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Economy, Tourism and Energy Committee

Comataidh na h-Eaconamaidh, Turasachd agus Cumhachd

Tuesday 1 September 2026

Session 7

The Scottish Parliament
Pàrlamaid na h-Alba

Tuesday 1 September 2026

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ECONOMY, TOURISM AND ENERGY COMMITTEE
2nd Meeting 2026, Session 7

CONVENER

*Duncan Massey (North East Scotland) (Reform)

DEPUTY CONVENER

*Daniel Johnson (Edinburgh Southern) (Lab)

COMMITTEE MEMBERS

*Gary Bouse (Falkirk West) (SNP)
*Kate Campbell (Edinburgh Eastern, Musselburgh and Tranent) (SNP)
*Kristopher Leask (Highlands and Islands) (Green)
*Martyn Day (Falkirk East and Linlithgow) (SNP)
*Rachael Hamilton (Ettrick, Roxburgh and Berwickshire) (Con)

*attended

THE FOLLOWING ALSO PARTICIPATED:

Dr Simon Gill (University of Strathclyde)
Professor Sir Dieter Helm (University of Oxford)

LOCATION

The Mary Fairfax Somerville Room (CR2)

Scottish Parliament

Economy, Tourism and Energy Committee

Tuesday 1 September 2026

[The Convener opened the meeting at 09:00]

Decision on Taking Business in Private

The Convener (Duncan Massey): Welcome, everyone, to the second meeting in 2026 of the Economy, Tourism and Energy Committee. We have received no apologies. I would remind members that they do not need to operate their own microphones, as they will be operated for them during the public part of the meeting.

Agenda item 1 is a decision on taking business in private. Do members agree to take item 3, which is consideration of our work programme, in private?

Members *indicated agreement*.

Scotland's Energy Sector

09:01

The Convener: Agenda item 2 is an overview of Scotland's energy sector. I refer members to papers 1 and 2.

I welcome Professor Dieter Helm from the University of Oxford—many thanks for joining us this morning, Dieter. He will give us a short presentation, and there will be an opportunity to ask questions afterwards.

Professor Sir Dieter Helm (University of Oxford): Thank you very much indeed. I am professor of energy policy at the University of Oxford, and I wrote the "Cost of energy" review for the British Government in 2017. That seems a long time ago, but I think that most of its points stand.

I thought that it would be helpful to make a few high-level remarks about Scotland's energy policy and strategy and then leave as much time as possible for questions, so that I can try to respond to whatever anyone wants to challenge or to throw at me. In any case, thank you very much for the invitation, and I am sorry that I am not with you in person.

Scotland's policy is pretty clear—it is net zero by 2045—and its energy strategy is to have some 20GW of additional renewables by 2030. That is in the context of a peak demand of about 5GW, and I should point out that that figure has been declining over the last 15 years down from 6GW or 7GW peak demand in 2010. It is pretty obvious that the gulf between how much capacity there is in the system and how much Scotland actually needs is pretty vast, and it essentially means that Scotland's system is primarily directed at exporting to England and through England to Wales and so on.

The system that is being developed contrasts very strongly with what was there before. Not that long ago, in 2010—that is, 15 years or so ago—Scotland's system was made up of nuclear plus coal plus gas plus hydro, with a bit of wind, and nuclear and the fossil fuels represented the overwhelming firm power supplies to Scotland. At that time, the industry in Scotland—and industry demand for electricity—was substantial. Since then, industrial demand has declined, and of course, there have been big closures or moves away. Grangemouth is just one example, but one can also look at the Clyde and elsewhere and see other examples of where new energy-intensive demands, particularly for electricity, have not developed or where industry has been exiting. The situation is not specific to Scotland; it is common throughout Britain, which has been de-industrialising for some considerable time. It is not

just about exits, although major industries in Britain as a whole, including petrochemicals, fertiliser, steel, car production and even fiberglass production, have been on an exit path. That has flattened the emissions numbers.

What matters is not so much what has left but what has not come to Scotland or Britain over the past 15 to 20 years. We are not a base for virtually any incoming energy-intensive industries. We will have a few data centres, but the US, whose energy prices are four times lower than Britain's, will be the centre for energy-intensive industries as we go forward, as will China, whose energy costs are at least two times cheaper than Britain's.

That is the context. The first question to ask is whether what we are doing is making any difference to climate change, which is the clear objective that, I am sure, everyone shares. My answer is that it is not. It could do, but it is not currently.

Are we producing cheap and affordable energy for customers and to encourage industry? No. Our electricity is about the most expensive in the developed world. Is it useful energy? What is going to happen to all the intermittent energy surpluses that Scotland is producing? The answer is not at all clear. It is not at all clear what the demand for that energy will be in the future, who will pay for it and where it will go, because, as well as Scotland and Britain, northern Europe will have surpluses when the wind blows and the sun shines and will have deficits when they do not.

Let me quickly sketch out the points about the difference that is being made to climate change, whether we have an effective climate change policy, why energy is so expensive and whether what we are doing is useful. I advocate climate realism—we should consider the facts rather than people's hopes, aspirations and optimism. I am not pessimistic or optimistic, but I am deeply concerned about climate change and how little is being achieved.

Let me put the situation in context: climate change is global. It does not matter whether emissions are created in Edinburgh, in Shanghai or somewhere in Texas, in the US; they are global. That is a crucial point.

How are things going? The answer is disastrously. We have added two parts per million to the concentration of carbon in the atmosphere every year since 1990. We are now adding three parts, which is taking the parts per million in the atmosphere to 428. There has been no progress in even slowing down the increase in the concentration of carbon in the atmosphere. The concentration of carbon in the atmosphere is the only figure that matters, because that is the greenhouse effect—it is the net of emissions and sequestration. We have done enormous damage to sequestration globally, particularly to the rainforests and the oceans, but elsewhere too. If the current policies are the ones that are supposed to address climate change, one more heave is not going to make much difference.

We must bear in mind that about 77 per cent of the energy in Scotland comes from fossil fuels, but everyone thinks that we are just about to become a clean energy superpower. In England, the figure is between 75 and 77 per cent, and the global figure is between 80 and 85 per cent. There is no transition from fossil fuels globally, and there has not been much of a transition in Scotland and England either. It is crucial that we consider the big bulk of oil and gas that is not going into electricity, plus the stuff that is going into electricity.

If we want to no longer cause climate change and create emissions via fossil fuels, the scale of what has to be done in Scotland and in Britain is huge. What we are doing with electricity helps, as long as it does not deter production at home while creating production overseas, but it is a small bit. Given that there is a reasonable expectation that global energy demand will roughly double by 2050, decarbonisation means not only decarbonising the existing economy but decarbonising a whole new world economy within 25 years.

Those are facts—if the doubling of energy is not a fact, it is very likely—and that is the scale of the challenge. We should always remember the size of the share of fossil fuels within energy production, within which electricity is encapsulated. It is true that more and more of the economy will electrify and that electricity really matters, but we must think about that as part of the challenge and not as the whole challenge.

Renewables are also not clean, although they are cleaner. If we look at where the minerals come from and at the supply chains, we realise that there are shades of clean and dirty and that it is not a case of black and white or clean and dirty.

Another area relates to the cost of that stuff. People go around quoting the marginal costs of wind and solar and saying that those are free. They might argue that water is free too and that we should have it for free because it does not cost us anything. That is nonsense. It does not much matter how much a solar panel or a wind turbine costs per se; the question is about the cost to the system of having those things. I can give you an illustration. Britain as a whole used to have about 45GW of peak demand, which we met with about 60GW of capacity. We already need just under 120GW of capacity to meet a peak demand that is lower than 45GW of demand. We need twice the grid capacity and we need batteries and storage.

Those are all additional costs for an intermittent, renewables-based system.

I have nothing against renewables per se, but the idea that that stuff is cheaper than fossil fuels is, in my view, only sensible if we examine the system cost of the alternatives. Intermittent wind and intermittent solar come with expensive system cost requirements because they need a huge amount of additional capacity and a huge amount of transmission and distribution addition, and because they also need batteries, storage, extra pumped storage and so on, which are not needed in a world of nuclear, coal, or gas power. That is not to say that we might not prefer that new world, but if we want to have a low-carbon world we are going to internalise the pollution, which will cost. That is why electricity prices in Britain and Scotland are among the highest in the developed world.

That brings me to an additional point, which is that we are paying for that by using contracts for difference. CFDs pay a generator to generate at a fixed price. It does not matter whether the power is used or is useful. The generator pays nothing towards the transmission system, the excess capacity or the backup that the system requires. They do not pay any of the system costs; they are just paid to generate and, as we know, if the power is not needed they are still paid, as long as the wholesale price is above nought.

