



## Energy and Climate Change Committee

Oral evidence: [Low Carbon Network Infrastructure, HC 613](#)

Tuesday 15 December 2015

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Members present: Mr Angus Brendan MacNeil (Chair), Rushanara Ali, Mr Alistair Carmichael, Glyn Davies, James Heapey, Matthew Pennycook, Antoinette Sandbach, Julian Sturdy

Questions 1 - 30

Witnesses: **Chris Morrison**, Head of Energy Construction Services, Distributed Energy and Power, Centrica, and **Scott Mathieson**, Director, Network Planning and Regulation, Scottish Power Energy Networks, gave evidence.

**Q1 Chair: Chair:** I welcome the next witnesses. If you could state your name and organisation for the record. I apologise for the late start. The last session overran for various reasons.

**Scott Mathieson:** Good morning, Chair. My name is Scott Mathieson. I am the Network Planning and Regulation Director for Scottish Power Energy Networks.

**Chris Morrison:** Good morning, Chair. I am Chris Morrison. I am the Head of Energy Construction Services within the Distributed Energy and Power business unit of Centrica.

**Q2 Chair:** Thank you very much. This inquiry is intended to consider the long-term future of the UK's network infrastructure. Network infrastructure is considered on very long timescales indeed. How important is it, therefore, to understand long-term trends in energy demand?

**Scott Mathieson:** If I may answer first, it is absolutely critical. We are planning to build assets on our network that will be there for anything up to 100 years. If you look at the current asset turnover rate of our assets, it has been 0.5% per annum up to about 2% per annum, so anywhere between 200 and 50 years, 100 years on average. Therefore, the decisions that we are taking now with respect to what we are installing on the network, its functionality and its capability must be planned over very long periods of time and take into consideration trends going forward. A very keen focus of the last two major infrastructure price control reviews, in both transmission and distribution, was the trends in growth in renewable generation but also the switch to areas like electricity for heating to

replace gas heating and perhaps trends in electric vehicles. In conjunction with the regulator and DECC, those trends are annually revisited and considered as part of the ongoing development of our investment plans.

**Chris Morrison:** If I may add to that, it is at a critical time that this Committee meets and looks at this issue. The networks we have in this country are currently fit for purpose but we are heading into a time over the next five to 10 years where we are going to see a very large increase in the amount of distributed generation and with that distributed generation, particularly with renewables, we will see a large increase in the intermittency of supply. To address that supply at the network level we will need to come up with new solutions, both in the network and particularly behind the meter for customers, in order to deal with distributed generation and the challenges that brings to the network.

**Q3 Chair:** Do you expect energy demand to rise, fall or remain flat over the coming years and decades in the UK?

**Scott Mathieson:** From 2009, the collapse of the Lehmans Bank, right up to date there has been about a 1% to 2% reduction in demand. The work that we have done with the future energy scenarios shows that that begins to flatten out over the period between now and 2023 and gradually, with the switch towards potential electric vehicles or electric heating, demand begins to increase by about 1% to 2% per annum. With scenarios there is always a high, low or medium, but whichever of those scenarios you look at they all show a trend towards increasing electricity demand.

**Q4 Chair:** I have been told that the heat demand in the UK can be between 20 gigawatts and 400 gigawatts but the power demand is somewhere between 20 gigawatts and 50 gigawatts with a generational capacity of up to 80 gigawatts. Electricity really can't do the replacement for heat fully, can it, because the peak demands are just so high?

**Chris Morrison:** As Scott said, the consumption of gas has gone down over the last years since the banking crisis and also in particular because of schemes such as CERT and ECO, which have done a lot to insulate consumers' homes and reduce their bills overall. We would expect an increasing trend in energy efficiency of UK homes and also businesses. Critically, the area that we work in is focused on increasing the energy efficiency of industrial and commercial customers through industrial processes, lighting, other forms of energy efficiency. While I know that many of the studies show that electricity consumption looks to be increasing over time, I think that is far from a certain outcome given the advances we are seeing in the number of energy efficiency technologies, in motor drives, LED lighting and so on.

**Q5 Chair:** What is going to need to happen to networks, given what you think will happen to electricity demand?

**Scott Mathieson:** My colleague mentioned the challenge that we are facing. Since about 2001, 2003, particularly on transmission and in Scotland we have faced the challenge of connecting renewables on constrained grids. If you look at our company in particular, we have about 14% of the UK's demand and we have connected somewhere around 30% of the UK's renewables to our grid. For example in Dumfries and Galloway, where we have a max demand on the network in that area of about 180 megawatts, we have connected 310 megawatts of renewables. We serve north Wales and mid Wales and we have a

system max demand there of about 0.7 gigawatts. We have connected about the same amount in renewable generation and about another 0.1 gigawatts in photovoltaics in those areas.

