



Economic Affairs Committee

Corrected oral evidence: UK energy supply and investment

[Tuesday 1 March 2022](#)

3.10 pm

Watch the meeting

Members present: Lord Bridges of Headley (The Chair); Viscount Chandos; Lord Fox; Lord Griffiths of Fforestfach; Baroness Kramer; Lord Monks; Lord Rooker; Lord Skidelsky; Lord Stern of Brentford.

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Questions 30 - 41

Witnesses

I: Christophe McGlade, Head of Energy Supply Unit, International Energy Agency; Catharina Hillenbrand von der Neyen, Head of Research, Carbon Tracker.

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Examination of Witnesses

Christophe McGlade and Catharina Hillenbrand von der Neyen.

Q30 **The Chair:** Thank you very much, both of you, for coming. Would you like to introduce yourselves, please?

Catharina Hillenbrand von der Neyen: I am head of research at Carbon Tracker. I have spent the past 25 years in the City on the sell side within equity research and corporate finance, and on the buy side in the energy sector, looking across the sector at fossil fuels, oil, gas, clean tech, infrastructure, power and utilities. I also spent some time with Ofgem in the early part of the 2000s. I was a senior adviser at BEIS between 2015 and 2017.

Christophe McGlade: I am the head of the energy supply unit in the World Energy Outlook team of the International Energy Agency. I have been at the IEA for the past five years.

The Chair: Over the last week or so, the debate about energy security and supply has become ever more acute, particularly in so far as this inquiry is looking into how we are tackling the trilemma. If I could start with you, Christophe McGlade, and ask about the IEA road map, which was published last year and you will know well, it stated that, "Beyond projects already committed to as of 2021, there are no new oil and gas fields approved for development in our pathway, and no new coal mines or mine extensions are required". Your director went on to say, "If Governments are serious about the climate crisis, there can be no new investments in oil, gas and coal from now—from this year".

This is a simple question just to start with. In light of the Ukrainian crisis and what we are seeing developing, if we want to have an orderly transition to net zero in which energy supplies remain reliable and affordable, how does that change the IEA's position, if at all, on those statements?

Christophe McGlade: As a little bit of background on the net-zero emissions scenario that we released in May last year. One of the assumptions of that scenario was that the world would start to act aggressively on climate change from 1 January 2022. Unfortunately, that has not happened. The world is not on track for achieving net-zero emissions in 2050. As many of you will know, we construct different scenarios. We look at the extent to which we are on track for different technologies across the full range of technologies that there are. And very few of these technologies and policies are currently on track with where we need to be. That is the context.

In the context of a scenario where we take action on climate change, we would have a surge in clean energy policies, which leads to a surge in investment in clean energy technologies, and that brings down fossil fuel demand, and brings down emissions in line with net zero in 2050 globally. If you have that decline in demand, you can satisfy that with

supplies from existing oil and gas fields, so you do not require investment in new fields.

As I say, we are, unfortunately, not in that scenario. In fact, when you look at what is and what is not on track, one of the few areas where existing levels of investment are aligned with net zero is investment in oil and gas supply. In 2020 and 2021, we had around \$350 billion spent on upstream oil and gas. On average, in the net-zero scenario over the period to 2030, we need around \$350 billion to be spent on existing sources of oil and gas production. So that element is in line with what is needed in the net-zero scenario.

What is not in line is investment in clean energy technologies. There, annual investment has been about \$1 trillion globally for the past couple of years; it needs to be \$3 trillion. We need to see that threefold increase in investment in clean energy technologies in order to be on track with net zero by 2050.

The Chair: Just to be clear, your exhortation stands that there should be no new oil and gas development.

Christophe McGlade: On the basis that the world starts to go towards net zero by 2050, you do not require any investment in new oil and gas fields.

The Chair: In terms of reliability and affordability, how does that play out in the next couple of years in your scenarios, given where we are now?

Christophe McGlade: The scenario, as I said, assumed that the world would start acting on climate change, and that everyone would start to work together towards achieving net zero in 2050. Because of the nature of our scenarios, we have to construct these with a set of assumptions. One assumption was that the world worked together towards this, and we modelled a smooth pathway towards net zero. One reason we did that was to highlight that it is possible to reach net zero in 2050 with a relatively smooth transition. In this scenario, prices would come down and people's energy bills would be lower.

Lord Fox: I understand the assumptions that you made when you released your last report. In light of the fact that the investment in clean technology has not happened and that some of the hydrocarbons that were freely available are likely to be locked in political embargo, are you thinking of doing a new scenario and when might we get it?

Christophe McGlade: We update our scenarios every year. I mentioned that I am in the World Energy Outlook team. That normally comes out in October or November of each year. We will be updating our scenarios as usual.

Lord Fox: Have you thought of changing your schedules in light of the fact that stuff is happening?

Christophe McGlade: Of course, the IEA is fully aware of what is currently happening and we are doing our best to monitor and keep on top of the situation. It is quite challenging to construct these scenarios.