That is really serious because the renewables that are coming online in Scotland and Britain lock the prices in until 2040 and perhaps beyond. In a CFD-driven world—particularly in allocation round 8, given that the capital cost has gone up a lot because we now have the highest cost of Government debt in the developed world—electricity prices are going to be high for the whole of the next decade. That is crucial. It may be that the wholesale pool price is nought. If there is massive excess capacity in the system, which is what we are creating, prices in the wholesale market may well collapse, but customers in Scotland will not be paying that price. They will pay the CFD price of £70, £80, £90 or perhaps more than £100 per megawatt hour. Some of the offshore wind in Scotland already costs £113 per megawatt hour.

It is crucial to understand that the policy means that we have locked in a very high price, even though the wholesale price might be extremely low. Also, the problem with a very low wholesale price is the question of who is going to use that power. You might think, as I do, that that represents a fantastic opportunity, but the people who are going to use it must be able to use intermittent energy.

09:15

The problem here is that the future industries are not low-energy-intensity industries, and, at the moment, they are not industries that are able to use intermittent power. To use it, they need to have a hell of a lot of back-up and storage and so on, which involves additional costs. The new industries are among the most energy-intensive industries that the world has ever created. When it comes to data centres or artificial intelligence systems, people talk about the five nines—the 99.999 per cent availability and reliability that they require.

In Britain, we are building a system that is exactly the opposite of that. That is not to say that we should not do it, but we must recognise that one of the consequences is that the opportunity for an inflow of substantial AI and data centre technologies will be limited. Nearly all of that work is taking place in the United States. Although there will be some data centres here, because companies need to be close to customers, it is no accident that, around the world, operators of data centres are looking at small modular nuclear reactors, and many of them are building their own back-up diesel and gas generation to handle the intermittency of the wind that is being brought on to the system.

Is the huge surplus of energy that is being built up useful? Who is going to use it? That will be a major challenge in the future, because there will be big surpluses. When that happens, will we export it through the 10GW of cables to the continent, when it is also sunny and windy in the Netherlands, Germany and Scandinavia? Are those cables secure? That is a big, open question.

We also need to think about what we will do when the wind does not blow and the sun does not shine. The answer to that question is that Britain is already projected to need 35GW of gas on standby, running perhaps 4 or 5 per cent of the time, by 2030. That is a huge cost. In effect, we are talking about replicating, in a context of a peak demand of 45GW or 40GW, nearly the entire system with gas standby stations. That is a cost of intermittency.

In the “Cost of energy” review, I advocated that we should focus on firm power, that we should use equivalent firm power auctions and that we should treat the existing locked-in subsidies to past renewables as social costs. However, in shifting the costs from customers to taxpayers, it is really important to remember that, for the UK, the costs do not go away simply as a result of moving around the deck chairs when it comes to who pays. Ultimately, those costs are still the same.

If Britain wants to be a competitive economy and wants to achieve the economic growth that I think

that all political parties agree on—why would they not?—we must face the fact that, when it comes to the three variables that count for competitiveness, which are the cost of energy, the cost of capital and the cost of labour, we have to do something about the really high cost of energy that is faced by industry. I have some suggestions about that.

We also have to do something about our having the highest borrowing costs in the developed world—I am talking about the 5.1 per cent return that is required on 10-year gilts—and to think about whether, in a world in which productivity is very low, increasing the costs of employing labour is going to increase our competitiveness. Of course, if productivity rises very strongly, the labour costs, relatively speaking, will be very different, but, right now, they are very high because productivity is low. Sadly, productivity is particularly low in the public sector—indeed, in some areas, it has not got back to pre-Covid levels.

That is the context. We can deal with climate change. As well as making a difference on climate change, we can deal with cost competitiveness and affordability. However, that will have very significant and, I would argue, painful consequences. I am glad that I am not in the political world, because trying to persuade the British public that paying for pollution is something that we will have to do is a task that is in your domain, not mine. I am grateful for that.

I hope that those introductory remarks help. I am happy to answer to the best of my ability any questions that members might have.

The Convener: Thanks very much, Dieter. That was a tremendous presentation and introduction.

Do members have any questions?

Daniel Johnson (Edinburgh Southern) (Lab): Thank you so much for that interesting presentation, Professor Helm. I have big questions to ask, so I apologise.

You were very clear about the importance of focusing on climate change, but said that what we are doing will essentially not be sufficient. What does the right course of action look like? What should we be investing in?

On the flipside of that coin, if you look at the countries that invest most in renewables, you see that China tops the league table. I wonder whether we need to consider what the future energy economy will look like as the world is moving away from fossil fuels. Yes, renewables are expensive today, but their costs will come down. There is a risk that, if we do not invest in the future energy economy, we will get stuck with a very 20th century model, while China will have already invested in and built the 21st century energy economy, and it will all be solar and much cheaper. Renewables are expensive now, but they will get cheaper and we have to see this through.

What should we be doing? Should we be looking at what other countries are doing and what the future electricity and energy economy will look like? Are those sensible questions?

Professor Helm: They are very sensible questions, but I am not sure that you will like the answers. If you want to stop causing climate change, which I hope that all of us do, it is your consumption that matters, not where the stuff is produced. If you were to write your carbon diary for today, you would say that you travelled here; you were all wearing clothes that, as far as I can see, were made using carbon; the table that you sat around was made substantially by using carbon-based energy; the seats that you sat on were made using petrochemicals and plastics; and the video link used a lot of energy. Those are examples of where the 77 per cent figure that I gave earlier comes from.

It is not simply about how we make electricity. Reducing territorial carbon emissions, which is what Scotland's net zero target is about, makes a difference to climate change only if your carbon consumption falls as a result. Let me give you an example. You probably think that Scotland has got out of coal, but you have not. I think that China burns 55 per cent of all the coal in the world. Many of the things that you buy in Scotland are things that used to be produced in Scotland. You are importing the coal; you are responsible for that.

I do not fly, but I am sure that most people do, and I perfectly understand why. If you go on an aeroplane, you are causing carbon emissions—it does not matter where the emissions are. That is the crucial bit.

If you really want to stop causing climate change—I think that most of the public believe that that is what they are doing—you need carbon consumption net zero. That is hugely more expensive than simply reducing territorial emissions, which does not take the emissions away, especially if they are augmented, dare I say it, by closing Grangemouth and a series of other industries and by producing your ferries in Turkey or somewhere else. You are very heavily dependent on carbon in your consumption. I hesitate to say this conclusively, but I suspect that your reduction of territorial carbon emissions in Scotland is probably increasing global emissions. That is touch and go, but you are certainly not making your carbon footprint clean. That is the first point.

Huge mistakes are made about China, which is massively coal based. Solar panels are made using coal. On the rare earths that are being dug

out, go and have a look on Google Earth at the mines and tell me how they are low carbon. China's bet is basically this: coal plus nuclear, which it is building really fast.

China has lots of solar and wind at very low utilisation—the load factors are about 20 to 25 per cent—but that is part of a sensible diversification within which the coal world sits and part of an industrial strategy to corner the world market in batteries, electric vehicles, critical minerals, solar panels et cetera. The numbers are usually about 80 or 90 per cent of the total world supply. It makes a lot of sense.

Hydro is the really big one in China. If we look at the sheer scale of the dams that are being built in Tibet and what they will do to the major rivers, we see that they dwarf almost everything else. China withstands the Iran war even though it takes 38 per cent of what is coming out of the Gulf because it bigs up on its coal and its oil and gas imports from Russia. I think it is a fairytale that we must all be like China and that China is leading the way towards climate change mitigation, because I doubt that. Remember that it is the largest emitter of carbon in the world.

You say that the world is decarbonising and moving towards renewables and that renewables can be cheaper, but I do not agree with you. The world is pumping out more oil, gas and coal year by year by year. I do not believe that we will be using less oil in 2050. Renewables are contributing to the extra demand for energy as part of the doubling of the world's energy demand. That is not the same as everyone moving to net zero. On the point about things becoming cheaper and cheaper, Chinese solar panels have fallen substantially in price, but that is a smidgen of the system costs of having solar, which includes excess capacity, management of intermittency and all the transmission and distribution impacts.

I will give you a quick example. I have lots of solar panels—I am trying to signal virtue, which I am hypocritical about, as I suspect most people are. I am producing loads of solar today—it is sunny where I am—and it is virtually useless to the grid, because everybody else is producing solar at the moment. It would be really useful if I could produce solar power in February but, of course, I cannot. That is the point: you have to look at the system implication and not simply the fact that I am generating excess solar today, which is spilling on to the system. I argue that we should focus on system costs and not fall for the magic of hearing, "This is all going to be cheaper." We should stand back and ask ourselves this: if this is all supposed to be cheaper and we already have a huge amount of renewables in the system in Scotland, which is very impressive, why are electricity prices not lower? They have gone up, not down. That is because system costs drive them up, which is what we have to confront.

