The Scottish Parliament
Pàrlamaid na h-Alba

Official Report

ECONOMY, ENERGY AND TOURISM COMMITTEE

Wednesday 27 May 2015

Session 4

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ECONOMY, ENERGY AND TOURISM COMMITTEE
14th Meeting 2015, Session 4

CONVENER

*Murdo Fraser (Mid Scotland and Fife) (Con)

DEPUTY CONVENER

*Dennis Robertson (Aberdeenshire West) (SNP)

COMMITTEE MEMBERS

*Chic Brodie (South Scotland) (SNP)
*Patrick Harvie (Glasgow) (Green)
*Johann Lamont (Glasgow Pollok) (Lab)
*Richard Lyle (Central Scotland) (SNP)
*Gordon MacDonald (Edinburgh Pentlands) (SNP)
*Lewis Macdonald (North East Scotland) (Lab)
Joan McAlpine (South Scotland) (SNP)

*attended

THE FOLLOWING ALSO PARTICIPATED:

Mark Crowther (Kiwa)
Professor Stuart Haszeldine (University of Edinburgh)
Andrew Jones (Electricity Storage Network)
Professor Susan Roaf (Heriot-Watt University)
Simon Skillings (Trilemma UK)
Chris Toop (Scottish Water)
Professor Karen Turner (University of Strathclyde)

CLERK TO THE COMMITTEE

Douglas Wands

LOCATION

The James Clerk Maxwell Room (CR4)

Scottish Parliament

Economy, Energy and Tourism Committee

Wednesday 27 May 2015

[The Convener opened the meeting at 09:46]

Security of Supply

The Convener (Murdo Fraser): Good morning, ladies and gentlemen, and welcome to the 14th meeting in 2015 of the Economy, Energy and Tourism Committee. I welcome members and our witnesses, who we will come to in a moment. I also welcome any visitors in the public gallery. I remind everyone to turn off, or at least turn to silent, all mobile phones and other electronic devices so that they do not interfere with the sound equipment.

We have received apologies from Joan McAlpine, who is not able to be with us.

Under item 1 on the agenda, we are continuing our inquiry into security of supply. I welcome our first panel of witnesses. We are joined by Simon Skillings, director of Trilemma UK and senior associate at E3G, and by Professor Karen Turner, director of the centre for energy policy at the University of Strathclyde. Welcome to you both.

We have written information from both of you, for which we are very grateful. We will allow about an hour for this first evidence session—up until about 11 o'clock, let us say. It would be helpful if members directed their questions at a particular panel member initially. However, if the other panel member would like to come in and respond to a question that was addressed to their co-panellist, they should catch my eye and I will bring them in as time allows.

I remind members to keep their questions as short and to the point as possible. Similarly, it would be helpful for the responses to be as short and to the point as possible if we are to get through the broad range of topics that we want to cover in the relatively short time that is available.

I will address the first question to you, Mr Skillings. As we know, it looks like the closure of Longannet power station will be brought forward to the spring of next year. I know that you have written a paper on the closure of coal plant and the impact that that will have on the electricity system. Will you give us your view on the impact on Scotland's security of supply should Longannet be closed next year, ahead of the originally planned scheduled closure?

Simon Skillings (Trilemma UK): The key objective of that paper was to tackle the myth that we are in some nationwide security-of-supply crisis or "crunch", which is the expression that we often hear used. There was recently a capacity auction, and the Government rejoiced in the fact that the prices were so low. Another way of looking at it is that there is huge overcapacity, and that is why the prices were so low. The paper that you mentioned was merely an exercise in trying to point out the extent of the surplus capacity that we have in the system as a whole at the moment.

There is a common misconception that the power system operates in one of two states: either we have the lights on and everything is fine and dandy, or we plunge into some near-Armageddon of darkness and cold. Nothing could be further from the truth. It is worrying that that mindset is not applied to other policy objectives, such as those in relation to cost and decarbonisation, where there is much more of a sense of having a bit of slack that we can play with here or there—we do not mind giving up a little bit here and there, or whatever. That has led to an imbalance in the so-called trilemma.

I will come to the point quickly. Obviously, all sorts of other issues are covered by your question regarding Longannet. The paper was an analysis of the system as a whole, and the conclusions were clear. We can take some extreme scenarios for loss of plant—we considered the loss of coal plants, and not just one power station but the entire fleet over the next five or six years—and we would not come close to having a global security-of-supply problem as there would be plenty of surplus capacity.

What that does not do is to tackle local issues. Security of supply can be viewed at all sorts of levels but, clearly, the pedal hits the metal at the local level as that is where people actually experience issues. In the paper, we pointed out that each power station closure should be subject to a more detailed local network analysis. However, as we also pointed out, many levers are available to the relevant institutions to manage the closure of a power plant such that we do not have local problems. In other words, we can time the closure at the right point so as to avoid problems.

I cannot see the closure of Longannet as a problem in terms of total capacity. I have not done the local network studies but, in so far as there are problems there, I am sure that they can be easily managed to avoid any issues.

The Convener: Your view is clear—we are facing no crisis. Is there anything that you think either the United Kingdom Government or the Scottish Government needs to do now to fill a gap, or is there no gap—is there nothing to worry about?

Simon Skillings: They have done a lot. The issue of a gap is a germane one that strikes at the heart of the issue that we are talking about. We are looking for a system transformation: a move from a high-carbon system to a low-carbon system. That requires us to close a number of the assets and to replace assets with new resources. The initial thinking behind the electricity market reform process was that it was about ensuring that we close the assets in such a way that the timing of the replacement of the assets does not leave a gap. It was also about trying to reduce the costs of the replacement assets.

One of the difficult issues to discuss is the planning of closure and the appearance of new assets versus the market. There is a narrative that still prevails in the industry that we have a market. People do not like to recognise the extent of the planning or admit the need for planning. The consequence is that the planning that is being done—and a lot is being done—is being carried out in a piecemeal way and certainly not in a strategic, co-ordinated way.

Is there a gap? Clearly, there could be a gap if the assets close before the new ones arrive. How do we deal with that? Do we try to leave it to some level of decentralised decision making or do we take control of the transition in a more centralised way?

The Convener: We will come back to planning, because I think that other members want to explore it.

Professor Turner, I want to ask you the same question about Longannet and its impact. I also want to extend the question a bit further into the future, because I notice that, in your submission, you talk about the closure of Torness and Hunterston, potentially in 2023, and the impact that that might have on security of supply.

Professor Karen Turner (University of Strathclyde): Thank you very much for inviting me along to speak to the committee this morning.

The issue that we raise in our submission is the need to think about the wider picture and base-load generation. There has been a great emphasis on renewables—quite rightly, as there are issues there—and on issues such as bringing in the correct investment and onshore versus offshore. Longannet is one issue, and there is the issue of it being a coal-fired plant and the whole climate change issue. The question is going to arise again when the two nuclear plants reach the end of their life.

In the analysis by Sinclair Knight Merz that we cite in our submission, the assumption of growth for renewables was based on a mix that included the three thermal plants—Longannet and the two nuclear stations. If we are losing Longannet, that has to be taken out of the analysis, so we are left with the two nuclear plants. Their lives have been somewhat extended, but the question of when they will reach the end of their lives is going to come up. We have to understand the issue in the context of the Scottish Government's long-standing energy policy that it will not commit to any more nuclear build on Scottish soil.

Scotland sits within the Great Britain market. National Grid has played different scenarios in which we can import, but the question seems to me to be how we consider being a net importer in the system. In particular, if we have views on renewables, low carbon and no nuclear, what does it say if we import generation from other sites? For example, there is nuclear capacity elsewhere in the United Kingdom and in Europe. We talk a lot about our carbon footprint and what it will be when we stop generating carbon, but it comes in through our trade.

We can also talk about our nuclear footprint if we become more dependent on electricity from nuclear capacity through importing. Where would that leave our stance of no nuclear? Would it become a nimby position—that we do not want nuclear to be generated in Scotland but we will rely on it from elsewhere? The position is similar in relation to the low-carbon goals if we import from thermal plants. Carbon capture and storage is a big issue and one that needs to be explored in Scotland, but if it has not become active elsewhere, importing from thermal plants will increase our carbon footprint as well.

We need to think about the imports. It is a fact that we can preserve our security of supply through imports but, given that we have Scottish views on low carbon and no nuclear, we need to think about those imports in that context.

The Convener: You pose the question in your submission:

> "does the Scottish Government's current embargo on any future nuclear new build on Scottish soil make any rational sense?"

You mean that, if we end up having to import nuclear from elsewhere in the UK—

Professor Turner: Yes. We talk a lot about our carbon footprint. If we think about our nuclear footprint, we are talking about similar issues.

The Convener: Are you saying that, if Hunterston and Torness close, as we expect, we cannot expect to provide base-load generation from within Scotland with our existing capabilities?

Professor Turner: We have the problem that, particularly with transmission pricing, there is a lack of incentives to invest in new thermal plants. If we are losing all three of our thermal plants, we will be left with our renewables capacity. We then

face issues of intermittency—if the wind does not blow, we will have to import.

The Convener: Thank you for setting the scene. That is helpful.

10:00

Dennis Robertson (Aberdeenshire West) (SNP): Good morning. I have a question for Professor Turner about the decisions that are made at Government level on, for instance, contracts for difference and EMR, including the setting out of the capacity market. How much of an obstacle are the policies in ensuring our security of supply for the next 10 to 20 years? Are the current policies the right ones or are they creating obstacles in progressing renewables, for instance?

Professor Turner: The main obstacle is the network pricing, whereby generators are charged based on their distance from the population centres that they serve. There could be an argument that, based on that policy, no power stations will be built above the Watford gap. If we think about the wider pot and a single European market, only three countries in Europe use that kind of transmission pricing. If we started to operate in a wider European market, Britain—along with Ireland and Sweden—could be at a disadvantage in attracting investment input into plant on site. The import situation might start to pick up and net generation might start to fall and fall. That has been the main obstacle with regard to the securing of energy supplies.

Dennis Robertson: Do you suggest that we need to alter our policies? Does the United Kingdom Government—because that is where the policies come from—need to look again at how we secure our supply for the future? It may well be that we need to redress the whole area of transmission charging.

Professor Turner: Through the Smith commission, the Scottish Parliament will have greater powers of oversight in relation to regulation of the electricity markets, so there would seem to be an opportunity for Scotland to have a bigger say in what is happening rather than it being entirely a UK Government responsibility.

We also have to consider how we work with National Grid given that it is a private body, which is a legacy of privatisation. There could be an argument that we need to look at whether we should have a non-profit public body in charge of systems operations, as they do in Australia. The Smith commission will give the Scottish Parliament greater powers of oversight and the ability to raise a number of issues—particularly, I would think, things such as transmission pricing.

On the point about capacity, we have Peterhead. Gas is lower carbon, but Peterhead is also part of the carbon capture and storage project, which would make it even lower carbon. However, Peterhead is operating under capacity because it is not economical for it to operate at full capacity. When we talk about security of supply in Scotland, we need to remember that we are not using our full capacity. That is not just because of excess capacity issues; it is also because of the economics of Scottish power stations.

Dennis Robertson: Do you think that the current policy is one of the reasons why Longannet needs to close?

Professor Turner: Yes.

Dennis Robertson: That was a nice short answer. Professor Skillings, do you have a view?

Simon Skillings: We need to make sure that we have a common view about what the energy policy is trying to do. The energy policy objectives seem to be very widely shared and widely held in relation to what we are trying to do and the fact that we are trying to do it over a long period of time.

Energy policy is about trying to minimise the risks of policy failure. It is about trying to make sure that we continue to deliver those objectives in the future. The problem is that the future is highly uncertain because we really do not know what is going to happen. We do not know how technology is going to evolve, what commodity prices are going to be or what demand is going to be. There is massive uncertainty around all those things.

The role of policy is to ensure that we have enough choices to be able to continue to deliver those objectives. You talked about UK policies and the EMR, but those are merely delivery mechanisms, or ways of putting in place policy decisions. You asked whether the policy is helpful or whether is it causing Longannet's closure or whatever. One of our biggest problems is that we do not have a clear and explicit policy at the moment. We do not have a clear set of objectives for how we will deliver our policy objectives in the future.