Lord Fox: Is that because it is moving?

Christophe McGlade: It takes about six months, just to highlight, from beginning to construct a scenario until it is ready. You cannot just flick a switch.

The Chair: Catharina, where do you sit as regards where we are now and the impact of the crisis on affordability and reliability? Are you also clearly sticking to your position that there should be divestment from oil and gas and fossil fuels as we look ahead? How are you viewing things?

Catharina Hillenbrand von der Neyen: Yes, very much so. We see it as an acceleration towards a clean energy transition. I do not have to go into the fact that this situation exacerbates our dependency on volatile commodities. This is just a prime example of risk from geopolitical events. If we look into what it does, we are currently in a situation where our systems are predominantly still driven by extracted energy, and we need to move to manufactured energy. Looking at the risk and affordability drivers of that extracted energy system, there is very little question that, if we move to net zero and clean energy, there is a very clear cost-competitive element, which I will come to in a minute.

If we first look at what we are currently facing, we have a direct dependency on security and affordability through counterparties who can withhold or through other counterparties who might not wish to withhold but are not in a position to provide the supplies that we need. If there is a lack of supply, you get that pricing impact that we are currently seeing.

What this illustrates so very clearly is a situation where it is not one place—the UK, Germany or wherever else. Interdependency is rising. One place sits on a shortfall of supply. Take Germany with its low gas storage levels at the moment, which were induced last year. That drives a pricing level across the continent and immediately feeds into pricing levels here. You have a combination. You get a double head of lack of supplies from withholding, directly and indirectly, and you get it through the price in a reinforcing mechanism.

The proposition holds more than ever. Perhaps before I get into the competitiveness element of clean, one should not be fooled into thinking that LNG is going to solve the issue, because LNG is a very fungible commodity. In particular, gas has become more global and more prey to arbitrage. Tankers and shipments are diverted very quickly. You have long-term contracts that dominate the market but, when there is a supply crunch—and they tend to happen together, as we are currently seeing—the entire world competes for that marginal and remaining 5% to 10% in the free market. That is the premium price that it dictates.

Lord Stern of Brentford: I wanted to bring in the notion of flexibility

and speed of expansion of capacity. Would you agree that renewables capacity can be expanded much more quickly than that of fossil fuels? A coal-fired power station takes about five years; you get up solar or wind in a year or less. You can see where I stand, of course, but the conclusion that the German Government have drawn is that they should bring forward the date of zero carbon electricity. Indeed, the head of the Free Democrats, who is in the Finance Ministry, started referring to this as “freedom power” and “freedom fuel”. The point that I wanted to introduce there is that, with increased uncertainty, speed of reaction matters. You can move more quickly on renewables than on other things, over and above everything you said about volatility and so on.

Catharina Hillenbrand von der Neyen: If you wish, I can loop back into the clean argument, which comes precisely to that point. You first get the competitiveness point of view. That brings me back to the point on affordability. We have done the numbers extensively for this country and on a global basis, and we are very happy to provide those relative competitive numbers. If we look purely at a substitution, we are looking at about half the price levels of clean energy baskets compared to existing and new coal and gas. Those numbers were done before the current price spike.

I would fully agree with your point, because you get much shorter lead times on the construction phase. The industrial backdrop of your manufacturing landscape is largely in place. You do not have to build that up. The policies within this country have achieved a supply chain that functions, and perhaps we will go into those supply chain issues in a separate question, but clearly you need to consider that.

Christophe McGlade: You are fully right that renewables can be and are being built very quickly, and we can accelerate them more quickly than what we have been doing before. I would add into the mix another important element, which is extending the lifetime of existing assets. In a number of countries around the world, particularly in Europe, you have ageing nuclear facilities, for example. You have ageing plants that could use bioenergy. Extending the lifetime of those assets could also be an incredibly important way to avoid having to use a greater amount of fossil fuels.

Q31 **Viscount Chandos:** If I could follow up on Lord Bridges’ line of questioning, the argument has been that there are all the hydrocarbon reserves that are needed. Have the geopolitical changes of recent days, weeks and months changed that in terms of usable reserves? If it has not, or in any event, is it a matter of distribution and of getting those reserves to where the energy is being consumed, whether by pipeline or by tanker?

Christophe McGlade: In our net-zero scenario, we pointed out very clearly that there are enduring energy security concerns and things to pay attention to. One of them is that, in this scenario where you have no new fields being developed, production and supply will become

increasingly concentrated in the largest producers today: the Middle East, Russia and other large producer economies.

It is a smaller market as we are shifting away from fossil fuels, but supply will be increasingly concentrated. By 2050, you would be in a situation where the share of OPEC in the market would be higher than at any point in the history of oil markets.

