



Energy and Climate Change Committee

Oral evidence: [New Climate Economy](#), HC 666, Wednesday
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Members present: Mr Tim Yeo (Chair); Ian Lavery; Dr Phillip Lee; Mr Peter Lilley; Graham Stringer; Dr Alan Whitehead

Questions 1-33

Witnesses: **Professor Lord Stern**, Chair of the Grantham Research Institute on Climate Change and the Environment and Co-Chair of the Global Commission on the Economy and Climate, and **Jeremy Oppenheim**, Global Programme Director of the New Climate Economy and Director of McKinsey & Co, gave evidence

Examination of Witnesses

Witnesses: **Professor Lord Stern**, Chair of the Grantham Research Institute on Climate Change and the Environment and Co-Chair of the Global Commission on the Economy and Climate, and **Jeremy Oppenheim**, Global Programme Director of the New Climate Economy and Director of McKinsey & Co, gave evidence.

Q1 Chair: Thank you both very much for coming in. As it is a televised session, the broadcasters ask, although we know perfectly well who you are, if you would just each introduce yourselves by name and, very briefly, by function.

Professor Lord Stern: My name is Nicholas Stern. I am a Cross-Bench member of the House of Lords, IG Patel Professor of Economics at the LSE, co-chair of the Grantham Institute at the LSE, President of the British Academy, and Fellow of the Royal Society.

Jeremy Oppenheim: My name is Jeremy Oppenheim. I was the programme director in charge of leading the work for the Commission and writing the “Better Growth, Better Climate” report. I did that on sabbatical from my regular position as a director at McKinsey.

Q2 Chair: Thank you both very much for coming in. You are extremely welcome at this Committee. As you know, we have a very close and long-term continuing interest in the subjects covered by the

“New Climate Economy” report. I will ask a general question to begin with. How do you believe the “New Climate Economy” differs from the review that you carried out, the Stern Review?

Professor Lord Stern: That will allow me to give a little introduction to what the report is about, so if I could take two or three minutes on that.

Chair: Sure.

Professor Lord Stern: The “New Climate Economy” report starts with the challenge of growth. Policymakers around the world have growth and poverty reduction at the centre of their agenda, and understandably so. It is an experience I have personally had as Chief Economist of the Royal Bank in the UK Treasury and in my academic life as well.

What drives growth? Investment, innovation, research efficiency, technological change and structural change, so those issues are at the heart of this report. The question is: how do you foster growth through those kinds of mechanisms while, at the same time, embarking on radical reduction? It starts with the growth story, so that is one difference. Secondly, it focuses on the next 15 years. It asks about investment over the next 15 years because that investment and that period will be critical in determining a sense of direction. Delay in reducing emissions is extremely important because of the ratchet effect of flows of emissions into concentrations of greenhouse gases and the lock in.

That period is very important from the point of view of climate change. It is also very important from the point of view of growth in the world economy. We are going through a remarkable period of structural change over this next couple of decades. You are seeing a big shift in output; a fraction of output coming from emerging markets, developing countries. You are seeing tremendous urbanisation. The next 15 or 20 years you will see another billion in cities. You are seeing big investment in energy systems around the world as many countries go through rather energy-intensive periods of development. You are seeing refurbishment of energy systems and you are seeing very strong pressure on land, natural resources and forests.

I have argued that this next 15 or 20 years is critical from the point of view of climate change emissions reductions. It is also critical from the point of view of the economic transformations. The first difference is that this report started with growth. The second difference is that this report is very intensely focused on the next 15 or 20 years, particularly in the context of these radical structural changes.

A key driver of the conclusions of the report is that if we manage this process of structural change well over the next two decades, well in relation to pollution, congestion, resource efficiency, pressure on land, and so on, we will have done perhaps a very big majority of what we need to do in the next 15 or 20 years in bringing down emissions. We need to bring them down from about 50 gigatons or so CO₂ equivalent per annum now as a world down to close to 40. Continuing roughly as we are or not managing this change very well might see those emissions rise over 15 years or so into the high 60s from 50 now.