The key lever is the so-called levy control framework, which is about how much money will be available to be spent. How that lever is being pulled and what the forces are that are leading to decisions as to how much money will be spent and what it will be spent on is completely opaque. There is no transparency at all, so how do we know that the public money that is spent is being spent to help to ensure that we deliver policy objectives in the uncertain future that we face and not being driven by shorter-term, perhaps political reasons?

Dennis Robertson: How would you address that?

Simon Skillings: We need to step back from the micropolicy issues. I would describe transmission pricing as such an issue. We do not solve energy policy by worrying about transmission pricing; we solve energy policy and then do something coherent with transmission pricing that fits in with everything else.

Dennis Robertson: Are we talking about energy or electricity? Energy has a much wider aspect. It could be transport, for instance.

Simon Skillings: The best way to deliver our energy objectives of securing and decarbonising our energy system over the longer term is through some short-term focus on the electricity system. There are, absolutely, wider issues—there are many issues with heat and transport systems—but I would shorthand the next 10 to 15 years as being about the challenge of getting a broadly decarbonised electricity system.

The solution is to be clear about the uncertainties that we face and how we go about managing those risks. There are many analogies in national security, in which risk analyses are done and there are risks that we are prepared to spend money to manage and others that are simply too unlikely for us to spend money on. That is the sort of thinking that needs to be applied to the energy or electricity system. That will tell us where interventions are required and where good value can be achieved from spending public money, which can then lead us to what we want to do with our delivery mechanisms. It can ensure that we do that coherently and strategically and that transmission pricing fits in with contracts for difference, which fits in with capacity payments, which fits in with our approach to demand.

Dennis Robertson: Thank you very much. I apologise for calling you a professor. Perhaps you would like to be one.

Simon Skillings: Is it worth my commenting on that?

Gordon MacDonald (Edinburgh Pentlands) (SNP): I am still at a loss to understand how, if we lose Longannet, we can have security of supply. The margin that the United Kingdom has is about 4 per cent, and the two interconnectors from France and the Netherlands are running at capacity. My understanding is that, in the next 20 years, 25 per cent of UK generating capacity will come to the end of its life. If we do not build new base-load capacity in Scotland, where will the security of supply come from, given those backdrops?

Simon Skillings: There are two responses to that. When you talk about a margin of 4 per cent, what do you mean? Are you talking about 4 per cent over the Armageddon of darkness that people talk about, or 4 per cent over—

Gordon MacDonald: I presume that it is 4 per cent over peak demand, which is what has been explained to us in the past.

Simon Skillings: It is 4 per cent over something that is getting sufficiently close to that, which is when National Grid starts to get worried. If we lost that 4 per cent, would the lights go out? No. If we lost 5 per cent? No. Six per cent? No. Seven per cent? No. A lot more capacity is available, and it would start to be introduced. Even if National Grid started to run out of capacity, it could start to reduce the voltage on the system by a little bit. Would anyone notice? No. How much capacity would there be in the UK system just through voltage reduction? Far more than the capacity of Longannet. Even if we were at minus 5 per cent capacity, we would still have buckets and buckets of capacity.

It is very easy to frighten people with issues around security of supply, and there are people out there who are trying to frighten decision makers for their own interests. Everybody who has a particular objective wants to align it with security of supply. Saying, “If you don’t do this, the lights will go out,” gets you nine tenths of the way there with most politicians, although how true that claim might be is another matter.

The other point is a point of basic statistics. Small systems with big bits of kit in them are less secure than large systems with small bits of kit in them. The risk of losing your power supply is far less if you are dependent on lots and lots of independent bits of electricity supply, demand reduction or whatever over a much broader footprint. The conclusion from that is that, if you want to view security of supply within a domestic frame, you will have to pay an awful lot more for it. If you want to keep Scotland, as a country, secure to a particular level, you will need far more assets than you would need if you integrated Scotland into the GB system and had the transmission capability that allowed things to flow.

The same applies to integrating GB into the western European region. The amounts that are saved are not small. Endless studies have been undertaken on the issue of regionalising the European market, and those studies suggest that we are talking about tens of billions of euros a year. Some of those savings would come from the fact that you would build the wind generation systems where it was windy and the solar power systems where it was sunny, and so on, but the bulk of the savings would come from the ability to use existing power stations far more efficiently.

If you cannot export and trade between regions, you need more power stations that hardly ever operate. That is the context in which you were talking about keeping Longannet going. I probably should have looked at what the load factor of Longannet is, but it is probably not very high, and because it is not very high it is very inefficient.

Gordon MacDonald: The submission from the University of Edinburgh states:

"The closure of Longannet can be expected to impact negatively upon Scotland's security of supply, both in the context of addressing the intermittency of renewable generation, and in capability to respond and recover from a widespread generation failure—black start."

Why is the University of Edinburgh wrong?

10:15

Simon Skillings: I cannot speak for the University of Edinburgh, but I can tell you that all the studies of intermittency that have been undertaken around the world show the very clear conclusion that the best way, in respect of reliability and cost, to manage intermittency is by activating the demand side. The second best way is by building transmission infrastructure; the third best way is by building flexible generation assets; and the fourth best way, currently, is by storage, although storage is on an improving cost trajectory. However, the second, third and fourth ways are not close. If you are worried about intermittency and its effect on the security of supply, you should focus on the demand side and transmission.

Maybe the people to whom you referred have done the analysis and have said, "We haven't got the demand side or the transmission infrastructure in place, and that's a problem." They may be right, but that is a short-term problem and it should be where the focus is. As I said right at the start, if there are local issues because there is not sufficient transmission and distribution infrastructure in place to manage the fluctuations in flows, that can be focused on.

Black start is managed with open cycle gas turbines, which are the most cost-effective way to manage it, as opposed to large coal-fired power plants. I have worked with them for many years; they are not easy things to throw around and their operation is not easy to change. They are not the sort of things that we want to use to deal with emergency situations.

I am not saying that there would not be an issue in Scotland if Longannet were shut now—I have not done the system studies for that; I am saying that the focus should not be on whether we can keep Longannet going in perpetuity. The focus should be on how we get the demand side and the transmission going so that we can close Langannet in a way that means that we are comfortable with the impact on the security of supply.

Professor Turner: Were you referring to the paper from Professor Haszeldine from the University of Edinburgh?

Gordon MacDonald: Yes.

Professor Turner: I am not an engineer, but it seems to me that Longannet provides around half of the base-load, and I cannot see how its shutting would not be an issue.

There are several issues. As I said, I am not an engineer, but from the other evidence that I have read it seems that the black start issue needs to be examined.

To return to the previous studies, the Sinclair Knight Merz study went out along with the Scottish Government's electricity generation policy, and the analysis was clear: we need a combination of new renewable generation capacity, up to three new thermal generation plants and cross-border links. If we are talking about importing electricity, we will need the infrastructure to do that.

I am an economist by training, and I suggest that we need to think about how plants such as Longannet, other electricity generation and the wider energy sector—the oil and gas sector—are part of our economy. In Scotland, energy policy seems to be given a higher priority than it is given at the UK level, and it is very intertwined—just consider the name of this committee. Energy policy is closely interlinked with our wider economic policy and objectives, which is extremely important when we think about the number of jobs that are tied up in supply-chain activity and so on for plants such as Longannet.

The recent concern over the fall in the oil price and what would happen if there was a collapse is a wider issue. The offshore oil and gas industry ultimately supports hundreds of thousands of jobs in the UK economy. Yesterday, I talked with a colleague about supply chains for new onshore and offshore wind power. Companies now need to talk about how their supply chain would operate and the extent to which there would be local supply as opposed to imports. It is about building up local supply capacity when we have new things.

For example, we managed to get carbon capture and storage working and to get online for bridging the gap and getting to a point where we could have 100 per cent renewable energy. In the longer term, we will have the continued use of thermal energy. We should think about things such as carbon capture and storage as an industry within the economy, and, as that develops over

time, there will be more capacity and the supply chain of that industry can build up locally.

We are talking not just about energy supply but about industries and jobs in the Scottish economy and how important the Parliament and the Scottish people think those are. That is a big question. I am not an engineer, but I cannot see how the closure of Longannet is not an issue if it provides about half the base-load.

Gordon MacDonald: I have a final question. You mentioned cross-border links. The paper that we received suggested that the high-voltage direct current western link—the link that runs from Hunterston to the Wirral and Liverpool—might be helpful to Scotland in the future. The only problem with that is that the western link website states:

"The Western Link will bring renewable energy from Scotland to homes and businesses in England and Wales."

Are such links predominantly about exporting electricity south of the border or about importing it?

Professor Turner: Again, you should consider that in the context of the wider economy. With the growth in renewables, we will become a net exporter of electricity, but renewables will become a growth industry in the economy. Such interconnections are how we will facilitate exports. If Longannet shuts, unfortunately, we will start to think much more about imports. However, in a lot of industrial policy, including building up renewables and other parts of the energy industry more generally, we have been talking about exports as a driver of growth. We are now turning to talk about imports and everything going in the opposite direction.

As I have said, National Grid has played around and has said that it can do it, but it is not a publicly accountable body. The Scottish Parliament and representatives of the people must consider those issues, and through the Smith commission they are getting the power to do that.

Lewis Macdonald (North East Scotland) (Lab): I want to ask about who does what within the current system. A generation ago, the state determined priorities and investment, whether in generation, transmission or interconnection. Those decisions are now taken by private companies. Do the witnesses feel that the Government—at any level—has the right mechanisms and triggers to direct or incentivise the right investment? Who is setting the priorities for those investments and are they the right priorities?

Simon Skillings: That is exactly the point that I was trying to make earlier. I do not think that many people would use the characterisation that you have used, which is that the private sector determines the investment. The private sector can decide whether it invests but what gets built is largely the subject of Government policy, through the contract for difference mechanism or the capacity mechanism. Virtually nothing is now being built on a classic, speculative merchant basis with someone taking some sort of punt against future prices or consumer behaviour; it is virtually all driven by a Government mechanism. As I said earlier, I do not think that the mechanisms are in place that lead to a coherent set of processes that link decisions on what gets built with broader energy policy objectives.

In previous discussions, we have talked about bootstraps, transmission and the role of National Grid, and that is a classic example. National Grid does a lot of strategic planning of the transmission network, but is that being done on the same basis as the strategic planning on what receives a contract for difference or how we target capacity mechanisms? No, it is not, and that is in part because there is no strategic mechanism underpinning those latter two. To some degree, National Grid has to fly in the wind as to what the basis of its planning should be, and there are many ways in which a transmission system could be built to create more opportunities at quite low cost for delivering assets that simply are not being put in place.

I will finish with an example that is simple to understand. It is not directly a Scottish example, but there are lots of analogies. A link is being built from Norway to the east coast of England, and for a marginal increase in cost it could be diverted via the Dogger Bank and a hub could be built on the Dogger Bank. There would be a marginal increase in cost for that interconnection but it would—at a stroke—massively reduce the connection costs of round 3 offshore wind. However, there is no basis on which National Grid or the Office of Gas and Electricity Markets—it is Ofgem that approves such decisions—can say that it is worth spending that little bit more to create an opportunity to open up a whole new class of asset. Instead, the decision must be made on the basis of the cheapest way of building that link. That is just one example of the incoherence that exists.

Lewis Macdonald: That exemplifies the issue. The choices between transmission and investment are the responsibility of nobody in particular other than possibly the Department of Energy and Climate Change.

I would like to follow up Karen Turner's point about National Grid being the right body. In answer to the previous question, you seemed to be saying that devolving the power to the Scottish Parliament is part of the answer to reducing that gap, but your paper strongly emphasises the fact that we are part of a GB market. That raises the question of where we can go with a GB market

and another source of direction or decision making about investment priorities. Does that make the situation more complex rather than less complex?

Professor Turner: We already have some complexity in that the physical transmission network up in Scotland is owned separately: it is owned jointly with the Scottish three. When I talked about the Smith commission, I was saying that it recommended greater powers of scrutiny to raise questions even at the GB level. The Government and the public sector always have a role in the investment environment, but we are operating under constraints because transmission charging is going to affect investment incentives.