The challenge that we see going forward is that the networks were originally built for uni-directional flows, they were built on the basis of certain design standards that effectively you built them efficiently and you left them there. Now what we are seeing is much more active reverse power flows on to the grid, whatever scale of generation those connecting to the grid want to export back on to that grid in order to realise economic value from their investments. That has been a huge challenge in Scotland in particular because when you aggregate the connected distributed generation across the GSPs, the interface with the transmission system, we see points in time where we are exporting significant amounts back on to transmission. National Grid said that in Scotland over about the last 12-month period there was somewhere between 1.5 gigawatts to 2 gigawatts of what they call disappearing demand, in other words distributed generation exporting on to the National Grid. So that is the big challenge.

**Chris Morrison:** We would echo that. While we are a big supporter of renewables—we have offshore wind and we have also been developing significant amounts of solar PV—when we generate renewables and store renewables for solar PV our focus has been for customers. It is connecting on rooftops or on land next to customers' sites and the focus of those customers is to maximise the onsite consumption of the electricity that they generate and minimise the amount of export. I think that will reduce pressure on grid and it is certainly part of the systems that we seek to design. In addition, as the previous panellists mentioned, we see a huge opportunity for energy storage, particularly through batteries, and that could be applied to both solar PV and wind.

**Q6 Chair:** There is a huge challenge when there is an energy resource in the Scottish Islands, for example, the big wind resources that you just can't get to. Is there any way you can see that that is going to change?

**Chris Morrison:** We do see an opportunity for islands to develop energy storage so they can maximise the use of the wind that is generated on their sites and minimise the amount of import they have to take from the mainland. We are starting to see examples throughout the world, in Greece, Hawaii and other places, where battery technology has taken significant steps forward and, more importantly, reduced the cost of battery technology so that island communities can benefit from the wind and solar that they generate themselves.

**Q7 Julian Sturdy:** Just on that point, you talked about the importance of energy storage. Do you think the Government are prioritising energy storage enough at the moment?

**Chris Morrison:** We have had a number of discussions with Government on energy storage. It is clearly an evolving technology and there are a number of different options. Lithium-ion is a particularly interesting option at the moment and the price of batteries is coming down very rapidly, initially through computers and mobile phones and now increasingly through electric vehicles, and we are starting to see a huge increase in capacity. That increase in capacity of supply for batteries will lead to significant reductions in cost and we are already starting to see costs fall very quickly on batteries. The market for battery storage is evolving. It is evolving initially in enhanced frequency response, which addresses very short-term balancing requirements from the National Grid.

But more importantly now, we believe that we will start to see battery storage become a commercial option for our customers in the next year. We are already talking to customers about installing battery systems connected to their solar PV rooftop or ground-mounted systems next to their factories. Water companies, for example—

**Q8 Julian Sturdy:** Sorry to interrupt. You are saying the market is moving that way and is driving the technology, but my question was about, to put it a different way, the Government's strategy on energy storage. Are you feeding into that? Do you think the Government have the right strategy on energy storage?

**Chris Morrison:** The one thing that we have asked the Government to support on battery storage is to allow batteries to be put on the list for enhanced capital allowances. This would give a one-year tax relief of 100% of the corporate tax rate for the investment in battery storage. While not reducing the tax take over the lifetime of the installation for the Government, it would increase the investment returns for companies to invest in battery storage. It would be a big boost for investment if we can get the battery technologies on to the enhanced capital allowance list.

**Scott Mathieson:** I think there are other jurisdictions you could look at, particularly in America, in California, Pennsylvania and Jersey, where there are mechanisms put in place to look at installing storage within distribution grids to help provide frequency control but also to help manage load overall. There has been work on developing the regulatory mechanisms that are required to be put in place. There are targets for the level of storage that needs to be put in place in those jurisdictions as well. I don't think we have quite seen that coming forward.

**Q9 James Heappey:** Talking about domestic batteries within a year, which is great, but are immersion heaters and being able to store heat not a more readily available technology and therefore a quicker win?

**Scott Mathieson:** And more cost effective potentially too, yes.

**James Heappey:** Yes.

**Chris Morrison:** They are able to store sufficient amounts of power, but immersion heaters are already used for storing electricity through heat. I don't think they are necessarily as thermodynamically efficient but they may be more cost efficient at the moment. I was talking in particular about battery storage for industrial and commercial users, who are our main clients.

**Q10 James Heappey:** If we move on to talk briefly about intermittency, the proportion of electricity generated by wind and solar has quadrupled in the last five years. What challenge does this currently present to your networks?