We need to reduce carbon consumption, not territorial carbon emissions—that is the wrong target and the wrong measure of cost efficiency. You can argue about those points, but you cannot escape the fact that the price is really high, which has damaged the Scottish economy and damaged affordability for consumers who are poorer and less able to pay.

You asked a long question—I am sorry that I gave rather a long answer, but it is important to get the parameters right.

The Convener: I am cognisant of time, so I will move on to Rachael Hamilton. Just before I do, I can see my Falkirk MSP colleagues gritting their teeth a little bit. This is a specific point, but I just want to highlight that it was the Grangemouth refinery that closed, which is just one part of the Grangemouth facility. The world-class petrochemical plant is very much still running.

Rachael Hamilton (Ettrick, Roxburgh and Berwickshire) (Con): Professor Helm, I ought to say first that I agree that we should increase our nuclear capacity, and I am in a minority in the Parliament on that. I also believe that we should have the ability to open Rosebank and Jackdaw. I have put my cards on the table.

You made an argument about reducing territorial consumption. In the very rural area that I represent, there is pushback on data centres in outstanding areas of beauty and on the implementation of pylon and grid infrastructure across the southern upland way.

There is a general movement against spoiling the beautiful rural landscape by installing battery storage in fields that would ordinarily be used for growing food. I think that it is going to be difficult to sell the public on the idea of reducing consumption of imported clothing, food and so on from China, given that they are already pushing against the introduction of that infrastructure.

I noticed that you did not use the word "transition", which is a buzzword in politics—the phrase "just transition" is bandied around here a lot. How do you think that we can bring the public with us and ensure that they understand that we require there to be a—for want of a better word—transition in order to reduce our carbon emissions and our energy bills?

09:30

Professor Helm: There are a lot of component parts to that question, and I will try to address them all. First, though, convener, thanks for the correction about Grangemouth—I meant that the

refinery had been affected by closure, not the other parts of the facility. Of course, I could consider the various dimensions around other facilities in Scotland and give you a catalogue of what industrial capacity is exiting or not arriving, but that is an aside.

Let me touch on the nuclear question. The first thing to observe is that it was a huge climate change mistake for Germany to prematurely close all its nuclear capacity. That is about the silliest policy that anyone has ever dreamt up from a climate change point of view, because the facilities were well regulated and Germany uses lots of nuclear power. Scotland uses lots of nuclear power too, by the way; it just comes from England, and the plan is to expand that quite substantially.

I am not in favour of or against nuclear power, but I have always made this point: either do it properly or do not do it at all. We build one nuclear power station at a time—first Hinkley Point, then Sizewell C—and we might deploy some small modular reactors at the end of the next decade. America is miles ahead in that regard. I used to say that our nuclear power is the most expensive in the world, but apparently there is one plant in the US that turned out to be more expensive. Sizewell and Hinkley cost £16 billion per gigawatt, while gas costs £500 million to £1 billion per gigawatt. You can do that maths, but you can see that the cost is huge—it is completely unsustainable. From the customer's point of view, Sizewell will be much worse than Hinkley, because Hinkley is being financed under a CFD arrangement, so it is basically the French state that is losing lots of money, whereas Sizewell is funded through a regulated asset base framework. I am in favour of that model, but it will pass on the cost to consumers. The cost will be about £100 billion for about 6.5GW to 7GW of capacity. That is sort of equivalent to the cost of high speed 2, which is nearly £1 billion per mile. It is a huge cost. We have to do things differently if the approach to nuclear is going to work.

On the issue of the oilfields, I will leave Rosebank aside for the moment because it is not relevant to the electricity side of things. With regard to Jackdaw, I would claim to be radically interested in reducing climate change, so I do not understand why we are perfectly happy to take North Sea gas and North Sea oil, but only if they come not from the British North Sea but the Norwegian North Sea. If you want to stop the use of oil and just stop gas, you should just not use any, but that means cutting the 77 per cent of the United Kingdom's energy consumption that comes from oil and gas, which is a level of reduction that would radically impact on any economy. In fact, just stopping the use of oil or gas would probably cause revolutions—it is just that radical. Given that that is the case, why would you prefer US liquefied natural gas and Norwegian North Sea gas to British North Sea gas? I do not understand it. I will just leave it at that.

On the transition, what I am saying is that the reason why the world is not making much progress on climate change—the reason why your net zero policy does not really make much difference to climate change—is that taking such action is a really big and costly thing to do.

During the whole of the 20th century, we went from having 2 billion people to nearly 8 billion people on the planet and all the reductions in poverty and the huge expansion in economic growth were caused by fossil fuels. Marx should have written about the energy theory of value, rather than the labour theory of value, and he would have captured it. The 20th century would not have happened as it did without fossil fuels, whether that be fertilisers, transportation, the internal combustion engine, the diesel engine or the coal power station et cetera. China's growth would never have happened without fossil fuels.

If you want to get out of fossil fuels because you think that energy demand is doubling and that the new energy demand will be for firm power and the five nines, that will be a huge challenge to our accepted way of running economies and how the world will be. That is why I said at the outset that I am glad that I am not involved in politics and trying to persuade the public, because this will mean a cut in our standard of living—we are living beyond our environmental means and it is going to be very painful. What is more, it is worth doing if we think that China, India, Indonesia and Nigeria are going to do it, too. That is where all the emissions growth is—it is not in Scotland or Edinburgh.

There may be good reasons for reducing emissions to tackle local air pollution and for all sorts of other reasons, but we should stop telling the public what I think is, essentially—I say this in the nicest possible way—a fabrication. The energy is not cheap, it is not home-grown, and it is not necessarily secure. We tell the public to do all this stuff and they will be better off because their energy bill will be lower; it is a no-brainer. Well, it was a no-brainer for me to buy an iPhone, because the technology was much better than my fixed phone from BT that I used to try to use. The market is not doing any of this stuff without huge state subsidies. If you tell people that something will cost them, they will not like it. They also visibly do not like pylons, which Rachael Hamilton commented on.

The implication of what I am saying, which may be unpalatable in Scotland, is that we put a lot of the wind generation in almost precisely the wrong place. Why would you have lots of offshore wind

turbines off the north-east coast of Scotland if the total demand is, say, 5GW at its peak and the bulk of demand is south, in England? Why would you not put the turbines further south? It is true that the wind is better in Scotland, but it is more expensive to do that and the supply is a long way from the market. You have to explain to people that there are pylons all over the landscape—there is a thing called natural beauty—because wind is intermittent, the turbines are a hugely long way from the market and, frankly, they are probably in the wrong place. However, they are there, so the question is what to do now. Do not put any more there.

AR8 has been misconceived. It is a fact that Britain has a huge amount of wind and solar in our system; the question is where it should be. People have forgotten the cost. All those pylons and all the transmission costs are not being paid for by the renewables developers; they are just getting a CFD, but we are paying for them and we are taking the other consequences. I think that the so-called nimby revolt against the pylons should be channelled into the question why they are being built. What is their purpose and is that where you want generation?

That takes me full circle back to the point that, if you really do not want to do that and the system costs are very high, it is hard to avoid the nuclear question. The only firm power that is energy dense and low carbon—it is not zero carbon, but neither is wind or solar—is nuclear. Globally, there is massive development of small modular reactors, most of which is in the United States. I doubt whether anyone would make small modular reactors in Britain, because the labour and energy costs are so high; we would probably import. The technology is coming and it is more important than wind and solar for climate change in the short to medium term. That does not mean that the other technologies are not important, however.

The really interesting thing is that one of the small modular reactors in the United States, which is backed by Bill Gates, is a flexible plant. It runs flat out, like all nuclear power stations need to, but it stores the excess nuclear power generation in heat and other formats, which can then be used as a battery for the system. Those are really interesting developments.

If you want to say that there should be no nuclear power in Scotland and that you are going to do just wind and solar, get out of gas and not do Rosebank, in one sense, I hope you are right. It seems to me that you would be carrying out an experiment that virtually no major industrial country in the world would take forward. China has coal, nuclear and renewables; America has gas, oil, coal, nuclear and renewables. That “and” is perfectly sensible. If you say “or,” you really have to confront the public with the politics of what that will mean for them, particularly in Scotland.

I am sorry for that long answer, but you asked a complex question and I am not good at turning thoughts into short soundbite answers.

The Convener: I appreciate those detailed answers, which are really helpful, but I am cognisant of time. We have time for probably one or two more questions. If we run out of time, might we be able to send you some written questions?

Professor Helm: I would be delighted to answer any and every question. My time constraint is that I shortly have to chair a major meeting, so I must be there and cannot simply turn up late. I apologise for the deadline and will try to answer any and all questions, within reason, to the best of my ability.