There is also the wider issue of who the companies are. Scottish Power and SSE are Spanish owned, and most of the investment in wind power is going south of the border rather than north of the border. Even where we have investment in wind power companies that are operating in Scotland, we are not able to direct the investment other than by providing the environment for that investment. Now that we have a change in UK Government policy, under which onshore wind is not going to be supported down south, does that give us an opportunity that we should be looking at here in relation to the investment environment for onshore wind?

A key role is played by things such as the contract for difference, which has now been extended to cover carbon capture and storage. I believe that we still need to think about having a mix of thermal plants, preferably with carbon capture and storage, even for gas, and we have an opportunity to do that at Peterhead. Having to operate within the rules can be difficult, but what opportunities are there for public sector investment in the infrastructure that would help us with things like carbon capture and storage and the investment environment?

10:30

Simon Skillings: Can I come in quickly on the point of independent system operation? It is a very important point. In electricity markets worldwide, the structure that involves an independent system operator that also undertakes various delivery functions and operates the market is the norm—it is the norm everywhere outside Europe.

We are stuck with a problem that we have to resolve, which is that we have a privately owned company—privately owned companies, if we look across Europe—delivering the public interest. That is out of alignment. We can do one of two things. We can put an incentive process around the transmission system operators that aligns the public interest with their private investor interests, but I suspect that that is a really complicated thing to do. Alternatively, we can take away the private sector interests and create a publicly owned body delivering the public interest.

The independent system operator structure is a really good vehicle to start addressing some of those trade-offs. It is a highly technical and specialised thing, but in an independent system operator—as has been shown throughout the US markets, the Australian markets and elsewhere—there is a body of expertise that can tackle some of those complicated trade-offs, that understands power systems and that can be made to understand the demand side. In an ISO, there is a real understanding of some of those issues.

Lewis Macdonald: Finally, in such a system, how do you protect the consumer? How do you ensure that an independent system operator or some other mechanism does not simply make the investments that the private sector companies are keen to make without having regard to the interests of the consumer—I am thinking particularly of the costs to low-income consumers?

Simon Skillings: Traditionally, the way that that is done elsewhere is to impose clear statutory objectives on the ISO by defining in statute what they are to do. We have that situation for Ofgem, and National Grid has some statutory obligations, too. It was once put to me that such arrangements do not work in Europe because Americans are fundamentally more competitive—they just need objectives and they will get on and do the right thing, whereas in Europe it is necessary to put some money behind it as well. I do not believe that; I think that a clear statutory framework would be sufficient.

Professor Turner: On the issue of affordability, one concern is about costs being passed on to consumers, but when we are talking about increasing energy efficiency in order to lower demand on the system, there are issues of affordability for consumers in relation to investing in the technologies. Consumers might become better off as a result of energy efficiency reducing the cost of heating their homes, but up-front investment is required, and initiatives such as the green deal have not worked as they were intended to in helping with that.

I have been speaking to people from Community Energy Scotland and local energy Scotland. There is a mix of consumers and people who are involved in local energy generation and want a connection to the grid. There seem to be big problems with making connections to the grid and with the transparency of the decision making. In relation to the increased powers that are coming through Smith and more generally, the transparency of decision making and how it is affecting consumers and local community groups

who want to generate at micro level and to hook into the grid are issues that need to be looked at.

Chic Brodie (South Scotland) (SNP): Good morning.

I am somewhat confused, Mr Skillings. You said that there is nothing to worry about if our capacity margins fall by 4, 5, 6 or 7 per cent. However, the elephant in the room, which we have just discussed, is National Grid. You said that there is no strategic planning, and Dr Haszeldine's submission says:

"No performance standards are known to exist."

On the one hand, we have you saying, "Don't worry about the capacity margins—we're okay," but on the other, the transmitter of power is a private company that does well financially—it made £3.8 billion profit two years ago. We have heard about the Australian example. What should we do with National Grid?

You said that it is up to investors to decide whether to invest. That is okay in some circumstances but, in effect, we have a monopoly of transmission in the UK, which does not sit favourably alongside customers' interests. What specific concerns are there about National Grid and how would you alleviate them?

Simon Skillings: One thing that I would never do is criticise National Grid's professionalism. It delivers very well on what it is asked to deliver. Its statutory objectives are to maintain the system within certain safety limits and limits around voltage and frequency. It is not being asked to think in the longer term about how to get to a situation in which there are not lots of problems to manage in the shorter term or in which it does not have to invoke all its operational procedures.

We now have—we did not have this explicitly for a long time, although there are arguments about whether it existed implicitly—the Government saying, "We're going to take a longer-term view on a resource adequacy standard, so we're going to make sure that we have enough resources in the longer term that will enable National Grid to do its shorter-term decision making." That was an elegant solution to the problems of perhaps 20 years ago, but we now have a different problem overlaid on top of that. The issue is no longer just about how much supply; it is also about what sort of supply. Therefore, it is a case of transforming the system as well as keeping the lights on.

Chic Brodie: Forgive me for interrupting, but when Mr Calviou of National Grid was before the committee, we asked him about the 4 or 5 per cent margin and the position for this year. The longer term is of wonderful and strategic interest, but I am worried about the impact on our customers next winter. National Grid found it difficult to tell us exactly what its capacity margin was likely to be, but you seem to be very confident about that.

Simon Skillings: I am surprised that Mike Calviou struggled to do that, because part of what National Grid does is write—as Ofgem does—endless reports on upcoming capacity margins. Knowing him as I do, I think that, as an engineer, he was probably struggling to explain the concept of risk. We can never say never—we can never guarantee anything for sure; anything can happen—but we must live in an environment of acceptable risk.

That comes back to my point about security of supply being a lever of fear. It is always possible to construct a scenario in which the lights would go out. We could sit here and think about what will happen if Longannet disappears—if this line went down and that power station went, all the lights would go out. We can all do that, but when we look at the probability of such things happening—the probability of Longannet disappearing and other sets of circumstances arising at the same time—it becomes vanishingly small. That probability is still there—occasionally, life does such things to us.

Chic Brodie: With respect, Mr Skillings, you were the one who said that there is no strategic planning.

Simon Skillings: Yes.

Chic Brodie: If there is no strategic planning, why should people not be concerned? Why should there not be an element of fear?

Simon Skillings: The strategic planning that I was talking about concerned how we are going to deliver our policy objectives over a nice fluffy 10 or 15-year timescale. It is easy to look at the assets that we have on the ground today, the opportunities that are available to meet demand and the uncertainties over demand. The uncertainties are that much less if we are looking at next winter, which is six or seven months away. That is much more amenable to analysis, and National Grid has done that analysis—that analysis exists.

Chic Brodie: So why could it not tell us about it?

Simon Skillings: I do not know.

The Convener: We can ask National Grid, when it comes back.

Johann Lamont (Glasgow Pollok) (Lab): I am interested in what you are saying, Mr Skillings. You seem to be implying that, if we were properly organised and fully committed to low-carbon renewables, the market would follow if it had absolute confidence that that is what was going to happen. Am I right in thinking that you are

suggesting that there are interests in maintaining other forms of energy, and that it is in their interests to suggest that there is an issue about security of supply?

Simon Skillings: I wish that the situation were quite as easy as that. I would not like to pretend that there is a silver bullet that will make everything magically fall into place.

One of the great debates that is going on across Europe in energy policy at the moment is often talked about as the capacity payment debate. Most people believe that the internal energy market has failed. It is not delivering investment, utilities are going bust and customers are not getting a better deal out of it. It is not working. Two views are emerging. One view says that, because it is not working, we need to take advantage of the opportunities that we have created and move to what we might think of as electricity market 2.0, which is built around new low-carbon generation and operates from the customer's perspective rather than the perspective of large companies. The other view says that, because the system has failed and utilities are going bust and cannot keep assets open, we need to put in place mechanisms that enable utilities to have a more viable business model.

That is a vibrant debate at the moment. Germany is right on the cusp of it and is trying to answer that very question. Does it want to help its existing utilities or does it want to drive forward by closing nuclear power stations, having lots of renewables and tackling coal? That is absolutely the question that is at the heart of the German debate.

There are vested interests on all sides. Whenever I talk to policy makers, they are always frustrated, because they get a clear and coherent message from the existing industry, which is used to making those arguments, but when they speak to the new economy—the demand side and the renewable providers—they get a cacophony of noise and complete incoherence, because most of those people have not yet learned how to give a message that makes any sense at all. That is a fundamental asymmetry that exists in the messages that are going through to policy makers at the moment. The situation must be extremely difficult.

There are extremely strong voices in these debates. You must understand where those voices are coming from. There is a much bigger issue at stake that is to do with the existing utility business model. That is the question that is being asked across the academic press. What is the future of the existing utility business model?

Johann Lamont: So part of the issue is about Government having confidence in its own policy and, for example, seeing the development of renewables as being central to the economy rather than as something that perhaps creates a bit too much risk around energy. Presumably, we should be saying more about that.

10:45

Simon Skillings: Government must be clear about the risks that it is managing in delivering its policy objectives. It must be clear about the things that go wrong.

The strongest reason for building renewables is that no one can rely on nuclear plant being built or on carbon capture and storage facilities being built. If it could be guaranteed that carbon capture and storage could be deployed—and deployed cheaply—there would be very little argument to go for renewables, but that cannot be guaranteed.

Poland is, in effect, taking a huge bet on being able to deploy carbon capture and storage. It might be right, but the people of Poland should realise the bet that their Government is taking with their economy. It is not clear what bets the Government is taking with our economy over the next five to 15 years, nor is it clear how we are managing those bets.

Johann Lamont: I want to ask Professor Turner about the issue of investment in offshore wind, which was mentioned earlier. One of the reasons why people feel uncertain is because many of those developments do not seem to be happening. Why do you think that investment in offshore wind to date has focused on England?

Professor Turner: I have not studied the issue in depth. There are issues such as transmission charging coming in—offshore wind developments in England are closer to the centres of population—but I am not sure that that is the entire story.

The wider policy context has been mentioned. We are not talking only about electricity policy or even energy policy; we are talking about the wider economy and climate policy of the Scottish Government. The problem is that private sector investors are answerable to shareholders and need to provide returns; it is not their responsibility to take a wider view. With offshore wind and carbon capture and storage, investors look back for a policy commitment, and if they do not see it, that is a problem.

I was talking to someone from one of the investment banks about investment in renewables and green investment. They spoke about how they picked the low-hanging fruit, in relation to which they were confident that the Government's policy would continue to support the technology. The problem with offshore wind—this will be true down

south as well—is that, if investors are not sure about whether there is going to be Government support for its continued development and use, they will not invest. For CCS, a hands-off approach is being adopted until the investors see what the political climate is and whether longer-term support will be available.

It is one of those issues that run both ways when it comes to the wider policy context. Obviously, the Government takes a wider view than private sector investors. We need private sector investors, but they operate in a policy environment, and they need to be sure about the policy position.

Following the UK election, the Government has said—this was in the manifesto—that there will be no more additional subsidies for onshore wind. That affects the private sector communities. There may be opportunities here if there is seen to be a supportive environment for onshore wind. It is about communicating what the Government's stance is and how much support there will be for renewables and CCS.

Patrick Harvie (Glasgow) (Green): I want to check one detail for accuracy and to be sure that I understood. Near the beginning, Professor Turner talked about the prospect of Scotland becoming a net importer if we lose the existing thermal plant. Later, there was discussion about Scotland still being a net exporter of renewables. I want to be clear about what you said, in case I misunderstood it. Do you accept the Scottish Government's basic proposition that, into the 2020s, we can be a net exporter of electricity just from renewables—that is, that we can get beyond 100 per cent of our own consumption from renewables, albeit that we would be more dependent on interconnection?

Professor Turner: The closure of Longannet has thrown that into doubt.

Patrick Harvie: In the short term, yes. However, do you accept the basic proposition that, in the long term—into the 2020s—we can get above 100 per cent or is it your view that, without the thermal plant, we would always be a net importer?

Professor Turner: The problem is the intermittency of wind. It is all about thinking forward. In the absence of storage capacity, if the wind stopped blowing, we would be an importer if we did not have the thermal plant.

Patrick Harvie: In those circumstances, we would frequently be an importer, but we would be a net exporter.

Professor Turner: Potentially. I would not like to state that confidently without examining it. I have not done a study since the Longannet closure was announced. Quite a lot of the time, we could be a net importer if we did not have thermal capacity as well as renewables. Again, energy storage comes up because, if we had that, it would change the renewables picture.