The challenge we define on bringing down emissions is to take something headed for the high 60s, 15 years from now, down to close to 40. When we say at least half, perhaps the big majority of what needs to be done could be done by managing the transition well and investing well. We mean what needs to be done in relation to bring it down from the high 60s, 15 years from now, down to the low 40s or close to 40. It is obviously consistent in spirit with the Stern Review, consistent in many ways in the conclusions, but there is that big focus on growth in the context of

structural change and the big focus on the specifics of what we have to do over the next 15 years. That is roughly the difference.

Jeremy Oppenheim: Let me just add one thing if I may. We also had the benefit of seven or eight years since the Stern Review was published, so we have seen a lot of change and there are two things specifically that we have seen that we incorporated into the work of the Global Commission. One is obviously the astonishing progress on some technologies. I think it is fair to say that the Stern Review in 2006 did not fully anticipate the speed with which solar or wind technology would improve. We are seeing a range of technologies come through, not just around renewable energy but more broadly in terms of influencing and improving the carbon efficiency of the economy as a whole. One of our central propositions was to understand the speed and potential scale of the technological changes that are taking place and make sure that is deeply embedded in the way in which we think about the next 15 years and beyond.

We also had the benefit of looking at the policy innovations that have occurred across the world since the Stern Review, some of which we have learnt some very positive lessons from. Other areas of policy have been more challenged and we know what some of those are but, again, they contain lessons about how to make the transition work better, so we have the benefit of that experience over the eight years since the Stern Review. I hope what we did in the work of the Global Commission was to incorporate those two features of technological innovation but also policy innovation into the core of our work.

Q3 Chair: That is very helpful. The context is a reminder of the absolutely critical importance of the decisions made by Governments around the world during the start of this 15-year period and the danger that wrong decisions lock us into a trajectory that is then very difficult to adjust in the right direction. Also, on what you have just said about the unexpected nature of some of the changes, by definition changes are unpredictable from that point of view. There are a lot of reasons for being concerned, perhaps even very concerned or even worried, but it is a reason for perhaps being optimistic that we can get to the positive outcome of all this because of the nature of the technological innovation, some of which we have seen but a lot of which obviously by definition we cannot anticipate.

Professor Lord Stern: I can add two more things. We have come to understand the health costs of particulate air pollution much more deeply over the last three or four years. Partly that is a result of satellite observation, which allows us to observe where that takes place much more accurately. For example, the PM2.5 is not just in Beijing; it spreads across the whole of the east coast of China. You have that satellite observation, which has allowed us to understand the prevalence of air pollution and small particulates, in particular. The WHO have looked much more closely at what the health costs are. Those health costs are very big and that is something that is articulated in the report.

The second thing, of course, although it was not cause and effect, is that a year or so after the Stern Review was published the world went into an economic crisis, as you know, and that has led to a still stronger emphasis on growth, quite understandably, and, of course a period when the cost of capital is extremely low and there are quite a lot of unemployed resources. That means it is the ideal period for investment and the kind of infrastructure and innovation that is the low-carbon growth story of the future.

Q4 Chair: What was the input of the Economics Advisory Panel into this work?

Professor Lord Stern: I chaired that Economics Advisory Panel. It is a rather distinguished group. You have the list in the report itself. I take it you have a copy of this report.

Chair: We have had access to it, yes.

Professor Lord Stern: We interacted with them and asked for their ideas, often individually and sometimes as subgroups. We took their advice. For example, we talked to Dani Rodrik, professor at the Institute for Advanced Study in Princeton, arguably the world's leading economist who works on structural change and the role of structural change in economic growth of nations, particularly about that aspect of the work. Mike Spence has done a lot of work on the process of catching up and also on structural change. He is a Nobel Prize winner and he chaired the Growth Commission for the World Bank. Philippe Aghion of Harvard is probably the world's leading theorist who looks at the way in which technical progress takes place as a result of incentives and experience. We talked to them individually about particular areas that they were interested in.