**Scott Mathieson:** It presents a very significant challenge for us. I heard the NISM being quoted the other day and I think there was about 48 gigawatts of peak demand on that day, 3 November, 4 November. If you look back 10 years, that is not particular high peak demand on that day. There was zero wind across the UK. There was a relatively small plant, 500 megawatts out, that created quite a difficult circumstance for National Grid. I know they have presented evidence. They did very well on the day. Everything was being looked at, the distribution businesses were contacted. A 3% voltage reduction that we can

provide at distribution level equates to about a 1.5% reduction in demand. That is a very quick service that can be played back in to support the National Grid. But it is clear that that is a big challenge for us to manage, particularly with a much smaller margin overall on the grid and that cascades all the way down from transmission into the distribution system as you go through more embedded small scale generation. The problem transfers across the voltage levels.

I have to say that it is not just about the intermittent nature of the generation. It is also that with a much smaller margin you are relying much more heavily on the networks, the systems and the generation that is connected and their performance matters as well. We went a week or so forward and there was a problem on the interconnectors, a relatively minor fault with a disconnector but it meant that 800 megawatts of renewable generation couldn't get into the market in England and Wales just a week later. We managed to get that sorted out but the transmission interconnector with France went out, which is now one of the key components of the system for providing that balance in supply. This is a much more complex equation with much smaller margins that is trying to be balanced out across every voltage level of the system.

**Q11 James Heapey:** The written evidence that the Committee has received has effectively suggested four solutions to intermittency: storage, which we have already spoken about this morning and is the obvious one; demand side response and smart metering and generally being able to understand what is required from consumers; greater interconnection, although that also comes with challenges, particularly over the way that National Grid manages that; and better wind forecasting and better meteorological forecasting, full stop, I guess, in order to handle both wind and solar. Presumably you agree with those four but is there a fifth? When the Committee went to National Grid recently, it was somewhat surprising to see how little Grid was able to understand in real time of what was being generated and used in small scale solar installations. What are your comments on those five areas in which we could tackle intermittency?

**Scott Mathieson:** That is the five areas and perhaps the most exciting area is the latter one that you mentioned. What are we trying to do? We can bring down the average and the marginal cost to the consumer of using the grid. The way that we can do that is by better understanding both the performance of what is connected to the grid and how closely we are operating to the physical limitations of the grid. All of those five dimensions play together but the latter is the one that allows you the greatest picture to exploit the maximum opportunity available, on the LV network directly connected to the domestic customers all the way up into the transmission system.

For the last six or seven years that has been one of the key focus areas for our company in particular with the big challenge in renewables. We have our grid supply point at Dunbar that was potentially triggering a major reinforcement on the transmission system and through active network management, Accelerating Renewables was able to connect about 60 megawatts to that area. We were also able to connect and facilitate about 2.2 megawatts of photovoltaics, equivalent to about 750 homes in the Berwickshire area, through effectively investing in protection and control equipment that gave us in real time more information about how the assets were performing and the generation was operating within that area. That is the bit that allows us to get more parties participating within the

market and bring down the average and marginal costs and operate the assets to their fullest.

**Q12 James Heappey:** It begs the question: how well are National Grid and the distribution companies doing at developing the technology and installing it into their network so that they can achieve that real time granularity of generation and consumption?

**Scott Mathieson:** The ARC project that I just mentioned allowed us to be awarded the smart utility of the year. VISOR is another project. For small hundreds of thousands of pounds, they are saving literally millions. The ARC project cost about £800,000 and saved about £6.2 million. Avoided reinforcement was about £20 million as well from that.

**James Heappey:** We need to get Mr Kazim back with returns on investment like that.

**Chris Morrison:** It is absolutely right that innovation is critical for how we address the challenges facing the grid. We need to see an open and competitive market to allow all players, not only network operators but suppliers, aggregators and entrepreneurs, to come into the market and bring innovation, not only innovation of technology but innovation of business models too, in order to bring the overall costs of this infrastructure development down.

**Scott Mathieson:** We are very keen to do that as well. One of the important principles of the low carbon network funds that have been available is that all of the evidence that we produce as part of these studies is made available to all parties, all the other network operators and any third party that is directly interested. It has to be published and it has to be shared.

**Q13 Antoinette Sandbach:** I wanted to come back on that, because you said you are very keen to support that small scale connection to the grid. My experience with Scottish Power has been completely different in north Wales where it looked like there were incentives for people not to connect to the grid because the cost of good connection over relatively short distances was prohibitive and effectively stopped that kind of connection and generation going ahead.

**Scott Mathieson:** The two areas that I have quoted, two of the rural areas that are often the richest in the renewable resource potentially, also have very little grid. To connect the developers we have to extend out the grid and you get to the question as to who should bear the cost, the party who is potentially looking for access to the grid or the wider public who are benefiting from the grid. That is the optimisation problem. I am not aware of those specific circumstances but what I can say is that for the Welsh grid in particular, for a system max demand of 0.7 gigawatts, we have connected the same and equivalent in both renewables and photovoltaics. Do we get it right in every circumstance? Absolutely not. Can we always do better? Absolutely. But in that particular grid we have matched, effectively, the demand within the area, which is a significant achievement. Our colleagues in the south-east of the nation at the moment are only beginning to see this challenge. This is something that we have been living with for a long period. In Dumfries and Galloway, for a maximum demand of 180 megawatts we have connected 310 megawatts.