The Convener: We have time for probably just one more question.

Kate Campbell (Edinburgh Eastern, Musselburgh and Tranent) (SNP): Thank you for a thoroughly depressing return to Parliament, Professor Helm. I found what you said interesting and am new to energy policy, so I have some questions and would like you to explain a little more. You spoke about the need for far more capacity—I think you said that we need 125 GW on the grid to meet lower demand—but you did not talk about grid capacity. Can you explain why it is the case that we need so much more capacity for renewables? From what I have read, it seems that there is a bottleneck on the grid between Scotland and England and that that is one of the causes of high energy costs. You did not mention that at all, so can you explain what role that plays?

Professor Helm: Grid capacity is very much needed if you are going to have lots of renewables, which are low energy density, geographically dispersed and intermittent. That is a whole different ball game compared to a nuclear, coal or gas power station and that goes right down through the system. I floated an idea that is not quite right but is nearly right, which is that renewables are in the wrong place. That means that we now need the grid, the pylons and so on to go right up to the north-east coast of Scotland, because it is not clear that data centres and other power users will migrate to be close to what is sold as being cheap offshore energy when it will not be so.

The very nature of what renewables are, at the bottom of the system, requires a whole-system expansion. You are absolutely right about that.

I said that part of the cost of having intermittent, low energy-density renewables that are geographically dispersed is that we will have to double the capacity of the grid. That cost will be a big chunk of people’s bills in future. It is true that

that is not keeping pace with what is required, because of a host of reasons from planning to all sorts of other perfectly legitimate political and economic reasons. We have also constrained off quite a lot of the Scottish wind, which means that it runs and works but we pay for the energy, which is useless because we cannot use it and it does not get into the system. That is all part of the process.

Estimates show that, in order to meet net zero by 2030, we would have to spend between £30 billion and £70 billion more on the grid, just to create that connectivity. I actually think it would cost more because costs are substantially overrunning, as they do with major infrastructure projects.

The real question is, can we afford that? Is it a case of needing to do all that capital expenditure just because of a target, so we will just do it and everyone will pay for it? It goes through electricity bills, because the network costs are added to those. It is not £5 here and £10 there but hundreds of pounds per customer.

The alternative is to work out what we can afford, spend it as wisely as possible and realise that some of the items of capital expenditure that people have in mind, including nuclear, are simply unaffordable. We should have a retrenchment and ask what we can afford—what industry and customers can pay—then work out how best to spend that to get the maximum benefits for climate change, industrial competitiveness and consumer affordability.

It is, if you like, a collision with reality. I do not think it pessimistic to describe what reality is, as opposed to what many of us—including, probably, you and I—would hope it to be. However, we have sold a story of hope—that it is all going to be cheaper. Dare I say it? Observing from the outside, part of the politics of where we are today is that, for the first time in 10, 15 or 20 years, there is no net zero consensus. A large number of people have voted not to pursue a climate policy because, realistically, they can say that, although they may not understand the detail, they were sold a pup; they were told it was going to be cheaper but it is much more expensive. The explanation for that is not just Ukraine and Iran. They are not the real reason for the cost, although they contribute.

My urging line—I have a book coming out on the subject, called “Climate Realism”—is to be realistic about where we are, how disastrous it is globally and the fact that one more heave is not going to do it. Let us spend the money of customers and industry money in the most effective way to reduce or make some impact on those parts per million in the atmosphere; then we will make some progress.

The Convener: Thanks, Dieter. Noting that we have gone past your cut-off of 9.45, I thank you for your time. That has been a tremendous overview of energy with, perhaps, some hard truths spelled out. If we have some questions, perhaps we can forward them to you.

Professor Helm: Of course. I am sorry that I cannot stay for longer. Thank you very much for listening.

The Convener: Colleagues, we will have a short break as we wait for the next speaker.

09:47

Meeting suspended.

09:53

On resuming—

The Convener: I welcome Dr Simon Gill, director of grid innovation strategy and principal knowledge exchange fellow at the University of Strathclyde, who is our second speaker. There will be a similar format—a presentation and then questions afterwards.

Dr Simon Gill (University of Strathclyde): Thank you, everyone, for inviting me. It is a pleasure to be here. I will give a little introduction. My background is as an engineer and policy developer. I have worked on energy at universities, in academia, in consultancy and for the Scottish Government over the past 16 years or so.

Over the next 15 minutes, I want to give a brisk tour of Scotland’s energy system—what it consists of and what is changing—and set out some of the questions that that raises for the committee. I hope that it will complement the presentation and session that you have just had with Dieter Helm, but I hope that my message suggests that there might be a route through some of the challenges.

In setting the context, I have some points to make that are similar to those made by Dieter Helm, but the first and most important is that the energy system is made up of a mixture of things and that it must not be confused with the electricity system alone. I suspect that members of the committee understand that, but time and again people use the term “energy” when they actually mean electricity. Electricity accounts for only about a fifth of the total energy consumption in Scotland.

On overall energy use, heating dominates, and half of our energy consumption is for heating things up. Transportation accounts for more than a quarter, and the last fifth is the electricity that we use. That is important when we think about the energy system, and it is also important when we think about household bills and people. For example, we have not traditionally considered

transport costs as part of the energy bill, but, of course that is what we pay for when we go to the petrol station, and it is a large part of what we pay for when we get a train ticket or a plane ticket. It is important that we bear that context in mind when thinking about the energy system.

I pulled down a Sankey diagram illustrating the complicated flow of energy in the Scottish system. Although it looks good, I thought that it is probably quite complicated for a short session such as this, so I have tried to pull out some of the key features.

I will take you through the diagram. The left-hand bar shows the production of energy in Scotland, together with imports. The middle bar shows energy consumption in Scotland, together with exports, and the right-hand bar shows a blown-up version of the consumption bar. It is obvious from that that we produce much, much more energy than we consume, which has been the case for a very long time.

When we take account of North Sea oil and gas production and the electricity that we generate in Scotland, we currently create around six or seven times as much energy as we consume. About 20 years ago, the oil and gas sector was probably producing about twice as much energy. North Sea production peaked in around 1999 or 2000, and we are now producing less than half of what was being produced at that time. Therefore, the reduction in oil and gas from the North Sea is a long-term trend. However, over the past decade and a half, the amount of electricity that we produce in Scotland has risen significantly.

If we look at the final consumption bar on the right-hand side, we can see that, as Dieter Helm said earlier, the majority of energy that is used is Scotland remains fossil fuel: petroleum for transport and natural gas for heating. There is some bioenergy, and the electricity component is still small.

That is the big picture. The next thing that I want to try to do is to give you a whistle-stop tour of Scotland's energy infrastructure.

A while ago, I drew a map of Scotland's energy infrastructure. I was going to include it, and I am slightly regretting not having done so, because it is quite nice to look at, even if it is too complicated for you to see in this setting. I may send it to the committee afterwards.

Instead, I have produced something that looks a bit like the London underground map. I have pulled out the different lines, which represent the different energy vectors that we either have today or are developing. These are the ways in which energy flows around our system, and each comes with its own infrastructure. As the energy committee, I suppose that you have a remit that covers everything within here.

I will move down the list. Electricity is well known, and I think that we will come back to it in detail later. The headline message is that I expect its role within the energy system to grow significantly over the next decades.

Oil and production covers everything from North Sea extraction and Grangemouth to the tankers filling stations and cars that we use every day. That system, as I have said, is in decline, and I expect that decline to continue, regardless of the precise policy that is in place for energy overall. That is because of the maturity of that North Sea basin—we have taken out a lot of the economically viable resources.

Methane—natural gas—is an important infrastructure set for heating and industry today, and it will continue to be so over the next few years. Certainly under a net zero future, methane needs to be phased out, and there are big questions about how the costs of doing that are distributed among customers and taxpayers. For example, we have a big expensive gas network that is a sunk-cost asset that delivers lots of energy into houses.

There are things that we might want to do with that. We might be able to repurpose parts of it for transferring different forms of energy. For example, there has been discussions about hydrogen, and about biomethane, which is a sort of bio-based methane gas. A big question needs to be thought through in that regard.

10:00

Hydrogen is not a major infrastructure area at the moment, but it is one that is expected to grow. There is hydrogen production at Grangemouth, where so-called grey hydrogen is made from natural gas, which releases the carbon dioxide. As we move towards a net zero system, we have an opportunity to use hydrogen, which can play a significant role as an asset for storing energy, in a similar way to the role that natural gas has played in the past. We can put it into large underground caves. There are big opportunities to do that in northern England or off the North Sea coast. Hydrogen can be used as a low-carbon way of storing energy and providing resilience and security of supply to the system.