The pathway that we paint towards net zero in 2050 globally is only one pathway towards this, and there are other pathways that could equally achieve that. Bear in mind that, if you were in a situation where other fields opened up for reasons to do with energy security or domestic considerations, other fields would have to shut down prematurely; otherwise you would have a large drop in the oil price. There will always be a balance here. If you are moving towards net zero, demand is falling so sharply that you will need to have supply coming offline.

The Chair: If we all accept that gas plays a part in the transition, what you have just implied is that, if we abide by the scenarios, we are concentrating supply in the hands of Mr Putin.

Christophe McGlade: In this scenario, supply becomes increasingly concentrated because of the nature of the fields in those countries.

The Chair: From a geopolitical perspective, that may be a very undesirable thing for us to be looking at right now.

Christophe McGlade: This is one of the areas that we highlight quite clearly. You have to make sure that, during the transition towards net zero, that does not come at the expense of concerns around energy security.

Lord Fox: That is why that new scenario of yours is going to be quite crucial.

The Chair: Do you think that these considerations have been taken into account effectively to date when we have been approaching issues of energy supply, security and climate change?

Christophe McGlade: This is the ultimate question: how do you balance between affordability, security and environmental aspects? In the net-zero scenario, you have the very clear objective to get towards net zero in 2050. We also commented on aspects to do with affordability. For example, we looked at what the impact would be on household bills in this scenario versus a scenario where not so much happens on climate change—what we called our Stated Policies Scenario. This scenario just takes on board what Governments have currently set out they would like to do. We find that household bills are lower in the net-zero scenario in 2030 than they would be under that Stated Policies Scenario. Household bills decrease in that scenario.

There are, of course, going to be energy security implications. We are focusing on the traditional ones, but there are other energy security

aspects to take into account. One of them that we highlight quite clearly is the increasing concentration that there would be of supplies of critical minerals such as lithium, copper and cobalt. Those minerals today are more concentrated than is the case for oil and natural gas, and demand for those would soar.

Q32 Lord Stern of Brentford: I just want to underline one point. If greater uncertainty requires more flexibility and more capacity, the response to that question must contain an examination of what can be done most quickly. It takes close to three decades to go from discovery and exploration to production. That is a remark.

I want to ask a question about the incentive structures that you build in and the ways in which they manage risk in order to induce the kind of investment that we have just been discussing. I should declare that Fatih Birol, the head of the IEA, is a close friend. I do not know whether that is a conflict of interest, but economists tend to know each other when they are working in particular areas.

Incentives and the management of risk are critical to getting investment done. In the UK, we like to believe that the contracts for difference did make a big difference—sorry to use that word twice—to the speed with which offshore wind was built out, together with good finance from the Green Investment Bank and so on. That raises a question. Given that we want to rapidly induce the kinds of investments that we have been describing here, what measures can we use to pull through quickly in addition to contracts for difference?

Catharina Hillenbrand von der Neyen: I would quite agree that the CfDs have been extremely successful. As a reminder, we have brought the cost down by in excess of 60%. What have we been looking at? We have been looking at a very large-scale, quite industrial technology. What does that require and what do you need to scale up quickly? For it to scale up quickly, you need long-duration, low-cost finance, and those two tend to go together. That is why it has worked so well in offshore wind, precisely because you have large-scale volumes that attract that type of low-cost infrastructure finance. That is the finance that goes for long durations, which is why you need that long-term contract.

We definitely need to be looking at transposing that style of long-term visibility, creating long-term revenue models. That has to be the focus of policy and incentives. It is less about subsidising something here and now on the spot as opposed to creating a long-term revenue model that then becomes bankable. When you look at the cost curve of finance, long-term finance is where it becomes most effective and most affordable. For that, you need long-term visibility, which is typically large-scale infrastructure finance.

If you then move to a slightly less mature, intermediate or scaling-up stage, you are into private equality/venture capital, which is slightly more expensive but can take lower volumes. At the early stages, where it really is about deployment, you probably need a mix of loan guarantees and

other support, which then allow these technologies to grow into that longer-term space and to get the cost of finance down.

The very interesting part is that, in co-operation with the University of Oxford, we have looked at deployment and change in these technologies. It applies not only to energy but to major technology adoption—the old S curves and Wright’s law. You need to get into the positive reinforcement loop of markets and into the mid to higher level of your S curve, which then accelerates adoption. How do you do that? This is where you need to get the medium to long-term financing in, because then the volume of adoption helps that technology come up the S curve and drive the cost reduction on its own through economies of scale.

Lord Stern of Brentford: Could you be explicit on how you would see these kinds of techniques giving confidence in revenue streams and managing the risk on the finance side, whether through equity, long-term loans, mezzanines or whatever? How would you see that combination of confidence on revenue and sharing of risk in the finance applying to back-up, storage or green hydrogen?

Catharina Hillenbrand von der Neyer: One could see a CfD for green hydrogen. If you look at that at the level where you situate a strike price at the difference between green and an average of blue/grey, this is the point where the balance of the CfD will be very high—arguably, about 75%—of the cost of financing for new green hydrogen.