Patrick Harvie: We would be importing quite a lot of the time.

Professor Turner: Yes.

Patrick Harvie: That is not quite the same.

I was interested in the argument that Mr Skillings made about an overly simplistic model that gives rise to overly simplistic fears. It is a very simplistic model to consider security of supply purely in terms of how much intermittent supply matches how much base-load and to say that, if we plug the two together, we have secure supply. We are clearly moving in the direction of a system in which supply is a much more complex relationship between a diverse range of renewables and other low-carbon sources—there might be some waste to energy, some combined heat and power and some biomass—as well as storage, demand management, more interconnection and, perhaps, some fossil-fuel back-up for occasions when it is needed.

Do we not also need a much more complex and nuanced sense of our individual relationships to the energy system? Professor Turner hinted at that when she talked about small-scale producers. Do we not need to abandon the idea that there are consumers and producers and to recognise that there is much more of an overlap between the two and that we all have that more nuanced relationship with the energy system?

Simon Skillings: Yes. You raised a lot of issues there. If we leap forward 20 years, we will be in a very different place. The economics of the prosumer are changing enormously. In fact, I read a report about Texas the other day. Although Texas is a bit sunnier than Scotland—

Patrick Harvie: From time to time—Scotland has its days.

Simon Skillings: Nonetheless, that report shows the direction of travel, which is that, within the next few years, it will be cheaper for half the consumers in Texas to have a home photovoltaic and storage system than it will be for them to connect to the grid and buy centrally. If we add to that the building automation and smart home opportunities that are associated with information and communication technology, which really enable people to have more comfortable and convenient lifestyles—not only in relation to, but including, their energy uses—we are in a different world.

There are lots of obstacles in the way of getting from where we are now to that Valhalla in the future. I am sure that it will happen because, at some point, it will be economic. It will come like a

rollercoaster. We can do things to make that happen more quickly, but it will not happen from the bottom up. It will not happen from the industry sitting down in its expert groups and trying to level playing fields, remove barriers to entry and sharpen pricings. It will need top-down political direction to start getting the new demand-side opportunities working.

Again, I will give the committee a mindset example, as it relates to some of the previous discussion. There has been a lot of talk about the base-load, which always seems a rather odd concept to me. It means that we have a big asset that is there for 80 per cent of the time; it is not there for the rest of the time. We have built up a system that enables us to operate with big assets that are there for most of the time, but not all the time. With small decentralised assets and the sort of resources that the demand side can provide, we have 80 per cent there all the time rather than 100 per cent for 80 per cent of the time. Actually, the evidence shows that it is a bit better than 80 per cent all the time; it is 90 to 95 per cent all the time. However, it is not 100 per cent.

The system has grown up with the idea that there is 100 per cent for 80 per cent of the time. It cannot make the transformation. It is better to have 90 to 95 per cent for 100 per cent of the time. The way that people think about operating the system needs to go through a major transformation so that they can think in those terms.

Professor Turner: The point about consumers and producers is important. Interestingly, I was at Grangemouth last week, where I talked about its being part of the energy supply while the people there talked about its being a heavy energy user. However, it has a small power plant that is now feeding into the grid. There is combined heat and power in industrial locations that can feed in.

Obviously, the domestic sector is important. As I said, there are problems with access to the grid and transparency when there are very small-scale producers. I believe that Ofgem is carrying out a consultation in which it talks about non-traditional business models and whether the regulation and policy framework impedes access.

It is also about taking a longer-term view. Heat and transport are often talked about as long-term problems, but they really are not, if we are talking about the potential electrification of heating and transport. Hydrogen would be another problem—apparently, hydrogen burns down, which is really bad, because boilers could blow up. Again, I am not an engineer, so I do not know that for sure.

However, one issue with the electrification of heat and transport is to do with the huge changes in demand on the electricity supply system. There are two other issues, one of which is the requirement for people to invest in electric cars, new boilers and such things. Those are big investments, so there are affordability issues and a question about whether support is available.

Another important thing to think about in focusing policy on heat and transport in the domestic sector is that those emissions fall outside the European Union emissions trading system, so they contribute to meeting our climate targets. There is the whole area of domestic energy use and effective energy efficiency policy. We need to think about how we work to support households in that respect and about the longer-term shift in heat and transport. Policy needs to be focused a lot more in those directions, because such big changes are required and because there are big opportunities for climate gas reductions.

Patrick Harvie: Yes. I was going to mention the greenhouse gas reductions in relation to the closure of Longannet. It is clear that Longannet is a big polluting beast. If fossil fuels are burned, the stuff will end up in the atmosphere, but it will not necessarily end up in the domestic emissions inventory because it is in the traded sector. I want to mark that we are talking about emissions that will clearly be saved, but not necessarily about the domestic climate targets.

Professor Turner: Yes. Obviously, the situation at Longannet might have been different if carbon capture and storage had gone ahead there. We do not know, but that did not happen.

Coal has different grades, but it is one of the dirtier fuels if there is not CCS. As far as the overall climate is concerned, there will be lower emissions with Longannet shutting down but, because of how things are accounted for, that falls under the European Union emissions trading system, so Longannet does not play such a big role in Scotland meetings its targets. We have more opportunities in the domestic sector and elsewhere.

11:00

Patrick Harvie: We have spoken about some of the engineering and investment prerequisites for the development of the new and more complex system. What I was driving at was some cultural prerequisites. I was referring to the ideas that people have about their relationship with energy. If I conceive of myself only as a consumer or bill payer, and if I conceive of the profits from the energy system as benefiting only some remote big business rather than my community, that locks us into the same patterns of thinking that the system should just bring me energy when I flick a switch, rather than having that more complex relationship. Is there not a cultural change that is every bit as

important a prerequisite as the engineering and investment prerequisites?

Professor Turner: There are a number of issues. One of them is a common thing that we hear when talking to individuals. With funding from the Economic and Social Research Council, colleagues of mine did some research into whose responsibility it is to address climate change. The response at the household level was very much that it is a national Government or, increasingly, international Government responsibility. In some ways, I understand that view. There is the mindset that, even if we turn everything off, we might not have an impact on climate change, as we are too small to make a difference.

On the question of what people perceive they have a right to, they might think, "I have a right to drive my car," and so on, whereas, if we try to get people to think that they have a right to get around, a right to transport and a right to be warm and comfortable, rather than a right to turn on the gas, generate emissions or drive their car all the time—

Patrick Harvie: That is about social relationships, rather than consumption, for instance.

Professor Turner: Yes. It is a matter of people thinking about the service that they get and trying to restate people's rights in that way.

A lot of the issue concerns perceptions about Government. The UK energy research centre carried out an interesting study that involved asking households and individual people whose responsibility it is to get energy into the home, and 80 per cent of respondents said that it is Government's responsibility. With energy, people have a commercial contract with a private sector organisation, just as they do for their telecoms but, for some reason, they perceive that Government has a responsibility for energy. Do they think that the organisations concerned are Government bodies? Do they believe that Government should have oversight and should ensure that things work properly? Then, households are thinking about energy as a bigger thing rather than just what they get on their electricity bill.

Simon Skillings: That is a dangerous way to start thinking. People think a lot about different things, but they do not think very much about most things. Some people will think a lot about energy, but most people will not. Some businesses will think a lot about energy, but most businesses, particularly small businesses, will not. When people do not think a lot about things, their behaviours are driven by all sorts of biases, which behavioural psychology is beginning to explain to us by showing that people do not behave rationally in any sense, because they simply do not think enough about it.

All of our thinking about the demand side has been about how to get people to think more. That seems a complete fool's errand. We should think about how people, through thinking less, make the right decision. What do we have to do regarding the way in which energy is sold that enables people to reach the right decision with very little thought? It is easy for them to make a decision that improves their comfort and convenience and reduces their costs. That has to be made easy for people.

Patrick Harvie: I agree. I do not really see a huge contradiction here. Behavioural change, whether on public health, the environment or anything else, is not about getting people to overthink and overanalyse every detailed decision of their lives. The thoughts that people have are prompted by the environment and economics around them and by the social environment and expectations, and cultural expectations are critical to that.

The Convener: This has been a fascinating discussion, and it could go on all morning. However—

Patrick Harvie: I am sorry to interest you so much, convener.

The Convener: I am sorry to have to say that we are at the end of our time.

I thank Professor Turner and Mr Skillings for coming. It has been a very useful discussion.

11:05

Meeting suspended.

11:09

On resuming—

The Convener: I welcome our second panel of witnesses: Professor Stuart Haszeldine, professor of carbon capture and storage at the University of Edinburgh; Mark Crowther, general manager of Kiwa and member of the UK Hydrogen and Fuel Cell Association; Andrew Jones of the Electricity Storage Network; Professor Susan Roaf of Heriot-Watt University; and Chris Toop, general manager of the energy programme at Scottish Water.

In this session, we want to cover a number of areas around carbon capture and storage, electricity storage, demand-side response and demand reduction, and we have a number of questions to ask. We want to get through the session in about 75 minutes—the aim is to finish at about 12.25, if we can. There are quite a few of you on the panel, and if you all try to answer every

question, it might be difficult to get through all the subjects in the time allocated. I therefore ask members to direct their questions initially to one member of the panel. If other panel members want to come in, to agree or disagree violently with something that somebody else has said, just catch my eye and I will bring you in as best I can in the time allowed.

We will start by looking at issues around carbon capture and storage.

Dennis Robertson: I will direct my question first to Professor Haszeldine, who might have heard some of the evidence from the witnesses in the earlier session. Do Government policy mechanisms favour carbon capture? If we are developing new thermal power plants, should they be fitted for carbon capture?

Professor Stuart Haszeldine (University of Edinburgh): Can you clarify whether you are referring to the Holyrood Government or to the Westminster Government?

Dennis Robertson: I mean UK Government policies, which are obviously reserved.

Professor Haszeldine: Okay. The UK Government has a pretty well-designed system for supporting both the analysis of need and the design and build of a carbon capture and storage electricity-generating power plant. Uniquely in the world, the UK Government has a system whereby it will give a premium—a higher electricity price—to enable the operation of that carbon capture and storage plant. Inherently, we in the UK are therefore very well positioned. ,

The problem of course is the on-going discussion about the cost. The UK Government is going very slowly on that analysis because it is trying to avoid overspending. The cost relates both to capital grant and, in terms of operational costs, to the competition for the levy control framework. There is therefore competition on two levels: first, in order to get the capital grant, it is necessary to pass the hurdle of validation that the power plant has a good design; and, secondly, as part of the conversation before getting permission to go ahead, it is necessary to compete for the levy control framework, which means competing against the UK allocations for what we can call clean electricity generation from various types of renewables, and even from nuclear power. That is a very rate-determining step, which is one of several reasons why we have not yet seen the commissioning and operation of a carbon capture and storage power plant in the UK. I believe that all the components are there in terms of the engineering, the transport, the storage and the finance to enable such power plants to operate. The rate of progress depends on the rate at which the UK Government moves. That is my outline answer to your first question.

Your second question was whether we should fit CCS to all new power plants. I am very clearly of the view that it is essential that we do that, because it is absolutely clear that Scotland and the UK are on a trajectory to reduce our domestic emissions of greenhouse gases—mainly carbon dioxide—from whatever source. Energy generation from fossil fuels is one of the major components of those emissions—it is typically a third of UK or Scottish emissions. If we build new plants and want to go down the route of having renewed thermal generation with flexible output, we have to capture the carbon emitted from those plants, whether they are gas or coal plants.

Dennis Robertson: Would you favour gas plants?

11:15

Professor Haszeldine: That is a more complicated argument. It depends on your criteria. Both systems are capable of producing electricity with greatly reduced emissions. When you price in and analyse the chain of carbon that supplies fuel to the UK, it is clear that coal has a huge carbon emissions and social cost because we predominantly import it from other countries. That cost is not mitigated by our actions on carbon capture and storage in this country, but because coal is phenomenally cheap in terms of the cost of buying the potential to generate energy, there is a trade-off there. Gas is a much cleaner fuel and can be pipelined in from the North Sea and from Norway at very little embedded carbon cost. We can therefore mitigate most of that carbon cost via our own domestic power plant. It is inherently a cleaner but more expensive fuel and we will, of course, end up progressively importing more and more of it. We project that anything that we build now will have a lifetime of 30, 40 or 50 years.