The hydrogen aspect also interacts significantly with other infrastructure elements, such as the electricity system and the natural gas system as it is today, as well as the need for a carbon system, if we are to capture the carbon and make so-called blue hydrogen sustainable in that way.

The next item of energy infrastructure in the list is that relating to bioenergy, which includes woody stuff, such as bits of tree that we might burn, and energy crops. If we want to take land to grow energy crops, that has clear implications for land use. We also have organic wastes and manure, which can be used to produce biomethane and fed into the gas network, as happens today. However, there are limited supplies of sustainable biomass, and we need to think carefully about where we use those supplies and to what degree, and how, that interacts with other aspects of our country and our economy.

The next item of energy infrastructure is that relating to heat networks, which I think is a really important one. There are heat networks in Scotland, which provide a way of distributing energy around a local area. However, places such as Denmark have huge heat networks that cover the whole country and transfer heat from one side of it to the other, to the extent that Copenhagen has a fully developed heat market that looks very similar to our electricity and gas markets. That is one way in which we could think about tackling the big challenge of heat decarbonisation or moving away from the use of natural gas for heat.

Next on the list is carbon. Again, we would need to build new infrastructure for that. At places such as Grangemouth, St Fergus and Peterhead, there are opportunities to capture the carbon dioxide emissions that result from the use of fossil fuels, to transport them through pipes or on boats and to put them into some of the old gas fields in the North Sea that we have taken the gas out of. There are huge technical challenges with that, but work is under way in the north of England, particularly through the pathfinder projects. There is less activity in that area in Scotland.

The final piece of infrastructure that I mention is building fabric. That is not an energy vector as such, but I have included it because it is important to say that, as well as thinking about all the infrastructure that we need in order to obtain, transport and use energy, we also need to think about, as Dieter Helm mentioned, opportunities to reduce energy use, and building fabric is an area that gives us big opportunities to do that. If we build and maintain efficient buildings, we will significantly reduce the amount of energy that we use, and we will open up the range of economic technologies that we can use to provide heat.

The next slide is almost an aide-mémoire to remind me to list five structural trends that I think are important and that are baked into the energy sector as it stands. First—I have mentioned this twice already, so I might not need to spend much time on it—North Sea oil and gas production will continue to fall. I think that that will happen regardless of our view on net zero. For example, the sector's own view is that gas production in the North Sea will come to an end around 2050—the middle of the century. That will happen almost regardless of Government policy. The commissioning of one or two new fields in the near term will not change that long-term structural outcome for the sector.

The second trend is the increase in electrification, which is the obvious direction in several sectors. Electric vehicles are already cheaper to run, and they are more or less cheaper than their petrol and diesel equivalents when it comes to lifetime costs. I expect that trend to continue.

Heat is more problematic, but there are already housing groups, such as those off the gas grid and new builds, in which there are opportunities to use electricity to provide heating in a way that can be cost comparable with fossil fuels. However, the larger building stock is quite a challenge.

The third point is that there will continue to be geopolitical shocks. I am sure that you have thought long and hard about the impact of the conflicts in Ukraine and Iran over the past few years, and we have seen massive impacts on bills. We can perhaps talk later about what is causing those impacts. I almost guarantee that such impacts will happen again. By 2040, I am sure that we will have had several more such shocks.

I will now jump to the last point on the screen. When you move to renewables, you move a huge amount of your cost base in the energy system away from variable fuel costs and into up-front capital investment. A comparison that I like to make relates to the levelised cost of energy, which bundles together the investment cost, the cost of capital and the fuel costs. About 10 per cent of the levelised cost of a gas plant is in the capital investment up-front costs, whereas 90 per cent of it is in ongoing variable costs. For an onshore wind farm, it is almost the opposite: about 80 per cent of the cost is in fixed up-front costs and 20 per cent is in variable costs. That means that, if you build a wind farm and your aim is to recover the cost of that wind farm over 10 or 20 years through the electricity that it generates, the cost per unit is largely fixed up front, which gives you cost stability over time. That is a separate argument from whether renewables are cheaper than oil and gas in a particular pathway, because they can also deliver cost certainty. I think that that is quite an important thing that we can do. As we move towards an electrified system, we get that certainty from renewables.

A lot of the costs that were talked about during evidence from the previous witness—things such as the costs of the networks and of building the renewables in the first place—follow a pattern of

moving variable costs into fixed costs, which creates quite a different economic environment for the energy system to develop.

It is worth highlighting a couple of other trends. I will focus on the electricity system in the last couple of slides. First, strategic energy planning is an important area that is coming up on us quickly over the next year or so. In 2024, the United Kingdom Government, the Scottish Government and the Welsh Government commissioned the National Energy System Operator—NESO—in order to develop a strategic spatial energy plan for Britain. The point was to address a co-ordination problem. Increasingly, things such as networks, which take 10 years to build, were interacting with new generation capacity, which takes about 10 years to build in the case of large offshore wind farms. Both of those projects require confidence that the other one will be in place in order to justify the investment and enable a decision to be taken. There was a chicken and egg problem that the market-based system was not resolving.

The idea is that we move to a strategically planned energy system in which we come up with a spatial plan that says, "This is how much generation we are going to have in different parts of the country." Therefore, if that is set by the plan, we can start building the networks out to those areas. We have started doing that through the clean power 2030 approach, and that will continue with the strategic spatial energy plan that we expect to come out.

It means that the approach will be much more centralised and public sector led than the old market-based paradigm, in which we effectively allowed the energy market to define where generation would be and built the networks out to meet it, so that the system was ready when the generation projects were ready. That approach worked in the past when new generation capacity tended to come along in the same places as old generation capacity, such as when we replaced a gas plant with a new gas plant, or even replaced the old coal power stations in the centre of England with a gas plant still down in England. The approach worked then, but it does not work so well as part of a transition to a renewables-based system.

It is also worth saying, as an aside, that as well as the national SSEP, NESO is developing regional plans for each part of Britain. One of those regional plans, known as the regional energy strategic plan, will be for Scotland. The Scottish Government, Scottish public sector stakeholders and the Scottish Parliament need to be very much involved in that, making sure that there is democratic oversight and appropriate input with Scottish interests at heart.

The next slide captures the point about the need to build a huge amount more generation capacity. Again, that came up in the previous session and it is part of the clean power 2030 initiative. First, what is clean power? It does not mean that unabated gas generation will disappear. It means that clean power sources will produce at least as much electricity as Britain consumes overall, and at least 95 per cent of generation in total. Basically, for 5 per cent of the time, we may continue to burn unabated gas to fill up those gaps, to avoid having to do the really expensive last mile, when we might be better taking our effort to other parts of the energy system. However, it gets us 95 per cent of the way towards a decarbonised electricity system—noting, of course, my earlier point that electricity is currently not the whole energy system.

These numbers on the screen are for Britain. For Scotland, that pathway involves offshore wind growing to between about 10GW and 12GW, or about two and a half times the amount that it was in 2024, and onshore wind growing to between 18GW and 20GW, or nearly two times as much as it was in 2024. Progress is being made, but a lot needs to happen very quickly.

I am conscious of the time, so I will go through the next slide and then jump to the end of the presentation to make sure that we have got plenty of time for discussion. This next slide is about markets and network constraints. Electricity markets are changing. We had a huge national debate, known as the review of electricity market arrangements, which ran over the past four years and considered significant change to how the electricity market is operated. The review was run by the UK Government and it is a reserved matter, so it is something that the Scottish Government, the Scottish ministers and Scottish stakeholders fed into but were not responsible for.

The outcome of that review was that not much changed, which has delayed us evolving how our electricity market and regulatory framework develops to make it more suitable for the new energy system in particular. We have already heard that we are turning off a lot of wind generation, and curtailment is a real issue. In 2025, nearly 10 terawatt hours of Scottish wind generation was curtailed because the transmission link between Scotland and England was not big enough. That involved paying wind farms around £360 million to turn off, and curtailment occurred somewhere in Scotland for about 57 per cent of the year.

It is important to be aware that the curtailment of wind is to be expected as part of an effective energy sector. Eliminating it entirely would require building network capacity that might, at the extreme—at the margin—only be used for a few hours a year. The sensible objective is to find the

right balance between building that infrastructure and turning down generation.

I also do not think that that balance is correct at the moment. That is due to delays in developing the transmission network during the 2010s and the early 2020s. The legacy of that is that curtailment is also expected to rise until 2030. However, in 2030, we are going to get significant new capacity of the transmission network. A large fraction of that comes from undersea cables; we are now building four off the east coast, between either Torness and northern England or the Peterhead region and northern England.

That will relieve a lot of the constraint and allow new generation to connect. It will push up the cost of the transmission network, but, in return, it will be possible to connect renewables, which have the opportunity to be significantly cheaper and come with the benefit of providing cost stability over time.