Of course, we had Indian and Chinese members of the advisory panel. We would focus our discussions with them in that area. We did not ask them to write. We asked them to guide and advise, so we did not ask them to sign off. It was called an advisory panel and it was an advisory panel, but we gained a lot of insights and thoughtfulness from them.

Q5 Chair: Were the developments such as the “IPCC Fifth Assessment Report” and so on something that impacted on the economic case for investing in greater climate change mitigation and adaptation measures?

Professor Lord Stern: The report of the IPCC, the fifth report that has been coming out over the last year and a half or so—the Synthesis Report on the science came out very recently—obviously influenced our assessment of what was necessary in terms of emissions reductions. Yes, they mentioned roughly where we were going without much strengthening of policy and where we needed to go to be something like on a 2 degree path. Of course, that was strongly influenced by the IPCC. We looked at and took account of some of the modelling that the IPCC has done on the economic side, and Ottmar Edenhofer, a professor at the Potsdam Institute of Climate Change and Co-Chair of Working Group III on policy, was a member of our Economic Advisory Panel. We read and looked at and listened directly to some of the participants. Of course, like everyone working in this area, we take the work of the IPCC seriously.

Q6 Chair: Was there engagement with decision makers—policy makers—as well? Did they have an impact on the final report?

Professor Lord Stern: We were very careful to have on the Commission people who were no longer policy makers because we did not want them to feel obligated to defend a position that they are taking or defend a particular country position, but around a third of the commissioners were Finance Ministers, Prime Ministers and Presidents. Very deliberately in the early stages we sought out people who had to take the responsibility, Finance Ministers, Prime Ministers and Presidents, of economic decision making. They had to think hard about the growth issues. Similarly, another third were people in all kinds of business, from Unilever to banks and so on, who had to take big business decisions. They all took the investment, innovation and resource efficiency issues extremely seriously. We did have the benefit of that kind of advice.

Of course, the other third of the Commission were people associated with international financial institutions. I have been chief economist of the World Bank and of the EBRD, but we had the current chief economist of the World Bank on the Economic Advisory Panel. We had the head of the OECD, Ángel Gurría, on the Commission. Of course, he is also a former Finance Minister of Mexico. The input from people who have had to take and struggle with difficult decisions on the finance front were absolutely at the core of the whole story. As I say, I have been chief economist of the World Bank and head of the Government Economic Service in the UK.

Jeremy Oppenheim: In terms of the interactions we had beyond the global level, much of the work we did to feed the Global report was done at the country level. As you know, our thesis is that it is in the self-interest of countries and companies and cities to take action for many reasons, of which climate is only one. The Global report is not just a top-down view coming from a Global Commission with international organisation people on it. It was deeply informed by work that we did in China, India, Ethiopia and Brazil. The purpose of that work in-country was to anchor our learning in the real context of those countries and it was to anchor it in the world of the ministries of planning, energy, economic development and urbanisation.

The counterparties in each of those countries were very much those ministries that were either responsible for broad economic planning and development for the countries or more sector-specific areas of focus, such as in Brazil where we were looking very much at the land use topic, while in India we were looking more at urbanisation issues. Our objective was and remains, since the work of the Commission continues, to engage with public and private decision makers who are in the real sectors of the economy and help them see the opportunity to deliver their goals in terms of both sector and broader economic agenda and how that interacts with the climate.

Professor Lord Stern: The report that you have is an overall global story. Individual country studies are coming out. The China country study came out about 10 days or so ago and was widely discussed inside China, particularly led by people at Tsinghua University, including those who directly advise the Chinese Government in these kinds of areas. The India report will be published in January. They will be released over these coming months in different countries but, of course, India and China are two of the very important countries in this whole area.

Q7 Dr Lee: You made a comment, Mr Oppenheim, about the original Stern Report not anticipating such fast technological change.

Professor Lord Stern: I would agree with him on that.