Dennis Robertson: Should the decisions that we are taking at the moment look at our targets for combating climate change over the medium to long term and really be about investing? At the moment, in terms of short-term investment, we have been moving slowly with CCS, as you said. Should we grasp the nettle and invest? We would benefit in the long term from having security of supply and from reducing our carbon emissions.

Professor Haszeldine: I personally think that we should invest in a future generation of thermal power plants as a transitional measure. Clearly, even with carbon capture and storage, the use of fossil fuels has a lifetime. We have defined carbon stock that we are allowed to emit into the atmosphere for climate change purposes, and applying carbon capture and storage to generate

electricity when we need it has huge economic advantages, because it gets round the storage problem that we have not solved yet—some of the earlier witnesses referred to that. That technology can be developed and built, and it has a pathway towards being competitive against some lower-cost renewables.

We must also consider what we might crudely call the amount of electrical power that we need. Across the whole economy, people usually consider carbon capture and storage in terms of electricity generation, but if we start to move towards the electrification of heat in people's houses, rather than having gas-fuelled heat, or if we start to have electrically powered vehicles, we increase demand for electricity and there is the potential for us to need more of it rather than less. That scenario depends on multiple factors, and there are multiple futures. If we factor in electricity, heat, large carbon-emitting industries and transport, we can see from analysis that has been done by the Energy Technologies Institute in the UK, the Intergovernmental Panel on Climate Change and the International Energy Agency that everyone has come to a similar conclusion, which is that, rather than just ignoring carbon capture and storage, deploying CCS to mitigate something like 20 per cent of emissions is two and half times cheaper to do across the whole economy. There are choices to be made, and they have moral, policy and cost implications.

Dennis Robertson: Perhaps the other witnesses have an opinion on that. Before we move on, is transmission charging the principal factor behind not moving forward with carbon capture and storage at the moment? Is that holding us back? Is it the obstacle?

Professor Haszeldine: I expect that transmission charging will become an obstacle, but the main obstacle at the moment is the rate of progress from the Department of Energy and Climate Change in London on inspecting, validating and co-designing these proposals with the two developers that are currently on the slate. The real bottleneck will be the levy control framework, which is set at about £7.6 billion in the UK. That is the subsidy allowed by the Treasury for all new forms of low-carbon energy at the due date of 2020. DECC has resolutely refused publicly to allocate any parts of that to any particular technology. There is huge uncertainty on the part of developers about whether it is worth while being engaged with the carbon capture and storage mission, because it is unclear whether they will get a levy control framework allocation. Ultimately, there is a cost competition about how much low-carbon electricity the UK can buy for a certain price.

Peterhead, SSE and Shell are well on track to bid into that levy control framework. We also have the white rose CCS project, which the National Grid and Drax power station are well on track with. However, if we want to follow on from that and deploy CCS in multiple power stations, we can see that the second wave has a big problem, which is exemplified by the Summit Power bid in Scotland to develop a new heat supply and hydrogen supply power plant at Grangemouth. There is a bottleneck around proceeding because of the complete uncertainty about whether it will be allocated any funding from the levy control framework to pay for the additional costs of the electricity that is generated.

Dennis Robertson: Thank you for that.

Lewis Macdonald: I am, of course, particularly familiar with Peterhead. I will raise a couple of factual points just to establish the lie of the land. You mentioned mitigation of 20 per cent of carbon emissions. What level of mitigation from a fossil fuel plant do you consider would be commercially realistic in the context of the 2020s?

Professor Haszeldine: At the site of generation—at the fossil fuel plant itself—most designers around the world would look to capture at least 90 per cent, and they could go as high as 98 per cent, of the carbon that would otherwise be released. That choice is a commercial choice because, when you clean up anything, the more you clean it, the more the price goes up. That is a choice that is up for negotiation between the developer and the UK Government.

Lewis Macdonald: My second question is about the pipelines and the storage that are associated with carbon capture. In the case of both Peterhead and Drax, we are talking about storage offshore in depleted reservoirs beneath the seabed. Who would own and manage the pipelines and storage facilities? Who would be responsible for the CO_2, not only in relation to transport and storage but thereafter?

Professor Haszeldine: That is a commercial question. In terms of the way that the two competitions are conceived at the moment, the UK Government wants an integrated flow from the generation of electricity through to the separation of the CO_2, the pipeline transportation and the injection for permanent storage.

In the Peterhead to Goldeneye storage site proposition, the power plant is owned and operated by SSE but Shell UK, the oil company, has basically taken over the design and operation of separation, pipeline compression and injection. That will flow as one integrated project with only two partners in it.

By contrast, the other proposition at the Drax power plant involves a much larger array of actors,

from the power plant owner and operator to the supplier of the oxygen used to combust the fuel in a high-oxygen atmosphere, the supplier of the generation and combustion equipment, the pipeline operator, which is National Grid, and eventually the operator of the storage. That is a much more complicated chain of interconnections between companies.

Those propositions are fit for purpose to get those two projects up and running because the partners can make explicit A-B-C contracts along that individual chain of connection. However, if the UK and, in particular, Scotland want to envisage the development of that type of new generation and a new market for carbon storage, we will need to open things out. We need to disconnect the power plant operation and the CO_2 separating operation from offshore transport and storage, where there is a different array of actors. Those may include oil companies that transfer into a new, greener business or new companies. In effect, they will operate a storage site as a facility for an array of different power plants feeding into that storage site. At the University of Edinburgh, we have done quite a lot of research to establish whether that is technically feasible, and it is the least-cost route of opening things out.

While we are on the subject, I want to mention something that is particularly important to Scotland right now. The ownership of the storage site is a complex area. Underground oil and gas in the North Sea is owned by the Crown but operated by DECC. The ownership of pore space has been claimed by the Crown—pore space is, in effect, operated by the Crown Estate. With the Smith commission's devolution of further powers to Scotland, there is an enormous opportunity for Scotland to gain control from the Crown Estate of the pore space in what I loosely call the Scottish area of the North Sea, which we could decide is basically the oil and gas area of the North Sea.

I am extremely concerned that that is a very fuzzy negotiation at the moment. If the uncertainty is not resolved, and if Scotland does not take ownership or directorship of the Crown Estate asset of the pore space, the development of the Peterhead proposition could be stopped. That would also mean throwing away a huge economic opportunity for the future. The conversation about the Crown Estate is largely about the visible onshore assets of royal estates in the Highlands, coastline anchorages, fish farms and so on, but the real money to be made out of it is in the possibility of storing huge amounts—millions and billions of tonnes—of carbon dioxide into the future. That storage would be not just for Scotland and not just for the UK, but for the whole of Europe, because the UK holds about 35 per cent of Europe's easily accessible offshore carbon dioxide storage. There is the prospect of a £5 billion-a-year storage operation, if carbon capture and storage takes off. It would be negligent of Scotland to hand that back to Westminster now.

Lewis Macdonald: That is one of the areas that I am keen to get some views on. There is another other obvious option that might exist, given the Oil and Gas Authority's responsibility for decommissioning and for end-of-life extraction operations. There may be an argument that the Oil and Gas Authority would be the right organisation to manage that storage space in the future.

Professor Haszeldine: I think that the Oil and Gas Authority is one of the obvious candidates to supervise the entire offshore pipeline and storage operation. Our problem in the UK is that supervision is too segmented. Oil and gas extraction is run by one part of the Department of Energy and Climate Change, the carbon capture and storage clean-up is run by a different part of DECC, the Treasury controls the whole thing and there are interactions with the Department for Business, Innovation and Skills and of course with the Department for Environment, Food and Rural Affairs. It would be much more sensible to integrate that responsibility.

With the North Sea decline, we have two types of opportunity. The default position, which I think is the wrong position at the moment, is to just say, "That's it: we're uneconomic; stop producing oil and rip everything out—all done." Instead, if we have to decommission pipelines and oil fields, we should be doing so with a view to repurposing and reusing those pipelines and facilities, whether that happens in 10 years or in 50 years—we do not know yet when we might reuse them. The sunk costs—the information, the actual equipment on the seabed and quite frequently the bore holes—often have huge capital value. It can be literally many tens of millions of pounds per bore hole, so, cumulatively, we are talking about billions and billions of pounds, and we will never do that work again.

I think that there is an opportunity, paradoxically, to use the end of a field's life to generate a last gasp of oil by injecting carbon dioxide into the field, which will result in enhanced or improved oil recovery, typically producing an extra 10 per cent of oil out of an oil field. That method generates money for the UK Treasury, which we can and should reinvest in carbon capture and storage and in converting the pipelines for CO_2 transport. By using the last gasp of oil production, we can invest at no cost to the public. We can reinvest the profit from that oil in developing a carbon capture storage network decades faster than we could otherwise do. We would gain commercial benefit, transfer skills into the North Sea for a more sustainable future and build a CCS network that will last a hundred years into the future.

Lewis Macdonald: I have one final, but important, question. The Scottish Government's electricity generation policy statement two years ago talked about CCS being demonstrated at commercial scale by 2020, with full retrofit by 2025 to 2030. Are those dates now off the table? What is the earliest commercially realistic date for a commercial demonstration of carbon capture and storage?

11:30

Professor Haszeldine: The Peterhead project is the leading project in terms of calendar years because it is a much simpler project than the white rose project at Drax, which involves experimenting with equipment that has never been built at that scale before. The Peterhead project adapts equipment that has been used in oil refineries for 20 years—it has been fitted on the Boundary Dam power station in Canada, to which Peterhead has a similar capture system. Shell knows a huge amount about the pipeline and the oil field, so there are minimal obstacles.

As I understand the situation, the developer plans to be commercially operating towards the end of 2018 or in early 2019, if everything continues to work as it is working just now. Obviously, it will depend on engineering judgments, on assessments by departments in London, including DECC, and on the Treasury agreeing to allocate the levy control framework from its centralised pot to fund the project's running costs.

Lewis Macdonald: It would have to operate for a period before the lessons could be applied elsewhere.

Professor Haszeldine: The fact that it started up would be a validation of the learning. The learning starts this autumn, with the UK accepting the front-end engineering design. If that is in a state that is good enough to be accepted by the UK, that will be a tangible piece of learning—indeed, it should be a global piece of learning. If it goes forward to commissioning and if Shell makes a final investment decision on it, that will be another important piece of learning. There is no cliff edge when it comes to learning; we can learn progressively.

It is important to point out that some of the research that the University of Edinburgh is involved in is being used by provinces in China that have taken the learning from the Longannet project and the Kingsnorth project, and which will take the learning from the Peterhead project. They will use those projects as templates to design their own carbon capture and storage systems in China, which, as you know, is the largest CO_2 emitter in the world, in terms of emissions from power plants. We already have a large influence over what is happening in world developments.

The Convener: We cannot spend the whole morning on carbon capture and storage, so we need to move on. First, however, Patrick Harvie has a supplementary question.

Patrick Harvie: I am sure that we could spend the whole inquiry on this subject. I will try to be quick.

Earlier, Professor Haszeldine acknowledged the limit on the amount of carbon dioxide that we can emit if we are serious about the climate change challenge. That reality has led to a growing movement to divest from the fossil fuel industries, not only for ethical reasons but because of the view that those industries are profoundly overvalued, as they are valued according to the assumption that all of the reserves will be turned into revenue.

Given that view, and the notion that the fossil fuel industries are profoundly overvalued because they are sitting on stranded assets, if the engineering and technical challenges around carbon capture and storage are overcome, and it is capable of being used as a transitional step to give us some breathing space, how would we avoid reproducing the same economic problem that arises from the view that, because the industry has only a finite economic life, any investment that is put into it will not be worth anything in the long term? How can we avoid it becoming another bubble?

Professor Haszeldine: I would like to understand your question a little better. Are you asking about how we can avoid carbon capture and storage becoming a bubble that has no future, or are you asking about whether investing in carbon capture and storage will simply defer the fossil fuel bubble for 100 years?

Patrick Harvie: If CCS is a transitional technology—if that industry is not going to be a lasting part of the economy—how do you avoid the economic challenge of it not attracting investment because it is seen as something that will disappear? Opencast is dying and jobs are being lost. The coal-fired power station at Longannet is about to go, and economic problems will follow in the wake of that. How do you avoid the problems that are associated with dying industries?