10:15

I was going to comment on a few other areas, namely security and resilience of supply, and household energy bills, but I will skip to the last slide and finish there. I have set out a few questions that might help the committee to think about what will be important in Scotland's energy system over the next couple of years. The overarching point is still captured by the old trilemma that I have set out on the left of the slide, which is that energy policy is about balancing three things: security of supply, cost and sustainability. I am fairly sure that each of you in the room will land somewhere different with regard to what is most important or what the right balance is, and I can tell you that there is no right answer. Nobody is going to say, "This is the way to do it."

Let us take security of supply as an example. There are so many facets of security of supply. There is the issue of whether we can get enough imported energy—if we need to do that. There is the issue of whether we can offset some of that by producing energy in Britain. There is the issue of whether we can meet peak electricity demand without causing a blackout. Then, if there is a blackout, there is the issue of whether we can we get the system going again quickly, without major social and economic impacts. There are also a lot of technical questions about how the different infrastructure groups operate. There is a huge number of things that we need to think about, and going down one path will help us with some of those things but make other things worse. There is always a balance to be struck, and it is important for policy makers and the Government to understand the balance and to be clear about how they are balancing those aspects. That is one of the things that it is important to talk about. I will stop there, and I am happy to take questions.

The Convener: Thank you, Simon. That was another tremendous presentation. Colleagues, we will move to questions, and Kris Leask is first.

Kristopher Leask (Highlands and Islands) (Green): Thank you for the presentation, which was very useful. It covered a great deal that it will be good to explore now and over the next few years.

I am glad that you mentioned the strategic spatial energy plan. I wanted to bring it up as I have significant concerns about it, as do many stakeholders who have already flagged their concerns to me. You raised RESPs, and we also have the transitional RESP process. I have been vaguely involved in the process in Orkney over the past few years, and I have now seen the contrast between what the TRESPs and the RESPs are trying to achieve, versus what the SSEP is trying to achieve. The TRESPs and RESPs are very much sold to communities as an agentic model, through which they can have power to influence future development and to help shape and co-design the development pathways and thus influence the infrastructure that is required to enable that development.

That contrasts with what we see in the SSEP, which is likely to be published later this year. This document is potentially going to significantly stymie, if not kill off, large swathes of development. It will close down opportunities for public and private ownership, but, equally, community ownership, of future generation capacity. How do you square those two things? How do you see those plans going forward, and do you have concerns about them?

Dr Gill: That is a very good question. As I said in the presentation, the move to strategic planning is new and represents a very different approach to energy policy compared to what we have been doing over the past couple of decades. It is important to note that NESO is developing this by taking a very centralised approach. I will start with the SSEP. The process is that NESO has now produced—or is fairly close to finalising—half a dozen scenarios or pathways for Britain. It will then pass those to the secretary of state, who will either choose one of those or come up with one pathway for wider public consultation, and that will be finalised towards the back end of next year.

I was slightly disappointed that, although the SSEP was commissioned jointly by the UK, Scottish and Welsh Governments, it is only the UK secretary of state who will make the call on what the final pathway will look like. Although Scottish and Welsh ministers are expected to feed in and to have conversations on that with the secretary of state, it is a shame that Scotland's interests will not

be covered in the way that I might have expected when the commission first went out.

My concern with the SSEP process is that it is not as open as I would expect. NESO has pulled together a huge amount of information, and it is running a lot of models and processes to decide, in a theoretical sense, on the best pathway to its objectives. However, NESO has not been sharing that information as widely as I would like to see—not even in private with Governments and other technical stakeholders such as the transmission networks. It is important that the information is shared with them because those organisations can sense check and provide a critique on what is being developed.

NESO was given responsibility for delivering the RESPs, and that has led to the process becoming relatively centralised. It is being run on a kind of hub-and-spoke model: the main process for producing a RESP is held by NESO, down in Warwick; there are also 14 teams around the country producing RESPs for their respective regions, following the same kind of process.

I know that teams are engaging closely with local communities and stakeholders in considering local value as part of the process. My concern, however, is that the RESP approach could end up with a one-size-fits-all model that does not work in the same way in central Birmingham as it will up in Orkney.

Kristopher Leask: I am glad to hear about that—thank you for that very useful answer.

I had a slightly different understanding of the Scottish Government's role as a co-signatory of the SSEP: I was led to believe that it had more of a function in that respect. That is something for the committee to get to the bottom of, as this development in energy policy will be crucial. The committee has an important role in getting on top of the SSEP and of developments. We can raise that point later.

I totally agree with the point that you made on the RESP. It is slightly absurd that we have a notion of local plans for Scotland. I have been involved in discussions on the RESP: we are talking about the curtailment of community turbines in Orkney by up to 60 or 70 per cent, and about initial connections to transmission capacity. Essentially, we are talking about the curtailment of or limitations to development in the future in the Western Isles or on the west coast. Those are starkly different problems to those in the central belt, southern Scotland or even the north-east and the Highlands.

It is concerning to see what is being considered as strategic planning. I think that there is a role for the committee in pursuing and scrutinising that. As you say, however, we need to wait and see what models come out later in the year. I think that we are hurtling towards an inevitable stand-off between the various elements of the sector, the Government and NESO on the methodologies and models that have been used, and that it may be an unproductive relationship. I hope that that can be avoided, but that is the direction that I think we are heading in.

Dr Gill: My feedback to NESO has always been that it needs to think carefully about building consensus. I worry about the RESPs and where they have come from. They are there to support the development of the electricity and gas networks in Scotland by identifying how much demand for electricity and gas there will be at certain locations. They can therefore feed into the process of requiring the network companies to build more electricity capacity in certain areas and, potentially in the future, into that of decommissioning bits of the gas network as people come off gas. I do not think that the process of reaching a consensus on the most appropriate way forward has been developed as well as I would like to see.

The Convener: I am cognisant of the time and the need to keep things moving. I call Gary Bouse.

Gary Bouse (Falkirk West) (SNP): Thank you, Dr Gill, for giving us some clarity on the whole of the energy side. I have some construction background, so I get what you are talking about on that side, and on the carbon build-up there.

You have touched on electricity. At the moment there is what we could call a wave of data centres about to appear in Scotland. I do not know whether this is a scare story, but a report that arrived yesterday indicated that 20 per cent of UK data centres could potentially appear in Scotland. My concern is that those data centres could potentially mean that our renewables and our electricity are not feeding Scotland, particularly in the winter.

You will appreciate that that concern led me to look at small nuclear reactors. The UK energy minister said that there would be 12 of them—six, initially—for the baseload. However, could the fact that we have 12 small nuclear reactors end up meaning that we do not need renewables? Could we get into a situation where our renewables industry shrinks and people do not want to invest in it, because of those reactors? That goes back to your plan for the energy strategy. I think that that really needs to all tie together.

Dr Gill: I will start with a bigger point, which is about demand. I would reflect on the fact that the clean power 2030 plan is very much a plan to advance the development of generation, particularly renewables, and that it is being successful in that. I do not necessarily expect GB

to meet the 2030 target, but the plan is bringing forward generation capacity. However, it has only just started to engage properly with and to think about demand.

I mentioned a couple of trends earlier, one of which suggests that although electricity is currently a relatively small part of the energy system, its use is expected to grow significantly and we face a large increase in electricity demand. As Dieter Helm pointed out, we need to think about meeting that demand not only when lots of wind is available, but also when it is not.

We have processes to do that. For example, at the moment, we use the capacity market to support dispatchable generators in maintaining their capacity even when they are not being used very much. Although it is an extra system cost, which we have to be cognisant of, that process would help us to do that. However, it is increasingly important for things such as the SSEP to directly consider demand and not just generation. If, as a country, we decide that we want and are likely to get a significant data centre industry, we need to think about how to integrate it into the energy system and not just let it turn up as and where.

I share your concerns about data centres. However, Scotland will not have 20 massive data centres suddenly turn up, for several reasons. For instance, it will be difficult to connect them to the electricity network in the near future, which gives us time to ensure that we are lining up renewable generation, firm generation to backup, or flexibility, plus network, in order to meet that new demand. I think that that needs to become a much bigger part of that strategic planning process.

Gary Bouse: Maybe I could add my personal thoughts on the matter of pumped storage and hydro. I have been thinking of Cruachan 2, which is currently being worked on—I have experience of the project—and I suspect that that is probably where we need to go if we want to keep things truly renewable.

Dr Gill: Yes, we need a few things with regard to flexibility. I probably differ from Dieter Helm here, in that I think that there is a route through the maze and opportunities to provide flexibility. However, we need to understand all the different bits of flexibility and the role that they will play.