Dr Lee: The problem is that it is not the first time that a Government report has not anticipated something that happens in the future. It happens. For instance, we have just committed to high-speed rail and that is technology from the 1950s and 1960s. This is the problem when Governments get involved in choosing technologies. Since I have been engaged in this subject it strikes me that we have spread ourselves rather thinly. We can have an argument whether the state should be involved or not, but if state subsidy is going to take place might it not be better for us to concentrate on certain technological areas? We have committed to a nuclear power station at Hinkley, which is third generation technology. It does not even work yet anywhere on the face of the earth. We are making these big commitments with political consequences. I wonder whether we would be better off as a country, if the state is going to be involved and if the state is going to get commercial benefit on the global stage from it, if we concentrate our resources.

Professor Stern, you made a reference to satellites. The reason we have satellites is because the Nazis wanted to bomb London in the war, so the technology started with other motives and that rocket technology drove the space race and so on. Maybe we should concentrate on rocket technology, or the equivalent, then be ahead of the curve going forward and therefore benefit Britain, instead of the approach we seem to have, which is perhaps fingers in too many pies.

Jeremy Oppenheim: This is an area that is hotly contested in terms of policy making and I will offer a few thoughts and then I would like Nick to put his perspective. What we would tend to say is the history of countries picking winners sometimes works, but often it does not. At some level we remember the success story. You could argue, for example, that the French decision to focus on nuclear was a successful strategy. They put the state behind it and they created a power system that does generate reliable low-cost, low-carbon energy for the country.

However, there are many examples where focusing on a technology or two is prone to all sorts of mistakes. The perspective of the work that we did on the Commission was as follows. First, we do think there are a set of opportunities to invest in what one might call general purpose technologies, as opposed to highly specific ones, that will carry us a long way. Some of the digital technologies will spill over into resource efficiency in the way that Nick was describing. Some of the work on biotechnologies or life sciences will allow us to think about land use in a radically different way. The work that gets done on new materials feeds into renewable energy, but it does not force us to choose a single technology. There is a huge case, in our view, for increasing the investment in general purpose technologies that have a low-carbon dimension to them but that also have spillovers into the economies as a whole. Our broad perspective is that we and other OECD countries are underinvesting in those technologies both in the public sector and the private sector.

The second observation we would make is that there is a clear benefit in the innovation for a low-carbon world in having clear policy signals. The clearest of those signals is, of course, a carbon price that encourages the general purpose technologies to get applied in the marketplace to low-carbon submissions, but we also know that we live in a world where getting to the kind of carbon price that, in the short term, might give those signals to innovators and inventors and corporates is probably not going to be sufficient. We are unlikely to have the kind of \$40 or \$50 carbon price that might offer those kinds of signals to investors, so we need to live in the real world of how economies operate.

The question then becomes: what other forms of support do you provide? The broad perspective of the Commission is that we ought to be as technology-neutral as we can be when it comes to providing those incentives; for example, setting limits on the carbon intensity of a kilowatt hour of power and then allowing for different technologies to compete with the support on the one hand of carbon pricing and on the other of the kind of broad, general purpose technology. That is an ideal way to go, and then bringing in additional incentives for very particular technologies needs to be done with great care.

Professor Lord Stern: It was a report that was very market oriented in its approach to growth and in its approach to the problems that arise from climate change. It laid strong emphasis on the carbon price and that was a key element in its recommendations, and rightly so. That is technology-neutral energy efficiency, as Jeremy has underlined, but you can also, without picking winners, point to big problems, and coal is a big problem. Coal is the major source of the air pollution that kills so many people around the world and it is the most polluting of the hydrocarbons in terms of greenhouse gas emissions. You can point to a problem, and we did focus in on the problem of coal.

Just on general purpose technologies, to underline the point that Jeremy made, electricity storage, energy storage, is already one of those technologies that will have very powerful impacts across the board. That is an area where rapid technical progress is taking place and one where we should encourage both public and private working together. The recommendations here come out of the analysis of the problem. They do look for broad-based incentives, trying not particularly to pick winners, but they do focus in certain areas that have a very big contribution to make, like energy efficiency, encouragement of innovation around storage and so on, and big problems around coal. The mix of the general approach to incentives and the focus on particular problems is a mix that is suitable to the problem that is an issue here.