But there comes the point where you do trigger investment and in mid Wales in particular we have a big challenge of extending the National Grid, the transmission system, for about 600 to 700 megawatts of renewable wind farm resource in the area just because there is no grid in that location.

**Q14 Antoinette Sandbach:** But you get substantial subsidy in effect from consumers' bills to help support that network and make sure that—have I got that—

**Scott Mathieson:** No. In distribution, our rate of return is below 4% overall for our business. Our costs are stringently looked at. They are benchmarked to the upper quartile at the process of the price control review. They are challenged by the regulator annually. We submit 300 tables of data to the regulator for them to review our unit costs. They are challenged and they are also determinable. If a connected party is unhappy with the costs they are seeing, they can take those to the regulator. We would rather avoid that. We don't want to be in that sort of position. But there are not direct subsidies in any way within the networks business. The networks business is about 14% of the end energy bill, 30 pence a day in distribution and, if you take transmission on board, probably about 40 pence.

**Q15 Rushanara Ali:** I want to turn to grid connections. Mr Mathieson, your company has said that the continuous growth in volume of connection requests from wind and solar generators over the past decade have highlighted that. What impact has that had on your business?

**Scott Mathieson:** It has had a huge impact on the business. I can go back to about 2003 where we pushed forward, with support from the regulator and Government, a study called the Renewable Energy Transmission Study, and that was mainly transmission, and looked at the challenge of connecting large scales of renewables. We went from having, at that time, something like one to three applications per annum up to about 30 applications per day for access to the grid. From about 2003 onwards we have been on this journey all the way from our transmission system down into our distribution. Where it has impacted is threefold. First of all, we have to look at, study and understand our network a lot better and publish more information on that. We publish sheet maps on the grid, where to connect, where reinforcement is going to be triggered and therefore will be more costly to connect into that area. We have also had to look at helping facilitate competition within our areas, particularly at distribution level. We publish what we call a dual offer option for customers at distribution whereby you get two versions of an offer, one that you can take to an independent connection party or independent connection provider or what we call the licence quote, what we would price to connect, within a letter. We have looked at innovation—

**Q16 Antoinette Sandbach:** Can I interrupt there? Is that a relatively new innovation?

**Scott Mathieson:** That has been in place for the last 18 months for customers fully and we invested in IT to be able to deliver that. The heat maps that give the signal where to connect within our grid have been in place for about the last eight years, so it has been a continuous journey. Up to date it has caused us to invest in technology and look at reducing the marginal cost of connecting to the grid. The ARC project is one that I mentioned. We also have a transmission project, VISOR, that allow us to look in real time

at how the system is performing. It cost about £800,000 and its payback period was one day in terms of reduced constraint costs.

**Q17 Rushanara Ali:** There is still a substantial backlog. Could you say a bit more about that and how confident we should be that these changes and adjustments will have the effect of reducing the backlog?

**Scott Mathieson:** The substantial backlog is beyond the point where we can really optimise the solutions of the headroom and the grid. The big backlog for example in the transmission system in Scotland, which we were referring to, is the fact that we are waiting on reinforcements happening within the National Grid. To reinforce the network you have to take it out of service and that increases the overall level of constraints. You are always trying to balance the equation between cost of curtailment against the value of the generation that they can provide within the market.

**Chris Morrison:** If you look at these additional costs that are being incurred, as Scott has repeatedly said, there is generation where there is not demand. I think it brings us back to the need to focus on the point that we need to generate where there is demand, so generate behind the meter for customers. We need to look, as James said, at demand side response, and we need to look at battery storage and energy efficiency as well. These are the measures that are going to be the most cost effective that will enable us to reduce the overall cost of investment on the grid over time.

**Scott Mathieson:** It is definitely part of the toolkit.

**Q18 Rushanara Ali:** Do you have other suggestions of what networks can do better in managing connection queues?

**Scott Mathieson:** The key area for us to focus on is understanding the grid and how much we can get on in real time. We have a grid now and we have a grid that we need to invest in to improve. In electrical engineering, you are challenged by the thermal limitations of the grid, the fault level and the voltage impacts. That is what we are trying to balance in real time impacts. We are trying to move in the world from a set of design assumptions about that network to real time information that allows us to balance it most effectively and maximise it at any point in time. For example, on thermal ratings an overhead line will be designed based on a certain average temperature over the course of the year. Wherever you operate in Scotland and Wales it tends to be below that average temperature for significant parts of the day and year and therefore we can get more capacity out of that network. The more that we know the more we can utilise it and make it available to all parties, whether those are small scale storage players, domestic players who are looking to also export on to the grid. There is always this sort of drive as we connect more to replace the large scale generation at the distribution level.