Lord Stern of Brentford: Do you think we are there yet with green hydrogen or is there too much uncertainty? Is it too early to go strongly on contracts for difference?

Catharina Hillenbrand von der Neyer: We have a way to go but it is definitely a starting point. You need to start somewhere. If I said 75% of the burden would be borne by the subsidies, we would have to build in a trajectory to bring that down relatively quickly by the end of this decade. We are currently looking at about \$8 a kilo, and some of the cost projections go towards \$1 to \$2 by around 2030. If we kick-start this and accelerate the move on the S curve, the subsidies part of the 75% can be brought down.

Lord Stern of Brentford: What about forms of storage?

Catharina Hillenbrand von der Neyer: Again, this is a classic one where one needs to think about lengthening the revenue profile. Here, the temptation to think about the capacity market is very great, because it is a classic capacity-providing instrument, so would there not be room to shape the capacity market in such a way that you achieve your sustainable business model? It is about creating sustainable models through that capacity payment, which you want to align with the prime function of the technology.

Christophe McGlade: Contracts for difference have, of course, been very successful in the UK. They are not the only mechanism by which

costs were able to come down. Another area that is receiving increasing attention is carbon contracts for difference, where you set a strike price in relation to the prevailing CO₂ price rather than the prevailing electricity price. That can be very useful for a number of the technologies that are required in the industrial sector, green hydrogen being one of the key ones. It is not always just about the traditional mechanisms that we have used in the past. There are others coming through.

Lord Fox: I wonder, Catharina, whether you have written anything on that last point or whether you have a paper on that finance model for storage.

Catharina Hillenbrand von der Neyen: No, not at this stage, I am afraid, but we never know whether one might come.

Lord Stern of Brentford: On the subject of a paper, is it Cameron Hepburn's group at the Smith School in Oxford that you are working with?

Catharina Hillenbrand von der Neyen: It is the Smith School and Matt Ives

Q33 **Lord Fox:** Turning to technologies rather than the financing of them, we heard last week that the trick is to get a technology that can be scaled and then delivered in a systemised way. That is why offshore wind has been successful, in the sense that it became a process for installing. The person who gave us evidence suggested that floating wind can be a similar type of thing. What are the other technologies that we should be looking at and backing long term? Hydrogen has already been mentioned, as has carbon capture and storage, so are those where we put our money and our efforts, or are there others coming around the corner?

Christophe McGlade: Perhaps just to start with a very quick number, again referring to our net-zero scenario. We have all the technologies available to us to get our emission reductions needed to 2030. We need to cut emissions from today by about 40% to 45% by 2030. We have all those technologies available. Where it gets more challenging in terms of new technologies is after that. If we look at the picture in 2050, we have only about half of the technologies available in the market today to reach net zero.

Lord Fox: Have you included distribution and grid management technologies in your scenarios there as well as generation?

Christophe McGlade: Absolutely, all the investment that is needed into electricity networks and liquids and gases networks—we should not forget that they are very important as well—is in there. The demand for flexibility increases very significantly. Because you have an increase in electricity demand and an increasing share of variable renewables, your need for flexibility grows even more quickly than that. It is about a fourfold increase in the need for flexibility, and grids are going to be a very important part of that.

Another technology area, to come back to your original question, is advanced battery technologies. We need to see advances in advanced batteries to ensure that we have that clear pathway towards net zero in 2050.

Lord Fox: They are large-scale storage banks that you are looking at, in a sense. Is that new, basic battery technology, or is it better deployment of current battery technology?

Christophe McGlade: To be honest, it is a bit of both. Of course, this is the nature of innovation. We do not exactly know which technologies will come through. Just to be very clear, this is not about inventing new technologies. All the technologies that we need for net zero are in the lab today. We need to start rolling them out, get them to the demonstration phase and get them to that next stage.

Lord Fox: What should public policy be doing to get to those demonstration stages and beyond?

Christophe McGlade: This is where the sorts of support mechanisms that we have been discussing will be incredibly important. R&D is needed, and we need to see a big increase in R&D, but support for those demonstration projects, particularly for technologies like CCS, for example, will be incredibly important. They are not yet at the stage where you could start to use exactly the same mechanisms that we have been using for wind.

Lord Fox: When do you think we need CCS to be available?

Christophe McGlade: We need all this innovation and investment to be happening today.

Lord Fox: It would be industrially deployed when?

Christophe McGlade: CCS is already available and has been deployed in a number of countries around the world. We need a massive scale-up in that. We need a huge increase in the number of projects that there are around the world.

Catharina Hillenbrand von der Neyer: Perhaps I may beg to differ with Christophe on CCS. It is our position that CCS for decarbonising the power and electricity sector is not the appropriate thing to do. We recognise that you need CCS to decarbonise the system, but we would reserve that for the harder-to-abate sectors.