Q8 Mr Lilley: You have just mentioned that the most important instrument for bringing about this nirvana of green growth, which the report also says, is a carbon price, which the report says will provide dynamic energy benefits in the short, medium and long term, including motivating continued emissions reductions. When Lord Stern published his report, the price of crude oil was \$60 a barrel. For the last three years it has averaged \$120 a barrel. Is that the sort of impact of carbon pricing that you would like to have achieved, but by carbon price rather than the rise in the price of crude? Presumably it has exactly the same effect, whatever the cause of the price increase is. Have you seen any of these dynamic efficiency benefits since we have had a very high price of crude oil?

Jeremy Oppenheim: We will probably both take a shot at this. The first observation is that clearly if fossil fuel prices and the price of oil, as an example, are high then you could view that as having an implicit carbon tax embedded within it, which I think is the despatch of your offering. One of the things that we do see is that, when the price of oil is high and it remains high, that induces a response over time and, in particular, induces a response in terms of energy efficiency, which is exactly the kind of dynamic response in principle that one would like to see.

There are other consequences of a high price of oil but, in terms of the ambition to drive to a more resource-efficient economy, that is one of the effects that a high price of oil would generate. It is particularly the case, of course, if the price of oil or the carbon price associated with it is predictably high over time. If the price of oil is \$120 one year and \$80 the next and it keeps on bouncing around, then one does not see the sustained shift in conduct at an individual level, in what car people buy, or at the broader industrial level, in terms of industrial systems and the shifts in the approach that companies take to energy efficiency, play out over time. There is an important difference between a price that is embedded within another price that itself is volatile, and something that is a predictable carbon price that we have some control over and where we have some choices about how we use the revenues. At the moment we do not have a clear integrated approach to the revenue recycling side along with the pricing side. That is observation one.

The second observation would be that we need to be very careful to distinguish between the price of oil and the vector of energy prices that we are concerned about in the matter of the transition to a low-carbon economy. In particular, there is a relationship between oil prices, gas prices and coal prices. These things do have relationships. There are substitutions between them that are possible but, in the relationship between the oil price and the coal price, you are two steps removed. You can have a world of quite high oil prices and lower coal prices. Even in the last two or three years, until recently, we saw a high oil price and coal prices coming down because of the shale gas revolution in the United States.

Q9 Mr Lilley: In your report you point to the coal price having doubled, but you expect it to go higher.

Jeremy Oppenheim: It depends on which part of the world. It is a local price. There is seaborne coal and it is the case that, if you look over time from the early parts of 2000 onwards, we see particularly the seaborne price of coal rising and that was the price that we used in the report. As coal mining has to dig deeper and faces more technological challenges, there is a reasonable belief that, over time, the marginal cost of coal will rise. It is also a reasonable thing to believe that the cost of the renewable energy technologies, solar, wind and other technologies that come through, will fall over time. If one is making a bet, one can reasonably bet that the new set of renewable technologies will decline in cost over time. It is very unclear what will happen to fossil fuel prices.

Professor Lord Stern: Since you seem to be taking a special interest in the difference between the Stern Review and this one, I should add that Jeremy Oppenheim led the writing of this one and I led the writing of the Stern Review. That is a major difference. I did not write this report.

Q10 Mr Lilley: I was not pointing to a difference. I was talking to the difference in the prices, not the reports.

Professor Lord Stern: Can you let me go on to that?

Mr Lilley: Yes, of course.

Professor Lord Stern: I am making an observation about the line of interest of some general questions and I am turning specifically to the question that you asked. We are here for a friendly discussion, right? The energy efficiency over this last decade has increased remarkably in many areas. We all know about the much more efficient motor cars that we now have. Low-energy lighting, LEDs, uses maybe one-tenth of the energy of incandescent bulbs. We could go on, but we all know there have been major changes in energy efficiency over this last decade. Probably a big part of that is driven by the cost of fuels, particularly hydrocarbons.

