it is done around academic centres. I think it would almost have to co-exist with academic centres, because it will no longer be an adjunct to the energy sector itself. When one had National Power and Powergen back in the early 1990s, they had no interest in maintaining the R&D side, which I think was a shame.

Jimmy Aldridge: It is extremely important for innovation that support and funding is sustained over time. Gas turbines are one example. At one stage the UK was leading in the design of onshore wind turbines, but we let that go as well. It is extremely important that, if we start to increase the amount of support we provide, it is sustained.

A further point is about the vote to leave Europe. At the moment, a lot of available funding for innovation comes from European funds that will disappear, whether they come to universities or are for particular technologies, so there is a job to work out what fills the gap as we lose access to them.

The Chairman: Would anyone like to comment on that? Before we close, can I ask each of you to say very briefly what you think are the two or three most important steps the Government could take now to correct any failures in current policy?

Professor Green: I will come back on Lord Layard's question, if I may. On direction, the Energy Technologies Institute has done a lot of thinking about future strategy for the energy sector, so it has some expertise on where the needs might lie. The UK Energy Research Centre has tried to keep track of what is being done, but it is not a research council in the sense of directing where the money should go. Those are two sources of some helpful expertise.

As to policy, I think it is a matter of making sure we have an effective mix of whatever it sensibly takes to keep the lights on, whether that is getting capacity out of mothballs and, hopefully, finding ways of doing it for less than £250 million a year, if that is the number, or making sure we do not completely kill the option of CCS until at least we know how much it might cost. The thing that really kicked the companies in the teeth was that they were only three weeks away from delivering their bids when the thing was shut down. If you get the bids and then on information decide that it is too expensive, that is a rather different thing from saying, "We do not want this information".

Tony Lodge: The priority has to be to get a good capacity market auction in December so that we have sufficient new gas build in the pipeline. We have to stop interfering. We are interfering anyway, but let us not make it any worse by giving coal plants subsidies to keep it on. Let us have the same carbon prices as the rest of the European Union. We are about to leave the European Union, so let us not make ourselves any less competitive. Let us not try to build lots of interconnectors with the rest of Europe in an attempt to claim they are low-carbon imports when all they will do is undermine the case for more power stations at home. Finally, let us move to a market-driven electricity market again, as Amber Rudd said when she was Secretary of State, where all the technologies have to compete with all their costs.

Jimmy Aldridge: I have three key things. In a context where we have now signed the Paris agreement and have our own UK carbon targets, it is important that the Government follow on from that to show their

commitment to outline the envelope of spend for low-carbon technologies going forward. It is known as the levy control framework and it provides certainty to industry about the total amount available for low-carbon technologies. At the moment, we have no certainty about what that envelope is beyond 2020. In a context where there is a fair amount of uncertainty following Brexit, that is one thing that could help to shore up investment in the low-carbon sector in this country.

The second important thing that needs to happen is to address the flaws within the capacity market. The view of IPPR is that the capacity market should be split into a market that provides a price for keeping capacity online and a separate price for bringing new capacity on to the system. That is extremely important to ensure energy security going forward.

The third one is about energy efficiency. The rollout of energy efficiency in the UK has a number of very important benefits: the jobs included in it cannot be outsourced; it does not require single market access, so there is a fairly sustained market going forward; it reduces imports of gas and it reduces costs to householders, which is absolutely key in the context of the conversation we have had today; and it can also produce very broad and large economic benefits if it is seen as infrastructure investment.

The Chairman: That brings the evidence session to an end. Thank you very much for your helpful contributions.