Lord Fox: You mean steel and things like that.

Catharina Hillenbrand von der Neyer: Yes, in the industrial space. We just do not see why you would need to do that at this cost curve, which is very hard to deploy. Getting to the scale level is much more complicated than with some of the other technologies, by virtue of the size of each individual project, while we have competing technologies now. Renewables are competitive. If you look a few years out, renewable

storage becomes competitive. We feel we should go down that road and deploy more aggressively, and get into the positive market feedback loop on those.

Lord Fox: Just to be clear, you are saying that we have the generation technologies we need; we do not need new generation technologies. I think I understood both of you to imply that. When it comes to carbon capture and storage, there is a slight disparity, but your view is that it should be at the heavy industrial end rather than in the power generation field.

Catharina Hillenbrand von der Neyen: Indeed, that is our view. I am not making an end call to innovation—it would not be my place to do that—but the big challenge now is the integration and optimisation of these technologies, which we have written a paper on. It is about thinking about portfolio optics and conjunction optics. We should no longer think about it being solar or wind, and then we deploy but we forget about what is at the periphery.

Lord Fox: If I was working on wave generation or tidal barrages, should I stop?

Catharina Hillenbrand von der Neyen: You should think about how that integrates the system. Can it match the cost curve? How would it interact with other technologies? How would that provide a joint benefit with a combination of various technologies?

Lord Rooker: Just briefly, so that we do not make assumptions, who is prioritising carbon capture and storage? I just had a Minister downstairs show not the slightest interest, as far as the UK Government are concerned, about the use of it—maybe using gas to solve the intermittency problem for the next decade, say, but not the slightest interest. They just said, “It’s a technology that we are looking at”. Who is prioritising carbon capture and storage?

Christophe McGlade: The UK Government have a project that is in the pipeline. If you are talking about other countries, we have projects that are in operation in Canada. There is a big project in the US. A number of companies in the United States are looking at this. A lot of that work is where you capture the carbon for enhanced oil recovery, but it is a mechanism by which you can generate revenues from capturing carbon, which is, in many parts of the world, very difficult today. North America is looking at this.

On the slight differences between our views, our view is that CCS is, of course, crucial for the industry sector. There are some countries, developing Asian economies for example, that have very young power plants. If they are to move towards net zero, they will not want to shut down all those plants overnight. They will want to find ways in which they can continue to use their existing assets. Many of these plants are less than 10 years old.

Lord Fox: These are coal, are they?

Christophe McGlade: These are coal plants and, in many cases, natural gas plants. One way in which they can use those plants is to retrofit them with CCUS or to construct new carbon capture and storage plants.

Q34 **Lord Griffiths of Fforestfach:** I was very interested in some of the criticisms that Carbon Tracker makes of the IEA and the World Energy Outlook. I am a complete layman in this field, but I would like to ask you what the difference is between the two of you. There are four criticisms here of the IEA and they are pretty stinging.

Catharina Hillenbrand von der Neyen: We feel that, with the latest World Energy Outlook, the IEA has made quite a big change to its way of looking at integrating the net-zero scenario. It is our view that, if you are to achieve the transition and come to a sustainable system, the net-zero scenario has to be the central case scenario. That is our biggest point.

Lord Griffiths of Fforestfach: Do you mean that that is the case you have to meet, regardless of everything else?

Catharina Hillenbrand von der Neyen: You have to meet net zero. The IEA's net-zero scenario will have to become the central case. We felt that, in the past, clean energy investment and the reduction in the cost curve in clean energy had simply been underestimated.

The Chair: Just to pick up on Lord Griffiths' point, are you saying that carbon trumps security?

Catharina Hillenbrand von der Neyen: There is a possibility of achieving security. We recognise that we cannot have an insecure energy system, because you get failures on affordability and all kinds of repercussions on a societal basis, so we cannot throw security out of the window. What you need is a higher build rate and a different technology combination to achieve that security. For that, we need more rapid deployment, because that is your only way to security.

Lord Griffiths of Fforestfach: Can I just follow up on this? Let us assume some politician comes along and says, "I believe in net zero, but I don't believe in the timescale that net zero is put down on at present", and you get a whole lot of consumers who say, "There's a real cost to us. We either pay more taxes or, via regulation, we are, effectively, asked to do things to our homes that are costly". Then say a movement develops, where you need another 20 years; it is not before 2050, but before 2070. How would you respond to that? I know it is hypothetical but, frankly, the world in which we live is so uncertain that it allows us to explore hypothetical issues.

Catharina Hillenbrand von der Neyen: There would be two answers to this. The first answer is to send them straight to the IPCC report that came out yesterday, which shows the urgency, in that there really is no margin for moving the timeframe out. Then you get to the point where even your adaptation cost is far in excess of any transition cost, and you

get existential concerns for a number of countries. That will then lead you to societal upheavals that can go beyond the countries in question. You get a different level of security concerns if you let that run and push that out.