You are the Energy and Climate Change Committee, so you will know that the big driver in the rise of the cost of electricity in this country over the last decade or so has been the price of fossil fuels. Particularly because gas is the marginal fuel for electricity, it has been the price of gas that has driven it. It is not true that it is climate change policies that have driven these prices, and we have to recognise that. We have to recognise what has driven those prices and, because that is what has driven those prices, you have to worry about where they are going to go. Secondly, prices do induce change. We are economists, but you do not have to be an economist to work out that if something becomes more expensive you have a greater incentive to economise, and that is very much what has happened.

I think the markets have had the effects that you would expect them to have and that is why one would take carbon pricing seriously as a mechanism, because what you are doing is correcting a market imperfection. What you are doing is charging for the damage that the emissions cause. That is good market economics. Those who would have us not correct market failures, to give away for free something that is damaging, that is anti-market. We take markets seriously. We observe the effect that rising prices of fossil fuels have on efficiency and that, of course, reinforces arguments for carbon pricing.

Q11 Mr Lilley: We can all agree that more expensive energy will, other things being equal, be used more efficiently or that less of it will be used, but your theory seems to go beyond that. It seems to be saying that you can boost growth by switching from less expensive fuels to more expensive fuels. It seems to me a rather sophisticated version of the broken windows fallacy: that you can generate economic activity by breaking windows because it provides work for people mending windows and for glaziers and for people providing inputs for glaziers and so on. We all know that is a fallacy, but you do seem to be suggesting that by going from less expensive energy to more expensive energy we can increase our growth. I wonder if you could elaborate a bit on that.

Jeremy Oppenheim: I do not think we state that or say that anywhere in the report. If that is an interpretation then we will have to improve the quality of the communication on our side. We recognise that increasing the cost of energy, particularly in lower income countries that are still in an energy-intensive phase of their development, if one did nothing else would likely reduce the rate of growth. Your observation that there is a relationship between the two is absolutely correct. We would say that actions that raise that cost not only might lower the rate of growth in those economies, assuming nothing else for the time being, but also could have adverse distribution effects. We are very sensitive to those as well because obviously, in a household budget for poor people, the cost of basics such as energy and food is enormously important. As a Commission we are very sensitive to all of that.

That said, we took the following view. First of all we took the view that particularly within developing countries, but not just developing countries, there are enormous opportunities to improve the efficiency with which energy resources, but resources in general, are used. That is not related to the price of them specifically, but there is a strongly held view, not just within the Commission but if you look at the work of the OECD, the IMF and the World Bank, where all of those institutions are saying that countries that systematically subsidise fossil fuel consumption and energy consumption are not doing themselves a favour in terms of either growth or addressing poverty.

What we have seen wonderfully in the last few weeks is a response to that kind of consideration in countries ranging from Indonesia to India, where Indonesia is at long last tackling the very substantial subsidies that have artificially reduced the cost of energy in that economy and have not done so in a way that has been particularly pro-poor. As you know, many of the benefits of those lower prices have been captured by middle and upper income groups given their energy consumption. The shift away, consciously, from bad use of energy on the back of subsidies for fossil fuel consumption in a country like Indonesia is one of the things that we see as increasing the growth potential of that economy, because we are shifting resources through to the areas in which the Government needs to make investments in infrastructure and education. That will help support long-term growth in the economy and exactly the same is true in an economy like India.

In both of those cases you would find that the cost of energy for consumers will increase as a consequence of taking away those subsidies. It is our judgment, and I think a judgment shared by the mainstream economics profession and market economists across the world, that that will be good for growth.

Professor Lord Stern: This is an important question and I do not believe the broken window fallacy is part of this report. That is your interpretation, not ours. You have to look at the costs across the board. One thing that people who take economics and market economics seriously have to do is to look at the overall costs. Now, the cost of coal in terms of the lives lost through air pollution, putting to one side lives lost in mining, is very high. That should be part of any

serious economic analysis of what growth involves, and it is part of our analysis of what growth involves. You have to look at cost capping and the rate of change of cost. The rate of change of cost—how fast costs go up in some areas and down in others—is a key aspect of policy. For example, that is core to the work of what is called in our area “endogenous growth theory”. It is about the way in which you learn from experience and the way in which policy can induce learning from experience. It is very much part of Schumpeterian theories of growth in innovation as to how new technologies come to be and how they displace old technologies.