There will be an impact on reinforcement, there will be a need for increased investment, but we have been successful about ameliorating some of the impact of that on customers. On ED1, which runs from 1 April this year to 2023, so an eight-year price control, the big challenge was exactly this: how do we get more renewables connected to the grid? How do we invest in a 60 to 100-year asset and how do we reduce the cost to customers? The investors looked at bolstering the increasing investment with other savings, for example the application of smart technology. They also accepted recovering their investment over a

45-year window, so effectively for every £100 they recover £2.20 per annum, a return of around about 3.6%, 3.7% in a heavily regulated industry. In one area specifically, despite increasing underlying investment in the grid, the use of system charges came down by 18%.

I think the challenge for us is to continue to look at how we get more marginal value out of every pound that we invest in the grid and we evolve towards being a distribution system operator that has the capability and the intelligence to understand every unit within the grid and the impact it is having. Also we have big challenges as a grid operator ensuring quality of service, security of service resilience during the severe weather events that we are seeing more and more.

**Q19 Rushanara Ali:** I have a final question about the first come first served rule for dealing with connection requests. Do you think that is an adequate way of dealing with demand or is it problematic? What would be your recommendation if there were to be any changes to that?

**Scott Mathieson:** It is problematic. One of the things to remember is that the electricity connection charging regulations also allow for second comers. If a first comer comes and triggers a reinforcement, one of the big impacts is that, despite them having a small proportion of that reinforcement, there will be a significant proportion of the cost of that reinforcement. The rules have been set up to ensure that what we are doing with the connection charge is not subsidising the cost from the wider customer base. You look at if there is a fair principle there. But the rules allow for up to five to six years for a second and third comer to bear some proportion of those costs too. Effectively, we have the right to be able to credit that first party for some of the economic impact on them if a second or third comer comes along.

I think the whole area at the moment that does need to be looked at—there is a lot being done in technology—is how codes operate, how charging operates. One of the big challenges for us is the charging methodologies in distribution and transmission. Transmission has developed much more, but certainly in distribution they are not dramatically different from what we had at privatisation. If you are balancing the system effectively, that is one of the key areas that needs to be looked at.

**Chris Morrison:** We would echo that. There needs to be some sort of cost reflection of the charges to the grid. That cost reflective charging to the network through connections and use would then encourage the right market signals and the most cost effective investment in the right technologies that will allow us to have a modern, smarter grid.

**Scott Mathieson:** There are strange anachronisms in the codes as well. For example, a distribution business that is ideally placed to understand the impact that battery storage, perhaps at a primary or a secondary substation, could have in a local domestic area and that that can't go in the battery because you need to have a generating licence and we are prohibited to do so at the moment. That is one of the barriers that seems to have been dealt with in regulatory mechanisms in the US. It is a key area that needs to be looked at, along with the technological innovation as well.

**Q20 Matthew Pennycook:** I wanted to press you a bit further on the impact of distributed generation on yourselves and on other actors and what DNOs can expect in the future, what your expectations are. I know colleagues are going to come in on this as well. First, to get a

sense of how much we can expect to be generated in this area over the coming years, National Grid estimate 18 gigawatts by 2020. Is that a realistic expectation?

**Chris Morrison:** I think we have all been surprised at the amount of solar PV that has been installed over the last five years. It is up to 10 gigawatts now, which is well in excess of expectations, and that is increasingly cost effective to install. We are also seeing an increase in other generation behind the meter. There is some use of diesel backup but also looking at efficient gas generation behind the meter and biogas and other forms of generation. I think that distributed generation is important. To broaden out and look at where we can shift energy usage is equally important, whether that is energy efficiency through a variety of measures or whether it is using technologies to shift demand away from peak times for the avoidance of use of power and the need for new peaking plants. That shifting can either be done by intelligent use of motors turning down power, the demand side response side, or it can be done through load shifting with energy storage and solar PV systems. I think that is going to be a critical path for use avoidance.

I talk a lot about the industrial and commercial side of this, which is the present opportunity. As we see the smart grid roll out over the next five years, by 2020 when every consumer has a smart grid, the networks and the suppliers are able to understand exactly the usage for every half hour of electricity and gas. It allows our consumers to become empowered and take more control of their consumption. We did the trial that was funded through the low carbon network fund recently and that looked at installing 600 smart meters and encouraging consumers to shift their consumption. Overall that will let consumers save around 10% of their consumption at peak times. I think if you expanded that out it would be the equivalent of two CCGT gas turbines being used in the whole of the UK. Significant benefits will come through the use of smart meters as the technology rolls out.

**Q21 Matthew Pennycook:** A question specifically for Mr Morrison. British Gas has told the Committee that it is committed to prioritising investment in distributed energy and heating systems. You have touched on some of this, but could you expand a bit more on what you are doing in that area?