The second string of the answer is that I would not say that, by pushing it out, you get a more affordable system, just because you are not supposedly paying a tax or regulation cost or whatever cost it takes on. You are paying another cost—the cost through commodities and through instability. You are not comparing a cheap technology with one that is going up in price. It is the other way around. You have an inflationary commodity and a deflationary technology-driven transition. You have one level where your cost is going up by virtue of volatility and inflation. You have another one where inflation is being taken out through technology advance and manufacturing. That is the big difference between extraction and manufacturing, and that should, by far, outweigh your initial regulation or policy cost.

Christophe McGlade: Perhaps just to add briefly on your first question, I am not fully aware of all of Carbon Tracker's criticisms of the IEA, but we are an intergovernmental organisation and respond to what our members ask us to do.

On your second point, on the costs of delaying the road towards net zero, the one thing that we should consistently highlight here is that there are enormous benefits from moving as quickly as possible towards net zero. There is the climate change and emission reductions angle, but then there are benefits in terms of jobs. There can be a huge increase in industrial capacities if countries move quickly towards some of these key technologies that we have been discussing. There can be improvements in terms of security, because you are less reliant on importing commodities from overseas. Then there are benefits in affordability. As we have been hearing, the costs of renewables are falling. In most parts of the world today, new wind and new solar are the cheapest form of electricity. And, as I said, you have lower bills for consumers in a net-zero scenario than under a scenario where you delay it considerably.

Lord Griffiths of Fforestfach: Very briefly, the question I was going to ask is whether the Government have provided sufficient certainty on which technologies will be needed for a secure and affordable transition? To add to that, in spelling it out, what do we mean by "sufficiency" for a private company? Who chooses the technologies? Ultimately, how much oil and gas do we still need, given the proverb that a bird in the hand is worth two in the bush?

Catharina Hillenbrand von der Neyen: Under a net-zero scenario, we need no new investment in oil and gas, so that is the short answer to that. If we then go into what is sufficient for a corporate and what the transparency framework is, you need to go top down and comprehensive, with a clear road map that has an overarching concept, drills down into sectors and technologies, brings milestones and targets with precise years, and brings a monitoring framework. It then needs to underpin that

with a comprehensive regulatory framework, which needs to not only go into each technology but go cross-sector and do successful sector coupling, as some of the very successful frameworks do. We are now at the stage where the industrial sectors and the non-direct core sectors are becoming more important. If you drive deployment in transport, mobility, heating and industrial applications, those will drive the other sectors and create revenue models and scale.

Christophe McGlade: This links to some of the points that we were discussing on the technologies that are needed. The world needs to invest much more in innovation today. Of course, the UK has a high degree of excellence in a number of these areas. This could be in relation to batteries, low-carbon hydrogen, carbon capture and storage, or direct air capture.

All these technologies are going to be needed, but innovation policy is not about picking winners and saying, "This is the particular technology we want". It is about getting the framework and the groundwork correct, so that you can see which technologies come through. Those are the sorts of technologies that we have identified that are needed towards net zero, but which ones a country might choose to do is up to the country itself.

Q35 **Lord Stern of Brentford:** This is a question about financial institutions' commitments to net zero. For example, the Glasgow Financial Alliance for Net Zero saw \$130 trillion of assets under management committed to net zero. How do you see that playing through into investments in renewables and in fossil fuels?

Christophe McGlade: Again it is important to bear in mind the numbers here. There was the idea a few years ago that solving climate change was about shifting investment in fossil fuels into clean energy technologies. I mentioned those numbers before. Investment in fossil fuels today is a fraction of what we need going into clean energy technologies, so the key thing is to scale up that \$2 trillion gap that there currently is around the world in order to have that investment coming through.

Whenever we have these discussions with financial institutions and banks, that is really where we would like to see the emphasis placed: what are you doing to scale up clean energy investment on the ground, particularly in emerging markets and developing economies? There is an even larger gap between the levels of investment occurring today in clean energy technologies in those countries and the level that is going to be required.

Catharina Hillenbrand von der Neyen: The big question will then be matching project sizes to capital. You are going to have to think about grouping financial structures and so forth to make it effective to bridge the gap. There is a huge appetite for investment into the new technologies but then there is, very often, a mismatch of scale.

Q36 **Lord Skidelsky:** I found the whole discussion about a trilemma very puzzling. If you need to stop climate change by 2050 in order to prevent

large parts of the world becoming uninhabitable, there is no trilemma. There is no trade-off. You have to do it, whatever the affordability and whatever the cost in energy security. If you do not, the results will be far too horrendous to contemplate. That is the conclusion of the science, as I understand it. You might say, "Let us push it forward for 20 or 30 years, because we will have horrendous results, but then we might think of a trade-off between those horrendous results and increased energy prices". If 2050 is your target, and dreadful things are going to happen if you do not achieve that, there is no trilemma. The trilemma is not there. The trilemma implies a trade-off between different possibilities, which can be valued, to some extent, equally. That is my problem with the language.