I will list a couple of examples. Let me start with batteries, which get a lot of press—that is, large batteries connecting to the grid. They are very useful, but generally they have about an hour's energy storage. You can have longer than that—some batteries coming out now can store up to about six hours—but the duration is still kind of short.

10:30

There is also the existing pumped storage fleet. Typically, that can give you about 10 to 15 hours of storage, although some of the new pumped storage projects can store 20 to 24 hours. Those things are going to play different roles; by the time you get up to 24 hours, you will have good storage ability to start dealing with some of the intermittency.

However, we must also do something that we still have not engaged with properly—that is, think about very long duration storage. Earlier, I mentioned hydrogen as an opportunity in that respect. At the moment, it is technically challenging and expensive, as is often the case with new technologies, but the production of hydrogen from electricity through electrolysers, combined with large-scale hydrogen storage and hydrogen power stations, can provide a form of energy storage that can go out to hundreds of hours and can be a route for managing long-term intermittency. I am thinking of what is sometimes called dunkelflauten—that is, those long periods in the winter when there is no wind and demand is high.

We need to engage with that. We need to understand what is possible with each technology, and we need to ensure that we have a strategy that covers all the different time durations when we need flexibility. Pumped storage has a critical part to play in the middle band of all of that. The UK Government has a strategy—that is, a cap and floor support mechanism for what it calls long-duration energy storage, which is, I think, anything longer than 8 hours. However, we need something else to provide the 24-hour-plus—indeed, 100-hour-plus—storage that we will need and which traditionally has come from fossil fuel storage. If we want to move away from fossil fuels, that storage will need to come from somewhere else.

Gary Bouse: Thank you, Dr Gill.

The Convener: Before I bring Daniel Johnson in, I have a quick question of clarification on pumped storage. What size of capacity are those projects? I note those that are going ahead off Loch Ness, for example.

Dr Gill: At the moment, we are getting just under 1GW of power, and around 10GW hours of storage, I think, although I would need to double-check that. The new project is in the multi-gigawatt category and will provide longer duration—we are probably talking a couple of gigawatts plus 20GWh or 30GWh of storage. Such projects often get talked about only in terms of their power capacity—that is, how much energy they can deliver instantaneously—but it is really important to consider energy storage, too. In practical terms, that will come down to how big the lake is behind

them, because that will tell you how long they can run for.

The Convener: Sorry—I have another question of clarification. If you are talking about a 1GW project and 10 GWh, are you saying that you get the 1GW for 10 hours?

Dr Gill: It is a 10-hour project, yes.

The Convener: Thank you. I call Daniel Johnson.

Daniel Johnson: I feel that I need to correct Dr. Gill—the question is not how big the lake is, but how big the loch is. [*Laughter*.]

I have two questions: one about heat and the other about electricity. First of all, on heat, I really appreciate your putting all this in the context of peak oil being in 1999 and the long-term prospects for gas production, because I think that that is actually important.

However, do we have a plan in that respect? The chart that you showed us indicated that heat in buildings accounts for almost half of our energy requirements. Much of that conversation is about air-source heat pumps; however, when I look at my constituency, I have to say that, if that is going to be the route, it is going to be very expensive for people to heat their homes. I do not see what the alternatives are. We are for ever saying, "Oh, we should develop a plan for heat networks." There is legislation on the books, but I do not feel that there is any plan in that respect or any clear upgrade options for people. Do you think that we have a good enough plan for to get us away from using gas for heating, if that is the aim of the game?

Dr Gill: That is probably the biggest area where we need effort and thinking, because I do not think that we have a good plan at the moment. About four or five years ago, we had a plan primarily based on transfer to air-source heat pumps across a large swathe.

The Scottish Government had a target, which I am not sure is still in play, of taking something like 1 million homes off gas by 2030. It turns out that that is expensive, that it is quite hard to use a heat pump and that you have to be careful with the fabric of the building. Heat pumps work in some buildings, but you need high levels of efficiency and central heating systems need to have the right characteristics, including having big enough pipes and big enough radiators. I think that will take much longer than we initially proposed and that we need to regroup and come up with a better overall strategy.

You mentioned heat networks. That is another area where we set out a target but do not seem to have done much about it. We have a target of having 6 TWh of heat being delivered through heat networks by 2030. That was set out in the Heat Networks (Scotland) Act 2021 and is a statutory target in primary legislation but there does not seem to have been much movement because it is expensive. You have to spend a lot of money up front to build an asset base that will last for 50 or more years, which means that it takes quite a long time to recover your sunk costs. We do not seem to have managed to get a model that will roll that out.

Daniel Johnson: That is really interesting and is something that the committee should look at.

Professor Helm made a point about being realistic about competitors. To be clear, I take the view that we should be looking to transition because the planet is stuffed if we do not. However, we must ensure that we are competitive. Your numbers showed that the cost of generation was £74 per megawatt hour last year, which is £10 below the aggregate CFD cost of about £84 per megawatt hour and means that generation is being subsidised to the tune of £10 per megawatt hour. It is also about 20 per cent higher than the cost of around £60 per megawatt hour in France and is almost double the wholesale cost of around $40 per megawatt hour of electricity in the USA.

Are we building an expensive system and are you saying that those costs will reduce over time? You are saying that there is a lot of up-front cost, but will we see those costs coming down or are we building a system that is generating expensive electricity? How do we square those circles?

Dr Gill: First, the number on the slide was the cost that we are paying to turn wind down in Scotland, which is not a million miles away from the average wholesale cost of slightly more than £77 per megawatt hour. The point definitely holds.

Most estimates of how electricity costs will change over the next five years or so suggest that those costs will stay more or less the same if there are no other changes to policy. They might fall a little—by £50 or £60 per year—but there will not be a huge amount of change.

There are some policy things that we can do. The biggest component is the wholesale cost of electricity, which is about 35 per cent of the total bill. We will drive that down by connecting renewables, which means that the wholesale element of the bill will fall, but we need to build more networks in order to allow that. We have support mechanisms such as the CFD, which means that the other elements of the bill increase in tandem and we end up with a similar electricity bill.

One thing that we could do is to take legacy renewable costs—in particular, the renewables obligation certificate, or ROC, costs and the fit

costs—out of the bill and put them onto taxation. That would make a bit of an impact. I think that, once we get into the 2030s, we will find that we start to drive bigger changes to the underlying wholesale cost of energy, which will lead to a downward trajectory.

Daniel Johnson: How much would you expect that to be? By the way, the numbers that I was posing were just from quick google searches, so please correct me if any of them were wrong. Do you think that the prices could fall to French or US levels, or are we going to have more expensive electricity than those countries?

Dr Gill: I think that we are going to end up with electricity that starts to fall 10 to 20 per cent in the 2030s. I do not think that we will have a halving or a quartering of energy bills, or electricity bills. We will not get down to American levels, for example.

It is also important to pick up on the point about price security. If we can get prices down a bit, and through having a set of resources for which the costs are up front and are therefore fixed once we have invested in them, we can get to a position where, by the 2030s, if there is an international energy crisis, we will be massively less affected by it than we were in 2022. We can have slightly lower costs and we can have much higher certainty on price.

Martyn Day (Falkirk East and Linlithgow) (SNP): It has been a very interesting session and has certainly given me lots to think about, so I am sort of busking here. One thought is that, given that we produce so much more energy than we consume and that a lot of that production is intermittent, changes will come in due course that improve the transmission system, and there is a real danger that we let Scotland simply become a net exporter of raw energy, rather than planning what we want to do with the energy. For example, could we become a net exporter of high-end products produced by that renewable energy, which would surely be a better thing to export? Where do we square the circle to make sure that that happens? Should that be in the NESO regional plan, or do we need to find another vehicle?

Dr Gill: One of the big disappointments of the transition so far is that it has had so little impact on the bills of consumers and businesses in Scotland. The strategic plan will tell us where to build stuff, but underneath that we need to introduce new mechanisms in the market and in regulation that allow us to give value to Scottish customers where they are doing something valuable for the system, such as reducing curtailment of Scottish wind or reducing the transmission capacity that we need to build. There is a separate process going on in that area called the reformed national pricing programme, which is a UK Government market and regulatory reform approach with a couple of strands. One of those strands is about how to deliver what the programme would call locational value. For example, how can being located in Scotland and creating value for the system lead to something tangible for people and businesses in Scotland?

I will give an example of an approach that is being developed. NESO, which is responsible for balancing the system as well as for all this system planning stuff, is also responsible for the day-to-day operation of the electricity system. NESO is developing the idea of a long-term investment contract for new demand if a project locates in a place where it will reduce curtailment and therefore make more effective use of the resources that we have, such as wind farms and the generation that they can provide. That means that, if someone agrees that they will run when it is windy in Scotland, they may get a contract. It might be for 10 years—the details are being worked out at the moment. However, that would form a sufficiently strong up-front revenue stream, or guaranteed revenue stream, to support that investment case and make it more likely that they would invest in a location in Scotland rather than in England.