**Chris Morrison:** Yes, absolutely. Most of the points that the Committee has talked about is really where our strategy is focused, which is on serving our customers. Our customers' needs will change over time as we see more intermittency, more renewables. That intermittency and the strains that we are seeing on the network are increasing costs at certain times of the day in particular and our customers are seeing increased charges. We work behind the meter, as we call it, with our customers. Anything we can do behind the meter to manage their costs, to reduce their costs at those peak times when costs are so expensive, particularly the period of 4.00 pm to 7.00 pm, will help our customers save significant amounts of money. Our focus is moving away as a highly competitive electricity market for business customers. Our customers can save a very small amount by buying from different people but they can save significant amounts by introducing energy efficiency and managing when they use power.

We are doing a wide range of things with energy efficiency. We are working with the likes of St Thomas' Hospital to install new combined heat and power boilers to save costs on the heating bills and generate electricity at the same time. We install energy management systems to a wide range of buildings, which allows the consumer to understand the use of

their HVAC systems and be able to remotely turn them on and off as required. Then looking at onsite generation such as solar PV is a major one but also looking at other forms of onsite generation such as CHP, combined heat and power, and increasingly going towards battery storage and other new technologies as well.

**Q22 Matthew Pennycook:** What do district heating schemes change for gas transmission in distribution networks?

**Chris Morrison:** We have installed district heating for over 7,500 customers. These customers have typically been in high rise tower blocks, over 95% of them, typically in areas of fuel poverty. The majority of those systems have been run on biomass boilers, woodchip or wood pellet boilers. Maybe a heat network will cover four or five tower blocks in some examples and it enables them to reduce the dependency on the gas grid as well. It is worth noting that there is talk of electric vehicles coming on and increasing electricity demand and air source heat pumps and the like increasing heating demand from electricity. But we will also see significant opportunity for things like micro CHP, which is household level combined heat and power, so when you are heating your home you are also generating your electricity, and things called gas absorption heat pumps, which are gas-powered heat pumps, essentially, and could be more efficient than air source heat pumps for consumers. We are looking at a wide range of technologies at the residential and the industrial level.

**Q23 Matthew Pennycook:** The other main question I wanted to focus on was distribution system operators, which many DNOs have called for. What is the rationale for that and would it cover both transmission and distribution? Would it be a single operator or is there a logic for two?

**Scott Mathieson:** The GBSO evolved from the transmission business originally within National Grid to move out, and there is a good reason for that. It is because the commodity is the network itself. In my evidence today I have tried to emphasise that the most efficient use of the network is what yields the lowest cost to the end consumer. There are lots of third parties who can also participate within the market, but what you are trying to do is balance the physical impact of how you utilise the network. I think there is a system that could be developed very effectively with a small number, either the groups or the 14 licences, of distribution network operators evolving to be a system operator. Again, it comes back to the priorities. You need to balance fault level, the voltage impact, you need to understand the network thermally to get the most out of it, but also ensuring that you do maintain the quality of service. Some of the impacts of, say, voltage reduction schemes can impact the quality of service. That has real impact on manufacturers, vehicle manufacturers for example that we have at Ellesmere Port within our patch. We need to understand how that works electrically.

The big area that needs to be looked at is the economic development of that and the pricing signals. I think there is also a good opportunity for the distribution system operator and the network operator who is working in the grid to be unbiased with respect to how it works with other market participants. Do I see the DSO owning all of the storage? No. Do I see them owning or operating all of the demand side reduction products that might be available within the market? Absolutely not, but they are ideally and optimally placed to ensure that none of the actions taken at markets adversely impact the physically connected customers to our grids.

**Chris Morrison:** I would agree with Mr Mathieson. We are seeing increasing need as we see distributed generation and energy flows both ways for the DSOs. We think it is vital, though, that the DNO and the DSO would be a monopoly provider in a certain area and, while they would be procuring solutions for flexibility and management of the grid, it is important that we have an open and competitive framework that allows everyone to participate in the procurement of those services. Our view is that the DSO should not have a direct customer relationship.

**Q24 Matthew Pennycook:** Say Government went down that route, how would those DSOs co-ordinate or interact with National Grid?

**Scott Mathieson:** They effectively do at the moment. They don't do it at such a sophisticated level but the prime example is the one I talked about earlier. At the time of the NISM on 3 and 4 November, each of the control rooms of the distribution network operators were contacted by National Grid to say that they may have to take action to put us on standby. If you look at the market mechanism on that day, I think Grid had the market response of about 40 megawatts of demand side management. Very quickly, should we have needed it, a 3% reduction in voltage from the control room of the network operator would have yielded a 1.5% reduction in demand on the day. Those mechanisms are already there and established with codes, practices and procedures, but they need to be updated for the world that we are moving into.