Catharina Hillenbrand von der Neyen: It is a very fair point. Arguably, the trilemma is on a two to five-year horizon, whereas, as you go further out, even your affordability point begins to disappear, because the costs on the other side become so high. The security point disappears because other security concerns that massively overwhelm our current security concerns are going to appear.

Lord Skidelsky: So you still think it is worth talking about trilemmas. You believe in the language of trilemma. You believe that that is helpful.

Catharina Hillenbrand von der Neyen: I would argue that you need to look at the most cost-efficient deployment of technologies. We must not forget that bills need to be paid, so we must do it in the most efficient way. It is a consideration and one that should be delivered through market efficiency. Should we stop calling it a trilemma? There is a possibility, but our fundamental considerations are still here. We need to lengthen the time horizon. If there is a short-term challenge, to change the wording, we need to look at how we deal with this.

Q37 **Baroness Kramer:** I have to admit that I have been sitting here trying to structure special purpose vehicles for the difficult financing of small and risky projects. It would be great fun and very doable.

Can I ask you a question about investors and the green taxonomy? It is in the context that the EU has come forward with a green taxonomy that, after bitter battles, has included both gas and nuclear as transitional technologies, and the fact that the UK now has its own advisory group looking at developing a unique UK taxonomy.

I have three questions, so why do I not put them all in front of you in order to minimise the amount of time it takes to answer all of this? First, is the green taxonomy significant for investors as they decide where to put their money, or is it merely just another issue of guidance?

Secondly, should the UK include transitional technologies? There are rumours that it will include nuclear but not gas, but your thoughts on that would be much appreciated.

Thirdly, does it matter to investors and does it make a real difference to what happens if the UK and the EU have different taxonomies? Does it add to confusion, gaming the system or arbitrage? Your thoughts on those three would be much appreciated.

Catharina Hillenbrand von der Neyen: We can tackle them all together in a way. It is significant, because it provides a very clear framework, and the EU one is extremely detailed. You get to tag, by industry code, what is in and what is out, and what you can and cannot label. It is maybe not quite as visible at this stage, but certainly in stage 2 it is far beyond guidance and becomes regulation and legislation. In that sense, it is important. You can no longer market an investment in a NACE code that is wrong. If it is correctly executed, it should do away with a lot of the greenwashing, but that is, conversely, the danger.

If I move swiftly to your topic about transition technologies, we find that the inclusion of gas has greatly undermined the entire taxonomy. If you then go a step further, you have topics such as an improvement of the steel sector and investments outperforming their peers in decarbonisation within a sector. That is extremely confusing and undermining. If you have a very poorly performing sector and you do a tad better, you are already in, so that cannot be the aim. I would be very careful in including transition technologies. If you look at the EU taxonomy, what is extremely important is the inclusion of enabling technologies, which you want to be quite wide. You may have early-stage technologies or ones that bring to the market others that then decarbonise.

Lastly, on differences versus the EU, I am not sure whether this will go down well, but one should converge. It is not a question of GB versus EU. It should be one of global standards. The more proliferating regulations, prices, taxonomies and standards you have, the more confusing it becomes and the more they all undermine each other. We have to converge to global standards on these things. The investment industry is global.

Christophe McGlade: Perhaps I will focus on your second question of whether it should include transition investments. In our view, it should do, because, even in the net-zero scenario that we have constructed, around half of the investment that is needed over the period to 2050 is in these sorts of transition or contingent technologies—things that do not immediately deliver net zero but can be important to get you along that route. Including such things as improving the efficiency of existing processes is very important to help reduce emissions over the period to 2030, while also not ruling out the move towards net zero by 2050.

On the third point about divergence, we are already seeing that a number of international companies are struggling with the different taxonomies that there already are around the world today, so having lots of different things is a challenge.

Q38 **Lord Monks:** Rather controversially, the Bank of England had its remit changed to pursue the cause of net zero and was given a role in the drive for that. Do you think that central banks have a role to play in that? Is there any sign so far that the Bank's changed remit is having any effect?

Catharina Hillenbrand von der Neyen: You can see a role in precisely laying out road maps for the financial sector that will then translate into

industry. You can see them contributing to taxonomy frameworks. You can see an alignment oversight of the financial institutions. There is quite a large element of potential transition plan oversight by the financial institutions themselves, which then trickles through the system. Stress testing is a potentially important aspect for a certain number of institutions, with rolling, consolidating methodologies. There is the whole element of financial disclosure, which is lagging behind terribly. Investors are incredibly frustrated with the lack of consistency and of disclosures with regard to climate change and climate risk. Lastly, you have supportive action such as loan facilitation, finance facilitation and links to supra-nationals.