That is an approach for new demand, and large-scale industrial demand, moving to Scotland, but we need equivalent approaches for domestic customers, as well as existing customers, and that is just starting to be thought about in more detail through the reformed national pricing programme. There was, around Easter, a UK Government consultation on that that it would be worth having a look at; the next stages do not seem to have appeared yet, so we do not know what is coming next, but that would provide the starting point for the kinds of change that we need to see.

Martyn Day: Thank you for that. I am sure that we will have more conversations about this as we move forward.

10:45

The Convener: Thank you. I note that it is 10.45, and I think that we have had a—[*Interruption*.] Oh, sorry, Kate. I will bring you in now.

Kate Campbell: Thank you, convener, and thank you, Dr Gill, for what has been a very interesting evidence session.

I am kind of new to energy policy and am trying to get my head around it—it is quite complex. You said, I think, that it would cost £300 million to turn off renewables in Scotland and that the wholesale price was about 35 per cent of the electricity cost. However, is the wholesale price not impacted, too, by the turn-on costs, or is that not the case? Can

you talk a little bit about what we are turning on when we turn off renewables and the impact on the grid?

Dr Gill: The wholesale price is, as I have said, is about 35 per cent of the bill. The balancing of the system, which involves turning off wind in Scotland and turning on something else—which in England is quite often gas—is a separate part of the bill. Those are the balancing costs.

The £360 million that I quoted in the slides is what we pay to turn off wind farms. We have to do that, because when the farms were built, we guaranteed that they would be provided with network access—and by "we" I mean the Government, the system operator and the network companies. So those parties signed a contract that said, "This is what we'll do." However, they are not giving the wind farms all of that network access, because they have not built sufficient network capacity, and the farms and the investors that made the investment are now saying, "Come on—we need the revenue that we built our business case on and which you effectively guaranteed through the contract." That is why we have to pay them that money.

We also have to pay quite a bit more money to the gas plants in England to turn up. Effectively, it works like this: the market closes an hour before you run, and it takes no account of the transmission network. That is the wholesale price. Now, if we have turned up, and there is too much wind in the wholesale outcome—which we cannot use, because of the transmission network—the extra costs go into the balancing element. In total, those costs were nearly £2 billion pounds last year, including the £300 million to £400 million paid to the wind farms and £1.6 billion paid to the gas plants to turn up.

Not all of that is an extra cost—it depends. If the wholesale market had taken account of the transmission network, some of that £1.6 billion would have been included in the wholesale cost. However, you do end up with a situation in which you have a big balancing component. That said, although it is a big cost, it is still, given the scale of other parts of the bill, really quite small; indeed, you will see as much in one of my other slides, which I did not, in the end, talk to.

You are right to bring up the issue, though, because it is quite an important element of how the system is operated and balanced.

Kate Campbell: Do you mind if I have a quick follow-up? It is NESO that does the balancing.

Dr Gill: Yes.

Kate Campbell: Who scrutinises how effectively it is doing that? After all, it feels like it is quite an important part of our bills and costs.

Dr Gill: It is really quite an unusual situation for this country. Until 2004, the organisation that operated the electricity system was part of National Grid; at the end, it was called National Grid ESO, and it was regulated in a relatively traditional way. It was a profit-making regulated company; the Office of Gas and Electricity Markets agreed a price control regulatory settlement with it; and it was incentivised to reduce costs. In other words, if it reduced costs, it would get some of the saving, and Ofgem provided normal scrutiny, too.

When the entity became NESO, it became wholly publicly owned. It is owned by the UK Government, and because it is not for profit, you can no longer use incentive-based regulation to encourage it to reduce costs. Instead, Ofgem has ramped up its scrutiny of NESO to ensure that it thinks that NESO is doing the best job that it can do. However, that model is still evolving, and it would be worth digging into that to find out other people's views on how it is working.

The Convener: Do colleagues have any more questions?

I have one. Dieter Helm talked about the system costs of our energy system. To a certain extent, you are talking about the same thing, but what differentiates your position is that you think that some of those system costs can be overcome through the use of hydrogen and so on. Is that a fair representation of the difference in view?

Dr Gill: Yes, absolutely. It is really important to think about system costs and to make that the paramount test. As Dieter mentioned, the marginal cost of producing energy from wind is zero, but that does not mean that wind energy is free. It is not free for two reasons: first, it is necessary to spend a lot of money on a wind farm in order to get access to that marginal zero-cost energy, and, secondly, it is necessary to have the system around it.

There have been system costs for every form of generation that we have had. In building a power station, it was always necessary to have a network to connect it to. There was always a degree of that, but increasing the level of intermittent renewables involves raising the level of system costs. I would say that we need a better understanding of exactly how big those system costs are, because it is important that we quantify them.

However, my sense is that we can overcome that issue, particularly when we take account of the fixed nature of a lot of those costs. That gives us confidence that we can build an energy system that works for the country.

Rachael Hamilton: I have a quick supplementary on the issue of system costs. SP Energy Networks argues that undergrounding is a

lot more expensive, but not undergrounding is detrimental to communities and to natural beauty. I think that the committee has a role in scrutinising not only Ofgem but NESO, SPEN and Scottish and Southern Electricity Networks in relation to that argument. Where should the committee be able to ask those questions? What angle should we take to ensure that we scrutinise those organisations when they give such stock answers?

Dr Gill: As Kate Campbell mentioned, we are talking about an area that is so complicated that even people who spend their life studying it can find it very confusing to know which bit of it to dig into.

My view is that I would dig as hard as I could into how the SSEP is being developed, because that sets the requirements for the amount of transmission that we need and where the generation should be. That might say that we need to be able to transfer 15GW from the north of Scotland to England. In the next stage of its strategic planning, NESO will go on to work out how we do that and what transmission lines we need to build. Do we need transmission lines or more undersea cables, for example? If we need undersea cables, how big should the substations be and where should they sit on our coastline?

That NESO process sets the game plan. NESO then passes that over to SPEN or SSEN to build out the network. SPEN and SSEN will go through their normal stakeholder engagement processes, but they will proceed on the basis that what has to happen has been agreed as part of the strategic plan. That is why I keep saying that it is so important that we have a proper open debate on what is in the strategic plan.

Therefore, my advice to the committee would be to ask NESO questions and to dig to find out as much as it is willing or able to share on what the options are for the strategic plan and how those decisions will be made.

The Convener: I have a final question in relation to that point. What are the risks of that system build out? We have heard that there are issues with construction in this country and that there seems to be massive price escalation. There is also global inflation, which is mainly because of Iran and Ukraine. As we travel down this road, what warning signs should we look at that might suggest that those system build-out costs are becoming unaffordable and will keep driving increases in the price of electricity? What should we be looking for?

Dr Gill: My first comment in response to that question is that, in engineering, there are always different ways to solve a problem. We need to agree the way that we are going and stick with that process over a sufficiently long time horizon. It has taken us a long time to realise that, and we now realise it at a time when there is not quite as much consensus on where we should be going. One of the big red lights would be if we agree a plan that sinks a whole host of costs, such as transmission network build-out costs, and then change what we want to achieve or how we are trying to achieve it.

I know that this point is getting close to political questions, but we need to consider how best to use the things that we have already agreed to build. We have already agreed to build a certain amount of transmission network between Scotland and England, which will cost tens of billions of pounds, but those costs are now effectively sunk—we are building that network. Any future discussion should be about how we effectively use what is going to be built, not whether we should be building the things that we have already started to build, if you see what I mean—that is one of the really important points.

Secondly, we must make sure that the public sector has access to the expertise that is needed to understand these challenges. As an engineer, I have often found it difficult to get engineering expertise into Government and other public sector organisations. That is partly because those are not the typical places that engineers go to, partly because engineers' skill sets are not typical of the civil service or other public sector organisations and partly because people speak quite different languages, and it is difficult to cut across that. We need that to happen, and so do you, the Government and the wider public sector. It is important to find ways to access that expertise so that people can see when costs are starting to run away in a way that is not justified.

That last bit is difficult. If somebody says, "We want to spend £10 billion," we can argue over whether it should cost £9 billion or £11 billion to do the thing that they said that they will do. However, the challenge is getting agreement on whether spending money on doing that thing is justified, and I hope that you will be able to find ways to overcome that challenge.

The Convener: Thank you very much, Dr Simon Gill—that has been another tremendous presentation.

Colleagues, that concludes the public business for today. Our next meeting will be next week on Tuesday 8 September, when we will take evidence on AI and its potential impact on Scotland's economy. We will now move into private session to discuss agenda item 3.

10:58

Meeting continued in private until 11:23.

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