**Q25 Antoinette Sandbach:** I wanted to come in again on the district heating idea. There is quite a lot of evidence in front of the Committee that people in urban populations do better in terms of they have lower connection costs because the distances are shorter. Rural customers can't access dual fuel arrangements because there is no gas network for them to connect to. What are you doing to look at fairness in your systems to make sure that in this new world of distributed generation rural consumers are not paying higher prices and are not discriminated against with connection costs because distances tend to be greater.

**Chris Morrison:** You are absolutely right. The examples I gave often have been done in urban areas of fuel poverty where you have high rise and you have short runs, because the most expensive part is running the heat network. In rural areas where you may have a village with smaller houses it would be difficult to get the economies of scale for a district heating network, typically. This is where a number of factors would help. One of them is the current ECO scheme with a rural focus in terms of energy efficiency, and that has to be the first thing to consider for rural customers. The other point from an electricity perspective is that as we move to smart grids it will allow customers eventually to choose when to use their electricity at the most cost effective time. We are already starting to see that in some of our trials.

**Q26 Antoinette Sandbach:** For Scottish Power, in terms of connection?

**Scott Mathieson:** I think it is a constant challenge for the cost reflectivity. What we are charging for is the physical assets that we have to install to get to the rural customer and the question is the balance between who should bear that cost. Should it be socialised more widely as it provides a benefit and it may lead to better diffusion of the population? I think this is an area, to be honest, where we do need more support. It needs to be looked at more strongly. Within the context of price controls, what we have tried to do is to create mechanisms within the use of system mechanism that allow us to build grid towards areas

of the rural network least well served. Strengthening of the grid will have a benefit for customers in that area. One of the other things that we are trying to do as we try to develop a vision towards being a DSO is looking at what we can do in different classes of community. In Scotland, where we are, you have Glasgow or Edinburgh. You also have Stirling, which is a mixed rural and urban environment, and you have Lockerbie, which is a commuter base, rural agricultural base that does not have Wi-Fi, it does not have gas grids and it depends on the electrical system. We are trying to look at what we can do within each of those specific and different environments. We don't have all the answers at the moment. It is a key area that we do need to focus on, but it comes back to the tension between socialisation of costs generally on the wider customer base against the cost reflectivity. At the moment the model is cost reflective.

**Q27 James Heappey:** British Gas told us that network costs account for just shy of 25% of an average dual fuel bill but that, worryingly, that cost has gone up by about 30% over the last four years. Could you explain why, in your view, that has happened?

**Scott Mathieson:** If I can answer first of all on electricity specifically, it is about 14% or 15% for distribution and it is about 5% for transmission.

**James Heappey:** That does not tally with the numbers we have.

**Scott Mathieson:** That is based on Ofgem's own published numbers recently, within the last year. But the key thing, even if it was 25%, one of the things that I highlighted earlier was that in the ED1 distribution review that we have just concluded, in Merseyside and north Wales if I use that as an example—Liverpool, north Wales, Cheshire—for an increasing investment to support renewables and smart grid, the use of system charge came down by 18%. The reason we did that was we accepted further efficiency challenges elsewhere within the price control package and also accepted a move towards 45-year recovery periods for our investments, so a 20-year plus payback period.

**Chris Morrison:** But you are right. Our evidence is based on the amount that we have to add to our customers' bills in order to reflect the cost of the distribution and transmission. In 2014 it was £270 on the average dual fuel bill of £1,150, which we did see as a 30% increase since 2010. There is an element of this that reflects the significant investment that has gone into the infrastructure for the networks and the grid over that time. We are concerned that this is an increasing part of customers' bills and we need to focus on how we can try to keep these costs down, how the new investment in infrastructure is done in the most cost effective way in order to reduce any further growth in that element of the bill. As I say, that is why we are investing in this approach of distributed energy, as we see that working at the customer level is how we are going to reduce the impact on the new grid, as it will need to be, and reduce the need for investment in that grid.

**Q28 James Heappey:** I disagree, Mr Mathieson. Ofgem—20% is the distribution network that we are seeing in front of us. That 20%, that inflation in costs over the last four years has been driven by the distribution networks needing to quickly cater for the growing distributed generation that they are being asked to connect. That is right so far?

**Scott Mathieson:** No. If you look at the price reductions across England and Wales and Scotland you will see that the use of system charges—there is dual fuel gas and electricity

and I am speaking specifically about electricity. For electricity, the use of system charges in real terms came down on 1 April 2015, despite underlying investment going up. They came down for two reasons: the companies accepted bigger reductions in support costs and challenges on smart grid and they also accepted a move towards a 45-year depreciation from a 20-year depreciation for new investments. That brought down the impact on the bills. Thereafter, they are flat in real terms but they will increase with inflation in electricity. We have tried to offset the increases that we need to accommodate in that renewable generation. Your colleague highlighted the fact that the cost of connecting to the grid when you are further away in a rural area is being borne by the party that is connecting. They are actually paying that in a connection charge. That is not being socialised at the moment. In electricity that is one of the differences.