Christophe McGlade: To the extent that financial firms are exposed to climate risks—and they are—it means that the central bank has a role to play, whether in terms of transparency, stress testing, enforcing rules, or ensuring that things can be compared. These are the areas where central banks can really play a role. We have seen that companies have been waiting and holding back, because they want to see the regulator set some rules and conditions, so that they can start to carry out some of these tests that are needed.

Q39 **Baroness Kramer:** There has been a big dispute here about whether the PRA should be playing a role with the capital requirements against, for example, the exploration of fossil fuel assets, which are currently risk-weighted exactly the same as any other corporate asset. Is there a role like that? Are those risk weightings going to be something important that has to be introduced at some point? It is changing the cost of capital, in effect.

Catharina Hillenbrand von der Neyen: This is the whole idea. You could do it either through risk weighting or through disclosures—impairment pricing, timing of assets, and your assumptions on the front end of your financial statement and how that compares to your guidance. There clearly is a role for that, and that will change the cost of capital.

Christophe McGlade: We need to see this huge surge in clean energy investment, and mechanisms that can do that should, of course, be pursued by everyone.

Q40 **Viscount Chandos:** Can I end where we started, which is geopolitics? What do you think the key geopolitical factors are in terms of security and cost of energy? How do you see the Russian invasion of Ukraine affecting supply, and what can be done to mitigate that?

Catharina Hillenbrand von der Neyen: I would see it as a great accelerator of the transition, if you already look at some of the measures that have been put into place. We have had mini or medium-sized crises of this type before, but this is now a significant accelerator and those measures will bring things forward. It incites us to think about our dependency points. You have unreliable sovereigns of all sorts. This is an expression of one. You may find them somewhere else. You may find other desires for control and energy use for all kinds of purposes.

In terms of dependency, you have a sovereign, but what is clearly showing in this situation is that you have interdependencies. You have the off-taking nations competing with each other. There are interdependencies that we do not control or may not even be aware of. In the most peaceful of times, we may have made wrong decisions about the filling of storage or constructing the wrong infrastructure that sits in the wrong place, and you get instability occurring that disrupts the entire system.

If we move towards a manufactured system, you will do away with some of those. You may look at some others. Concentrations of material have been managed, but concentration of manufacturing capacity is something that one needs to think about and plan. Arguably, those sectors are lighter in touch. You do not take 10 years to develop some of those plants. You can do some of them in six or eight months, or a year or two. You have faster turnaround horizons, so your reactivity should, arguably, be higher, and some of this is more plannable.

The framework would be about where the sticking dependency is and where the plannable dependencies are that can be mitigated with foresight and a reasonably short reaction time.

Christophe McGlade: The traditional energy security risks around oil and gas are not going to disappear, even in a rapid transition towards net zero. The UK is going to remain a net importer of oil and gas, and so it is going to remain exposed to disruptions in all parts of the world related to that.

Viscount Chandos: Comparisons are being drawn with the effect of the Yom Kippur war in 1973 on the world economy. Is that a parallel that we should bear in mind now?

Christophe McGlade: I am not aware of what comparisons are currently being drawn.

Viscount Chandos: That war was, in part, about energy and led to a huge increase in the price of oil and energy, which persisted long term.

Christophe McGlade: After 1973 and 1979, we saw, with high oil prices, that efficiency measures were rolled out very strongly, but a number of countries chose to pursue domestic production as well. Those are the sorts of issues that we are seeing being discussed today. Lessons will be learned from this. It is probably a little early to be saying what the impacts are going to be right now.

Q41 **The Chair:** If we follow the output of the scenario—that is, no new oil and gas development—and given that, according to your scenario, gas demand is going to rise during the 2020s and that we are going to therefore see supply concentrated in the hands of OPEC and especially Russia, what you are saying, as far as I can see, is that there is sufficient technology out there of a renewable kind that can be scaled up. Therefore, it is not a risk to energy supply to do that, rather than going

and investing more in gas. Is that the position? Does that summarise your overarching position?

Christophe McGlade: The scale-up in clean energy technologies should be the focus.

The Chair: You think that that will deliver reliable supply. We have not really got into intermittency.

Christophe McGlade: The extent to which the energy system used to be secure—and, of course, it was not secure when there were disruptions in 1973 and 1979, and many other times—was because we invested in energy security then. Going forward, we are also going to have to invest in energy security, even on the route towards net zero. We should not pretend that just pursuing net zero by itself will achieve all these other objectives that there might be. That will require investment and careful examination, but the scenario aims to show that it is possible to do that.

Catharina Hillenbrand von der Neyen: If I may add to that, it is a different concept of security that we have to look at. If we go towards batteries or system security, there is a perception that clean is insecure, but we can greatly increase the security level of clean. We can do away with that insecurity. If we achieve that—and the chances are that we are able to, because we know what the pathway is—we get an arbitrage that looks very good.

The Chair: I am sorry to cut you off. We have gone over time already. There is so much to talk about. Thank you both very much for a very useful session indeed.