Professor Haszeldine: I agree with a lot of what you said in the first part of your question. Clearly, there is a divestment movement, and it is sensibly founded. However, I disagree that that is having a global impact, because—fortunately or unfortunately—that divestment is not having an impact on the share price of those fossil fuel companies.

It is a tangible, demonstrative action and, of course, my university—the University of Edinburgh—decided in the past weeks and yesterday to divest from particular companies. That is how it is; I have a private view, which I will not bother with for the moment.

The Convener: Oh go on. [*Laughter*.]

Professor Haszeldine: Well, I think that it is sensible for public universities such as the University of Edinburgh to send a very strong signal that the present rate of progress and behaviour of fossil fuel companies are not acceptable. That is a sensible view to express, but I also argue that we should be part of enabling the transition because we clearly do not have enough renewables at a low-enough price and a high-enough volume not only in Scotland but around the world to transition overnight into renewables. There is a slope—a gradational transition that could take 50 or 100 years.

Patrick Harvie's point is germane. How do we manage that transition? My answer is that I am mentally and in this evidence decoupling the value of the fuel as a compact and high-value energy source from the problem and cost of the emission. Carbon capture and storage tries to enable us to gain the energy value out of gas—methane gas, for example—and greatly reduce the penalty of the emission.

It is clear that the use of fossil fuels has enabled vast wealth, health and population benefits in the world because, before we began to use fossil fuels in the 1700s, we had very different societies. In the intervening time, we have realised that the emissions of carbon dioxide and greenhouse gases and, sometimes, the social cost of gaining the fuels are unacceptable to us as affluent nations, so we are now trying to reduce those emissions.

Carbon capture and storage can enable the use of those fossil fuels for energy generation for perhaps another 100 years, should we choose that. However, alternative ways of generating electricity, whether it is renewables or hydrogen as a vector, are arriving and reducing in cost rapidly, so burning fossil carbon as a fuel will rapidly become a strange thing to do. Although the fossil carbon resource has a value as portable fuel—in a car or an aeroplane, perhaps, although we can obviously find ways around that—it has huge value as a source of carbon for petrochemicals for plastics, paints, pharmaceuticals and all the other materials that we take for granted in our societies. I imagine that the use for that will continue.

The Convener: We need to move on, as there are other issues to discuss. We turn to electricity storage.

Gordon MacDonald: I hope that I can bring Mark Crowther, Andrew Jones and other witnesses into the discussion.

Up to now, our electricity storage has been via hydro schemes. Scotland has 145 hydro schemes and there is potential for building two large ones in the Great Glen area. Is hydro enough to provide Scotland's electricity storage needs, or do we need more innovative solutions? If so, what would they be and when will they be commercially available?

Mark Crowther (Kiwa): We tend to think that energy is electricity whereas, in fact, the elephant in the room is gas. Most households use four times more gas than electricity, so I consider such matters a bit more holistically.

We have just completed a test programme south of Glasgow in which we released large quantities of hydrogen and natural gas into a farmhouse and ran tests that showed that hydrogen is merely another flammable gas. It is not inherently more dangerous than any other flammable gas. I cannot put it any more simply than that. Therefore, rather than tying yourself to electricity, you want to explore the potential for using another green vector, which is hydrogen.

You talked about the simplicity of storing electricity in hydro rather than hydrogen. The Cruachan scheme here in Scotland is a vast scheme with tunnels the size of this room. The head stock of one of the Texas underground hydrogen storages, which are used for commercial purposes to balance supply and demand, probably has a floor area smaller than that of this committee room, and that is all that you see above ground. In terms of land use, nimbyism and public acceptability, hydrogen scores to a very large extent.

The general use and distribution of hydrogen, because it is green and does not emit any carbon at point of use, also means that you can effectively distribute energy production through fuel cells without always having to build more expensive wires. Typically, transporting one unit of energy through a gas pipeline costs one unit, and to transport it through an electricity network costs seven units. Electricity is a much more complicated beast to move around than gas is.

There is a host of reasons why hydrogen is a much better energy vector than pumped hydro, which produces only electricity. The other advantage of hydrogen is that it provides a marketplace because it entirely separates production from demand. One of the problems in raising money for a power station is that you are not only unsure about the price you will get for the electricity rate per hour, because it varies, but uncertain about how many hours per year the

power station is going to run, depending on the competition—there is a huge number of variables. If you build a power station or hydrogen production facility using steam methane reforming, you can run it for 8,500 hours a year at a price that can be relatively well organised through a static market, rather than trying all the time to bid into the hugely variable costs that you always get when you have no storage mechanisms.

To answer the question, there are a number of reasons why we should be looking outside the box, rather than merely asking about another route to energy storage. As an aside, most people think that, for interseasonal energy storage, there really is almost no alternative to hydrogen. I am choosing my words carefully, because for interseasonal storage the volumes of energy are so vast that only that is possible.

Andrew Jones (Electricity Storage Network): I look at the issue like the food supply chain. If I run a company making pizza, there is a pretty good chance that I will have a warehouse somewhere. I will pick one of the well-known supermarkets—Tesco, for example—just because I know its name. It has large distribution depots, large superstores, smaller stores and metros, and there are still corner shops, so there is a pretty good chance that you will have some of my pizzas in your house.

My view of storage is that we need all of those. Every part of the supply chain needs to exist, and the problem is often how to decouple, because it is such a large topic and you need to be clear about what you are actually trying to do with the storage. For example, Germany is encouraging self-consumption with solar panels and energy storage to alleviate the constraints on the ground. In California, to meet the 2020 renewables target, people believe that they have to have storage at transmission level, distribution level and household level. There is no one-size-fits-all solution, and that is the problem. If there is no one-size-fits-all solution, the challenge is how to create a market with the different technologies that exist.

Professor Susan Roaf (Heriot-Watt University): I perfectly agree. You have to look at what you are doing with the storage, where that storage is needed and what type of storage is most appropriate.

I often think that I deal a lot with what I call boys with toys: big technologies and “mine’s bigger than yours” sort of stuff. Why do we need energy security? Is it to keep the lights on? Is it to keep commerce ticking over? Is it to stop people dying of hypothermia in their own homes? Is it to keep them out of hospital and place less burden on the national health service? Is it to keep people productive? Somebody said earlier that people do not care about energy; actually, 30 per cent of people in homes care an awful lot about energy. I would say that people in about 30 per cent of homes in Scotland probably very seldom turn on the heating.

11:45

We therefore have to look at the social function of energy and energy security. A trend has happened under the radar—it was not predicted by consultants or Government departments, which really like big energy solutions—which is the solar domestic revolution. I call it the people’s power solution. I happen to have built the first solar roof in Britain on my Oxford house. I am having a party next month because there are 1 million solar roofs in Britain. We have only 25 million houses in Britain, but we have 1 million solar roofs this year.

Underneath the radar, we have had a huge revolution because people have worked out that, once they buy a means of energy generation that is on their own roof, they do not have to pay ever-increasing energy bills—10 per cent a year—and can create enough energy so that they do not die in their own homes from hypothermia and can get comfortable warmth in one room at least.

We have done a number of studies. Some of you will have helped us do backcasting, for example, and looking at the 2030 energy supply in terms of big energy, regional energy and small, decentralised energy, the latter of which is a no brainer for Scotland. Professor Haszeldine did a wonderful study on where we need big energy that showed that we need it in the central belt with industry. It is no use putting hydrogen gas pipes up in the middle of the rural Highlands; we need other solutions there. We need to start intelligently mapping the energy storage requirements for Scotland and the people of Scotland.

We have done a number of studies on fuel poverty. There is a very high level of deprivation in Dundee, and we worked out that for a cost of £67 million the means of solar energy generation could be put on all the houses in Dundee, which would take everybody there out of fuel poverty for ever. The figure of £67 million is less than the cost of the new Victoria and Albert museum in Dundee. Do we as a society have to start making decisions about such matters?

We were asked by the Scottish Parliament to do a report on solar thermal systems. We gave a rather good report on that in a week because every solar thermal storage tank in every house is a bit of distributed storage of warmth. We came up with a number of figures and showed that we could get 4,000 megawatt thermal hours by putting solar thermal systematically in the homes of Scotland at a price that is probably less than the

cost of Hinkley Point C nuclear power station. That would take people out of fuel poverty, increase the economic viability of the population, build self-repairing local community technology systems, help to keep the lights on and help load shave.

That is my punt for the people's power.

Mark Crowther: I cannot agree with some of that. [*Laughter*.]

Solar PV is great at producing electricity at lunch time during four summer months; I know that it produces electricity outside that time, but it is hugely peaky. Solar PV is not much good at 6 pm in December, so there clearly has to be some sort of interseasonal storage.

Certainly, my calculations show—Professor Roaf and I can trade calculations—that interseasonal storage is extremely difficult unless we are going to use swimming-pool-sized heat stores everywhere, which are extremely difficult to retrofit into an urban environment. We would get into the practicality business that is the great problem of large district heating schemes. It takes years to get permission to run a new eight-inch gas pipe down a high street because of all the traffic and the interference that is caused. We are probably looking at 24-inch heat mains, plus their insulation.

Professor Roaf mentioned domestic hot water tanks. A domestic hot water tank typically takes up 1m^2 of a house. If a person paid £200,000 for their house, that will be £2,000 of house that they do not have. That is why 80 per cent of people like and buy combi boilers. Maybe it is an educational thing, but they love their combi boiler and it is very difficult to have a mindset to move away from them.

The Convener: I will allow a brief response from Professor Roaf.

Professor Roaf: We are also going through a micro storage revolution. One of my requests to the Scottish Government is to seriously consider approaching Elon Musk to set up his new Powerwall battery storage for smaller, medium and larger buildings in Scotland. If we start to attract people who can provide systems for in-house storage, we can start to lay the foundations for a truly low-carbon economy.

Gordon MacDonald: We have heard about a range of options for electricity storage—not everybody agrees on them—and about the need for a mapping exercise. Does DECC have a coherent strategy for addressing that? Is it putting funding mechanisms in place to achieve what you have talked about?

Mark Crowther: Back in December, DECC let a contract to an Edinburgh-based consultancy that is doing a comparative study of a town in Scotland. The end cost in 2050 of heating a town by means of district heating schemes, with everything that goes with that, is being compared with air-source heat pumps and the electrical infrastructure that they require against the existing gas distribution system converted to a hydrogen system. I presume that the results of that study will come out in the autumn. It will be interesting to see them.

You asked whether DECC is making investments. It is certainly—

Professor Roaf: I rest my case, your honour. There is no consideration of the sensible people's power of solar. Why is that?

Professor Haszeldine: I will go back to the original question and give a simple answer—which is a wrong answer, of course. Are two more Cruachan-type storage schemes enough? Hypothetically, we could cancel all fossil fuel generation and rely just on wind power in Scotland, but we know that wind generation goes up and down. We know from the April just gone that there can be whole weeks in which wind generation ticks along at 10 or 20 per cent. To get through such lulls a week at a time in a simplistic conceptual system, we would need around 10 or 15 additional Cruachan-type pumped-storage schemes.

That gives members a sense of what is needed, and it is clear that that is not a very sensible option. The effect can be mitigated by decentralising and dropping demand so that people can generate and store more locally, which is exactly what Sue Roaf has been talking about. If it was decided that building a huge set more of pumped-storage facilities was wanted, as that is the most efficient round-trip technology that we know about, we would eventually end up having to drain or dam a sea loch, for example, to get the required tonnage of storage.

That gives members some idea of the options. That was not a recommendation; it was just a scoping answer.

Andrew Jones: DECC has been active in funding demonstration projects for electricity storage. First, it provided a capital grant for the Shetland project. It also helped to fund the Orkney project, and it is funding the project in Gigha, plus other projects throughout the UK. DECC is pretty clear that there are commercially viable technologies today, but it is still working with some of the emerging technologies to come up with a cost-down curve requirement to make them more competitive.

DECC is struggling with how to make the market work for storage. It admits that the capacity mechanism that it brought out does not suit storage, because the lifetime is too short and the

cost of capital for new technologies makes it difficult to participate, so it is rethinking things. Our association spends a lot of time with DECC exploring how that mechanism could structure itself.