I am aware that in gas, for example, there was an acceleration of the depreciation because it was assumed at the time of the gas distribution review that the asset was coming towards the end of its life and needed to be recovered more quickly. I think that is fair to say. So there will be tensions between gas and electricity within the numbers that are you quoting, but in electricity, ED1, the companies were looking at a fairly tough review. You would expect me to say that. But British Gas then challenged that review at the Competition and Markets Authority and, of the five items that they challenged on, only one was changed and it was a mathematical error.

**Chris Morrison:** I would flag that as part of that change there was a reduction in revenues of over £100 million that will fall through to customers over the next 10 years on the point that we won.

**Q29 Chair:** We are looking for a bit more of an understanding of the strengths and weaknesses of the network regulation and governance. For Scottish Power Energy Networks, what is your experience of the strengths and weaknesses of RII price controls, particularly in relation to how effective they are in encouraging network companies to innovate?

**Scott Mathieson:** For a network operator, praise of a regulator is always grudging, but we have been on a bit of a journey with respect to the mechanisms that they put in place. We started with something called the innovation funding incentive, which was fairly limited and allowed companies to invest up to about 0.5% of their turnovers in research and design. Up until about 2000, the millennium, RPI-X had effectively stifled the drive towards efficiency, stifled the research and design. The companies, jointly with Ofgem, managed to recognise the fact that that was adverse to the world that we were moving into and IFI was the growing mechanism. There are new mechanisms such as the low carbon networks fund, and in particular I think the network innovation competition is a good innovation. It is like a “Dragons’ Den” for the companies. There were seven bids from the companies and I think five were ultimately successful. We were three of the seven in total and we won two of our bids, but it is a pretty intensive technological competition. The information that we get from the successful bids is shared with all companies, made available to third parties, to academics, to third parties wanting to participate in our market.

This was a joint industry regulator; I don’t think it happened in isolation. They also recognised that one of the big challenges, once you have developed a clever idea, is implementing it. The innovation rollout mechanism and the network innovation allowance give us a bit more capacity in moving ideas that we have into implementation. The one bid

that we were unsuccessful on at the recent network innovation competition was ironically about becoming a distribution system operator. The feedback we got was that generally it was a good idea but there was more work that we wanted to do and we are able now to take that forward, hopefully within the network innovation allowance so it is not lost. The reason I say it was particularly ironic was because the regulator wrote out to us to say they wanted to see more work and more effort in this area in conjunction with the National Grid. We have the opportunity now to use a different mechanism to try to get that moving.

The costs of these are not significant in overall investment levels but the savings are very materially significant. The example of ARC that I mentioned earlier had very significant material savings for a relatively low cost. That is generally true of the list in front of me: VISOR, an £800,000 scheme, saved the same per day in terms of constraint costs on the transmission system.

**Chris Morrison:** I would add that we are very supportive of innovation in network operators and we have participated in three low carbon network funds, all of them focused around smart meters. It is vital to have that innovation funding in order that we are able to do live field trials of some of the concepts that we have talked about, that perhaps are not commercial yet, and understand where the benefits lie so we can roll them out further as we expand this new smart grid.

**Q30 Chair:** The final question from this morning's session: in written submissions to the inquiry many have called for a whole systems approach. What might that mean to you?

**Chris Morrison:** That is what we are looking at in this. We have a concept of what we call a virtual power plant and that really underlies the whole approach of distributed energy for us. Centrica has historically been building centralised power generation plants from gas. Our vision of the future is that all of the distributed generation assets on our customers' sites, all of the demand side response tools—whether that is turning down motor speeds or turning off pumps and adjusting air conditioning systems—are connected up to this virtual network through the cloud. That enables us to remotely control customers' assets to turn them down at times when we know there is going to be a spike in prices as a result of a spike in demand or a falloff in generation capacity. It allows us to hopefully smooth out some of the increased costs caused by the increased intermittency and the increased flexibility that we have and allows us to remotely manage that for our customers. That is our vision of the future and it would reduce the costs of energy for our customers overall.

**Scott Mathieson:** We don't have a hugely different vision. At the distribution level the growth of embedded generation means that you have the equivalent of what we describe as cells on the network where you are balancing generation and demand within a given cell, you are aggregating that up to a bigger cell and you are looking at the impact that that has on the whole network and also at the grid interface. We see the whole system as being an aggregation, from small scale embedded generation connecting into the LV network all the way up into the 400 kV, co-ordinated within local franchise areas. The distribution network operators are working effectively with the grid system operator. For all the reasons that we talked about earlier, intermittency needs to support grids, transmission to support distribution and vice versa at points in time. There needs to be an effectively co-ordinated system to make sure that at end of the day the connected customer enjoys a secure supply and an excellent quality of service.

**Chair:** Thank you very much. Thank you both very much, Mr Morrison and Mr Mathieson, for your time in sharing your expertise this