There is a debate about interseasonal storage. Hydrogen provides one way of doing that. In our association, we have a company that uses liquid air, which can also provide interseasonal storage. Hydrogen is one way, but electricity storage is also available.

Chris Toop (Scottish Water): I will give a large user's perspective on energy storage, which is of interest to Scottish Water. I can certainly see benefits to customers, the first of which is from potentially increased operational resilience. We have stand-by generators at our treatment works, but energy storage could offer additional resilience. There is also a potential for cost savings, particularly when we combine storage with renewable self-generation, which we have on more than 40 of our sites. At times, we export to the grid. There is an opportunity to store the energy and use it when we would ordinarily be drawing off the grid.

We are agnostic on the form of technology for energy storage. We are looking for a cost benefit for customers. If there was a benefit for customers through operational resilience and savings, Scottish Water would pursue that. We have a track record of working with partners on new, pioneering technologies, and we would be a willing partner in something such as that. I wish my colleagues the best of luck with developing them.

Gordon MacDonald: If I picked you up correctly, Mr Jones, you said that the market does not work for the storage sector. How much of a part does constraint cost play in that? I refer to paying generators not to generate. I understand that, in 2011-12, the total cost of constraints was £324 million, of which about 10 per cent went to wind. Is that figure likely to go up if we do not have storage facilities in place?

Andrew Jones: The answer to the last part of your question is that, if we put more wind on, the figure will go up if we do not have some type of constraint management—and storage is one aspect. The challenge is that, although storage benefits the complete electricity supply chain, the market is designed in such a way that generation, transmission, distribution and supply are segregated, which makes it difficult to get the true value across all the areas.

It would be possible to see a renewable generator benefiting, with a transmission operator benefiting, too, as a constraint would be taken away, but what is the mechanism to get revenue from both of those? That is a complex discussion, which will go on for some time. The simple answer is that, the more storage there is, in whatever form, the more that will help with having less constraint.

Chic Brodie: I am glad to hear that my city of Dundee might forge ahead. It is known as the sunniest city in Scotland. I am sure that we will all benefit.

I wish to discuss the different forms of energy and I will put my point to Mr Crowther and Professor Roaf. There has been little discussion of geothermal energy and what we can do with it for energy supply and district heating systems. Do you have a view on why we are not tapping into the huge web that we have in, for example, coal mines throughout Scotland? Do you have a view on what the cost might be?

Mark Crowther: We have considered recovering warm water from waste coal mines on the north-east coast of England, but it is technically difficult. The water is not very warm, and we get into all the problems of running district heating schemes with not very warm water while wanting good coefficients of performance out of the schemes. That becomes practically and technically challenging.

Many things in the energy sector are doable, but are they at reasonable cost? Unfortunately, economists sometimes seem to avoid the terrible word "practicality".

12:00

Professor Roaf: In Shettleston in Glasgow, there has for the past 20 years been a nice little district heating scheme, which uses hot water from the coal mines below. There is more interest in that, and it is being looked at. I think that the technology will be exploited more in the future. Glasgow has schemes that are good at that.

I will squeeze in one point that has not been mentioned, which is to do with behaviours. We are looking at systems to orchestrate supply and demand. There is a good project up in Findhorn in which, instead of having stochastic supply and demand mismatch, price tariffs and really good weather forecasting are used basically to get people to turn on their washing machines when a lot of free energy is around. That is perfectly possible.

The Convener: We will come on to that.

Professor Haszeldine: To go back to geothermal—I take that to mean mid-depth geothermal, which is 500 feet to 2,000 feet below ground—I agree that there is a resource in former coal mines. We have done a bit of work on that. Again, we are pretty cautious, because it is difficult to develop and more particularly because the

resource lasts for only 20 or 30 years, as the rock starts to cool down when the heat is extracted. We have to be careful about how long the resource will last.

There are propositions for using that type of thing as an interseasonal store. Low-grade heat can be extracted in the winter and, if we ever need large-scale air-conditioning and cooling in Scotland in the summer, the heat could be recharged then. [*Laughter*.] Actually, that is not a stupid statement because, as climate change proceeds, we will get hotter and hotter summers. I think that, within our lifetimes, we will see more need for that. We can balance—we can use the rock as a seasonal store, and coal mines are one easy access place for that.

Southampton has for the past 20 or 30 years run a geothermal system, which uses heat out of regular sandstone. That can be done in the UK, but the system needs re-engineering every 20 or 30 years to drill into a different and warmer part of the reservoir from which the heat has not been extracted.

Chris Toop: I have a closely related point. We have heat in sewage across Scotland. Next month, we will pilot the UK's first scheme that involves extracting heat from the sewerage network—it will be used to heat a college campus that is close to one of our waste water treatment works. That looks financially viable.

We are working with the Scottish Government on a heat-mapping exercise to show the heat sources and heat demand centres. I hope that the pilot next month will succeed and that we will take it forward and look at other sites where we can do that.

The Convener: There was a rich source of comedy material in that answer. We will move swiftly on.

Chic Brodie: Mr Toop, your submission covers a lot of what Scottish Water is doing. I made efforts to convince Scottish Water Business Stream's previous management to enter the energy supply market. You have a huge database. Given that Scottish Water supplies to every household in Scotland, why are you not communicating more about systems that domestic users might use?

Chris Toop: I am sorry—could you repeat the question?

Chic Brodie: You could be a conduit for meaningful information on demand response. You are doing work on that issue. Would it be possible for you to market that, given the scope and range of contact that you have? Why is Scottish Water not engaging more on the issue?

Chris Toop: We are doing more of that, particularly in relation to water efficiency. A lot of the use of heat and energy in homes is from heating water, so we have been promoting water efficiency through many of our communications and leaflets that we send to customers. There has been a range of television adverts to promote water efficiency. I am sure that we could extend our communications on demand management even more, but we have been more active on that—you have probably seen some of the adverts.

Chic Brodie: I have not. I look forward to getting your leaflet.

The Convener: We need to move on and I am keen to cover a couple of other areas in the time available. The first is the potential impact of the closure of Longannet on the electricity network. We have taken quite a bit of evidence on that, the balance of which indicates that most witnesses do not view the closure of Longannet as a serious problem.

Professor Haszeldine, you say in your submission that

"current interconnection to rest of UK ... appears inadequate to fully provide appropriate backup until completion of the western link interconnector"

in 2017. Are you concerned that, if Longannet closes next year as we expect, that will create a problem?

Professor Haszeldine: Let us unpack the statement a little. I still harbour a residual concern, because the situation depends on what we predict for the weather in the winter. National Grid does a good job of predicting demand—it has probably given the committee lots of statistics and models and suchlike. However, if we take the example of last winter, there were several days when there was negligible wind generation in Scotland, so there was reliance on thermal from Longannet, the nuclear plant and the existing interconnector running from south to north. That just made it through, but the interconnector was running at maximum. National Grid said that it was holding about 1GW in reserve so, in principle, Longannet could have been dispensed with. That worked for the winter.

My concern is that it is not clear to me that National Grid models a -15° winter, in which we have -15° for two or three weeks. If the polar vortex did not come down to New York but decided to come down to Scotland in the intervening two or three years—no one seems to know whether that could happen—we would have a vulnerability, which could be tunnelled through by closing down high-demand consumers. National Grid would probably manage to do that, so the risk for domestic consumers would be very

small. However, the risk is still there, because we are in this inconvenient period in which the interconnector is not large enough to cover fully the missing Longannet.

Longannet's closure was predicted yet, for some reason, it has taken us by surprise. It can be predicted that Peterhead, Hunterston B and Torness A and B will close. Are we going to build more and more wires from south to north to manage the shortfall of electricity supply? How will we balance our renewable generation with the energy storage that we have been talking about for the past hour?

The Convener: In your submission, you say:

"The expected closure of Longannet should alert Scottish Government to its lack of coherent strategy for electricity generation, energy supply and climate ambition delivery in the period post 2020."

Your sense is that we are not thinking enough about what we will do.

Professor Haszeldine: I would like to see a much more coherent plan for how we want to generate our electricity and heat for the central belt and all the rest of Scotland in the next five years, the five years after that and the five years after that. We have a good move towards building lots of renewables facilities—mainly for wind—but that on its own is insufficient to balance the demand, if we are progressively closing all the thermal power generation plants.

The Convener: I know that Patrick Harvie wants to come in. I just want to ask you a question, Mr Toop, given that you are a major user of electricity. What arrangements do you have in place in case of a sudden blackout? How would Scottish Water cope?

Chris Toop: I appreciate the opportunity to give evidence. What prompted our response was a number of the submissions to the committee, particularly from National Grid and SP Transmission. Particularly in the case of a black start, skeleton restoration of the grid in Scotland could take more than 24 hours. In your meeting on 11 March, National Grid stated that

"it might take anything up to 36 hours."—[*Official Report, Economy, Energy and Tourism Committee*, 11 March 2015; c 16.]

However, we heard interesting evidence this morning from Mr Simon Skillings that there is a huge overcapacity out there, which could be easily managed if Longannet were to shut. The committee can understand that, from a large user's perspective, there is some confusion out there.

In response to your question, I understand that the risk is low, but a black start of that extended nature—of, say, 24 or 36 hours—would pose additional challenges for Scottish Water's resilience. We have a range of measures in place; after all, we regularly have power outages at a number of our water treatment works, so we are not unaccustomed to such events. I mentioned standby generators, which, as you would expect, are commonplace at our water treatment works. We store a significant amount of water at those works as well as in the large service reservoirs that are distributed throughout the water distribution network, and another layer below that is our fleet of tankers that can move water from location to location. As it stands, we have a good degree of operational resilience.

However, we are not complacent. We are continuing to carry out detailed assessments and to look at the range of scenarios that were presented by witnesses from whom you took evidence. We take a site-by-site approach and, if we need to top up measures at certain locations, Scottish Water will consider that and do it where necessary. In the meantime, we will continue to drive down and flatten out demand, increase our self-generation and do everything that we can to take our resilience off the grid.

Patrick Harvie: I note that, in the exchange about the lack of coherence or the coherence that is needed in joined-up thinking about what gets built and how the system fits together, all of that was placed at the Scottish Government's door. I am never one to give the Government an easy time when I do not think that it deserves it, but is it not clear that part of the problem is the fragmentation and the lack of coherence in the powers and responsibilities of the Scottish Government, the UK Government, the regulator, the grid and the private sector?

Professor Haszeldine: That is true. I did not mean to place responsibility for delivering all electricity supply at the Scottish Government's door, but it is appropriate for the Scottish Government to have a view on the matter. After all, we are a large region of the UK in the same way as Northern Ireland is, and we are progressively becoming more and more like Northern Ireland, which has no thermal generation left and depends on Scotland for a large part of its electricity supply.

Unless the Scottish Government puts forward a different view and unless thermal power plant with carbon capture and storage facilities or whatever are rebuilt in Scotland, we will end up being supplied for large parts of the year from England through electrical wires. At the moment, the transmission charging regime militates against the rebuilding of thermal power plant in Scotland.

Patrick Harvie: Whether or not that is the solution, the issue is the relationship between the different levels of government.

Professor Haszeldine: That is correct.

The Convener: The final item that we want to discuss is demand-side response and demand reduction.

Johann Lamont: Much of this conversation has been about how we will meet demand, but I would be interested to hear your comments on how demand might change over time. Will there be a significant shift to electric heat and transport and, if so, what impact would that have on the electricity system and what can be done to improve developments in that area? Some people have suggested that folk are not interested at all in such matters, while others have said that they are hugely interested. All I would observe is that over my lifetime people have come to expect a great deal more from electricity than we were allowed to expect in our homes previously. Indeed, our homes would probably be considered stone cold compared with what is considered to be tolerable now. How do you think demand will change, and will there be any unintended consequences of moving to electric transport or whatever?

12:15

Andrew Jones: Today electricity demand stands at 60GW but, according to figures from DECC for the UK meeting its carbon targets by 2050, it wants 110GW of electric transportation and 200GW of heat. In other words, under that scenario, electricity demand will be six times greater than it is today.

By 2050, there will have been a huge change in the way that we do it, which will fundamentally change the way in which people look at electricity and gas. I am in the industry and I dialled in this morning to find that my electricity and gas yesterday came to £2.50. The UK Government is trying to reduce the price spreads, but there are not enough signals to the consumer at the moment to change their demand. Do I want to argue with my wife at 6 o'clock and tell her not to put the dishwasher on in order to save 5p? For some people 5p is important, but for a lot of people it is not.

Government targets are driving us in a certain way and other technologies could come along and change that, but if there is to be a six-times increase in demand for electricity, policies will be needed to decide that. One of the big debates, which is not popular with Governments, is about whether electricity as a commodity is now too cheap for them to get people to change their behaviour because of the way that they look at it. This morning, a Costa coffee cost me more than all my gas and electricity yesterday. As consumers, we weigh up such things daily, and I bet that some people have two or three Costa coffees in a day.

Professor Roaf: Andrew Jones is lucky to be one of the 20 per cent whose standard of living has gone up in the past couple of decades. I, too, am one of the 20 per cent. The other 80 per cent of the population are experiencing a decreasing standard of living. If people think that people are going to be using twice as much energy in a decade or so, they are living off with the fairies. The gap between people's incomes and how much they spend is gradually widening.

In 2007, I was teaching in Arizona when suddenly, overnight, people found that they could pay for their health service, their energy and their gas to get to work but what they could not pay was their mortgage and, within a year, 265,000 people in greater Phoenix had lost their homes. The gap between what people can afford and what they spend is the critical variable.

If people think that those 80 per cent can pay more and use more energy, they are absolutely bang off beam. We must look at decoupling quality of life from the amount of money that is spent on energy. That is the challenge. I think that, by ensuring that people survive okay on less money over time with the same quality of life, we will find ways in which we can use less energy and pay less for it, although big energy does not like the idea of fewer people buying energy or paying less for it. The use of selective tariffs—for example, using a washing machine between certain hours costs half as much—is critical. For a lot of people whom I know, £2.50 a day is a huge amount that they cannot afford. Demand-side management will be critical.

Professor Haszeldine: That is fine, but it does not answer the question. For me, the question is whether we are going to shift from using fossil fuels for our distributed domestic heating and our transport. If we honour our decarbonisation imperatives, we will have to do that, and it is not clear to me how that is going to happen. I see very little analysis of the implications of that for electricity supply and distribution in the UK. I do not have an answer, but I think that it is a really important question.

Mark Crowther: To support what Professor Haszeldine has just said, I would add that that is one of the reasons why DECC is doing its study to compare district heating with electricity and with gas. Particularly if we are going to go down the CCS route—or any other route—it is likely that electricity will become disproportionately more expensive than gas. Gas costs about 4.5p per kWh at the moment; electricity might be 12p or 14p. That is a big ratio.

If we are trying to persuade people, particularly in DECC's all-electrification scenario, to move from gas at 4.5p to electricity at 14p, no one has explained to me how that is supposed to occur. Even if we go down the heat pump route, that is quite a problem because, as they say in the trade, people's boilers work for them but if you have a heat pump, you tend to work for the heat pump, as regards your living characteristics. That is a bit cynical, but heat pumps have to be lived with. Much of this, regrettably, does not solve the problem but I hope that it elucidates the problem a bit.

People often speak highly of smart controls. There was a report last year that talked about huge savings from smart controls. There are sound building physics reasons why those smart controls do not do what they claim they do. The evidence appears to show that smart controls, combined with intelligent metering, might produce about a 4 per cent saving per year. That has been shown in long-term American studies and in Scandinavian studies. There is also the controversial paper by Shipworth and Shipworth, from University College London, which says that the difference between having a few basic controls and the ultimate sophistication is lost in the statistical noise because people cannot use smart controls or get bored with them. Smart controls just do not do what they say on the can.

I am sorry to come back to my hobby horse—hydrogen—but the great advantage of making the transition, as part of the entirety, to hydrogen is that the household only has to stay in for two days. It is just like the transition from town gas to natural gas—you hang about for two days, a guy comes and changes your boiler and changes the gas fire and the job is done. Suddenly, we have zero-carbon fuel in the community. One of the great problems with CHP, for example, is taking natural gas into the community. That is taking more carbon into the community; why would we want to do that, apart from biomass-derived carbon, which is all very difficult to validate? The answers are not easy but I think that they have to be looked at—sorry, I have probably overused this term—in a holistic fashion.

Chris Toop: From Scottish Water's perspective, the cheapest unit of energy is the one that we do not use. There is—and always has been—a programme of energy efficiency. As regards where we see demand going in the water industry as a whole, every water company that I have spoken to has an energy efficiency programme and demand has been falling steadily year on year.

There are lower carbon, lower energy treatment technologies out there, including some really quite exciting ones that could reduce energy quite considerably at some of our waste water treatment works, so we have made some good progress. However, there are challenges with the demand-side response, which is the other part of the question. We have been participating in one initiative in particular that shifts demand quite successfully—where we have to use demand—to cheaper tariff periods or to lower demand periods. However, we need to know that the other initiatives that are out there will be around for a reasonable period of time to make them worth investing in, and that the benefits will be there for customers for a few years to come.

Johann Lamont: It seems as though there are two separate points. There is a dilemma when it comes to using price as a means of reducing demand, in that people who are in fuel poverty are in fact rationing demand themselves by simply switching off. How do we address that while also recognising that, for good reasons, we are moving to electricity in order to save the planet? People's shopping habits have transformed in the past 10 years. People use big discount stores in a way that we would never have imagined simply because they have been persuaded that it matters to them. Similarly, we may have to find a way of addressing the issue of those who are rationing their own electricity because of their income as measured against the other consequence of making good choices around travelling and heat.

Professor Roaf: There is only one energy source that takes people out of fuel poverty and that is the energy source that they own themselves so they do not have to buy energy.

For Scotland, putting systematic solar hot water and photovoltaics on the roofs of the social housing would take those people out of fuel poverty forever. As regards electric cars, I drove an electric car from 1994 onwards, which was run with a solar roof and with a Tesla Powerwall battery. I used public transport for long distance, but I could almost do my entire local shopping using an electric car with a solar roof.

The Convener: Okay. We are almost out of time. Richard Lyle, did you want to comment?

Richard Lyle (Central Scotland) (SNP): First, I apologise to the witnesses and to you, convener, because I had to go to another committee to speak to an amendment to a bill.

I was interested in Professor Roaf's comments. Last week I suggested that new houses should all have solar roofs. Councils that are doing upgrades and which, for years, have done roughcasting and put in new windows and so on, should put on solar roofs as a next step. We should reduce the cost of some of the bulbs, which cost a fiver. You mentioned Shettleston and Springburn. In Springburn, wind turbines were put on the side of

some of the houses a number of years ago. That did not take off, but people are paying lower rent.

We are being asked by uSwitch.com and other companies to do things such as change tariffs and our electricity supplier. How do we ensure adequate communication to allow for a successful roll-out of smart metering and tariffs, and consumer buy-in? Is it worth moving from one supplier to another?

The Convener: Hold that thought for a second.

Lewis Macdonald: Following on from that, at least in part, what about opportunities that must exist at distribution network level and improvements in efficiency? For example, at the moment National Grid will agree a contract only with a supplier who is supplying at least 10MW of power. There might be potential for a collection of smaller producers or self-generators to feed into the grid. Should something be done at this stage to enable that, so as to improve the efficiency of production and supply?

The Convener: Thank you. Hold that thought, too.

Patrick Harvie: Many of the arguments about energy affordability and inequality that Professor Roaf was talking about already apply to transport, and to a transport justice agenda that is not being addressed. If we end up electrifying a lot more of the transport network, is the energy sector ready to start talking about transport policy and transport demand management as part of an energy demand response?

The Convener: Okay. Those were three disparate points. Perhaps we could have fairly brief responses to any or all of them—as many as you would like. Who would like to start?

Professor Haszeldine: I will answer just one or two points, because I am not an expert on the others.

On aggregating small suppliers, I do not know technically whether that possibility exists but I have certainly seen research proposals and evaluated small business propositions where people are trying to aggregate community solar power, for example, to sell into the grid. Mobile phone technology is the enabling platform for that, and it is a useful and forward-looking approach. We should be trying to roll out and encourage that in Scotland. All those innovations were in England, unfortunately, and we should encourage people to innovate such things in Scotland.

As a consumer, I look at supplier switching and it is just too complicated. I cannot understand what I am getting for my money, so I have not bothered. That is my citizen answer.

Mark Crowther: I still have a problem with the scale of solar panels and some of the roll-outs. We are unlikely ever to get as much electricity out of solar PV to be a net exporter of electricity; that comes in only at noon during the summer months. That is perhaps 3,000kWh a year, and a typical Scottish house might use 16,000 to 18,000kWh for heating. There is a mismatch with the sheer amount of energy that is required to heat a house. Insulation is very difficult. The average cavity wall insulation programme in the UK saves only about 1,200kWh a year. That is a DECC figure, and it is far less than theory would have.

Regrettably, many of those energy-saving programmes do not do what it says on the box. We have to address the problems—using a certain amount of heavy engineering, unfortunately—with electricity and hydrogen. I agree that that should be done holistically, but we will not get there just by sticking a solar panel on a roof.

12:30

The Convener: Professor Roaf, do you want to come in? The answer is not solar panels.

Professor Roaf: No—I think that the answer is to get your wives to pay the energy bills.

Members: Oh!

Professor Roaf: You are all saying that—just imagine the pain there.

We are talking about 18,000kWh a year, and a fairly chronic building stock. Fundamentally, we are moving to a new generation of slightly overglazed, modern buildings that are lightweight with no thermal storage.

Scotland has to ensure that the building stock that it owns is part of its resilience. We have to redesign, and push buildings towards being sensibly glazed with not too much overheating, with sensible mass and with a nice hot water tank. Even if someone is older and cannot pay their bills—our ageing population is a problem—at least they will not die of hypothermia if their house has some thermal storage.

The DNO's role must be investigated carefully, because there is an entrenched conflict of interest. One arm of an industry is telling people that they cannot connect to the grid because it is not technically feasible or because it is inconvenient for their business model. There will probably be a lot of scrutiny of the DNO's role.

The Convener: Can you tell us what a DNO is?

Professor Roaf: It is a distribution network operator. At present, for instance, if someone wants to install a solar panel on the barns on their farm, they have to ask the DNO for permission, and the DNO might say, "Oh—sorry, we really

cannot do that." Basically, the DNOs have too much power and they are too closely linked to the other side of the industry.

Andrew Jones: I have a couple of comments. On the aggregator point, such a mechanism actually exists at present. DECC is working to encourage a market mechanism whereby small householders will be allowed to participate, and that work is on-going.

Picking up on the point about distribution network operators, the view from DECC and Ofgem is that, at the end of the current regulatory review in 2023, the DNOs will become system operators. That will diminish their role with National Grid because they will have to balance locally, so there will be requirements.

Picking up on the previous comment, we can debate whether DNOs are proactive in connecting, but unfortunately the regulations that Ofgem has set down say that there is only a certain amount of money that DNOs get for connecting. Unless somebody changes those rules—and such a change would usually come from Government—we are stuck with them. A Government change would be needed if we really want to connect more solar to the grid.

The Convener: Mr Toop, do you want to add anything?

Chris Toop: Just a brief point—I want to reinforce the message about smart metering and simple tariffs. Pretty much all our consuming assets—around 4,000 of them—have smart meters. We were probably the first in the water industry to roll that out. We have three simple tariffs for the cost of electricity, which is hugely empowering and provides visible performance for our front-line operators, who can see immediately the effect of changing the way in which we operate our assets and of putting more energy-efficient practices in place.

Likewise, we can measure accurately the benefits of the photovoltaic systems that we have been rolling out alongside small-scale wind turbines at our sites. The message should be to keep it simple in terms of the number of tariffs and to use smart meters, which are helping us to get a grip on our costs and thereby reduce them.

The Convener: We are slightly over time, but I am very grateful to you all for coming along and giving evidence. The session has been lively, and we appreciate your input. We now move into private session.

12:34

Meeting continued in private until 12:50.

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e-format first available
ISBN 978-1-78568-668-9

Revised e-format available
ISBN 978-1-78568-686-3

Printed in Scotland by APS Group Scotland