I am adding to what Jeremy has to say because I agree with what he had to say. The first part of what I wanted to add is you have to look at costs seriously across the board. The damage, particularly from coal, is intense and it ought to be part of any serious analysis of cost. That alone would breach most of or more than the gap between that and other renewable technologies at the moment. The second is the rate of change and how you influence the rate of change of technology costs. One of the positive things we have learnt from the last eight or nine years is how quickly costs can change if you encourage investment and experience in a particular sector. Falling costs of solar have been dramatic and in a large part it has been a result of policy and movement to scale. You have to look at the full set of costs. You have to look at how costs change over time and how policies influence the way in which costs change over time. That is all part of the growth story and it was part of our growth story.

Q12 Mr Lilley: I think the Committee would agree with you on particulate emissions as we have just been to China and experienced appalling pollution.

Professor Lord Stern: Where did you go?

Mr Lilley: Beijing, Wu’an and—

Chair: Shenzhen, Wu’an, Dongguan, but the day we arrived in Beijing was one of the worst they have had for some time.

Professor Lord Stern: Yes, very good. I have been working in China for 25 years and the change in the air pollution in that time has been quite remarkable. Remember the stuff that you see is not the stuff that is most worrying.

Q13 Mr Lilley: Anyway, we are all agreed on both on internalising external costs and making prices reflect opportunity costs, which is what we are talking about.

Professor Lord Stern: It is an issue of immense quantitative importance.

Q14 Mr Lilley: On the business about renewables costs coming down faster and this somehow being stimulated and predictable—

Professor Lord Stern: No, not predictable.

Mr Lilley: Not predictable, right.

Professor Lord Stern: The fact that they come down from stimulation is predictable. How fast—we learn something but you cannot predict it entirely. It is one of the joys of economic life.

Q15 Mr Lilley: But you imply that they will come down to be competitive, which does not accord with the forecasts in the International Energy Authority's work, which says that by 2035 they expect onshore wind costs to come down by about 12% and that will only be competitive with fossil fuels if fossil fuel prices rise, partly boosted by a carbon tax. Also, it says that large-scale solar, to my surprise, would come down much more but still remain wholly uncompetitive everywhere, even allowing for their forecasts in the rise of wholesale prices. They say as a result subsidies to renewable energy are expected to amount to over \$220 billion a year even in 2035. Does that accord with your analysis?

Jeremy Oppenheim: The first observation I make is it is very dependent on what assumptions you make about fossil fuel prices. As we know, those range enormously and we could find ourselves in a high fossil fuel price world or in a lower one.

Mr Lilley: Indeed, of your forecast of carbon tax, which they are including in—

Jeremy Oppenheim: There are many unknowns in the estimates they are providing, but there are some things that we do know. We do know there are parts of the world where it is already the case that, even without taking into account the externalities that Nick was describing in terms of coal, you get wind and solar competing successfully on an unsubsidised basis. Let me give you three examples of that.

Example one is Chile, where the latest industrial-scale solar won the auction. It won it versus gas and it won it versus coal. We are finding in parts of the world, and in parts that you might not expect, renewable energy competing without the benefit of subsidies, and we are seeing it already today. We see it in Brazil where the latest auctions on wind came in underneath the cost of gas and coal. The only thing that could beat wind in Brazil right now is more hydro. We saw it, astonishingly, in Texas. It turns out that in Texas the wind resource is a very strong resource, as you know.

There is a general point which the IEA is making and that is that we will find in 2030 there will still be very substantial fossil fuel in the power mix specifically, particularly if we fail to take account of the air pollution issues and particularly if we are not willing to take on board a carbon price. If we ignore those externalities, you will see more fossil fuels and they will be, as a consequence of ignoring the externalities, in a restricted-market sense more competitive.

It is also fair to say that the IEA has historically lagged behind the development of renewable energy technologies and there are different groups within the IEA, as you are I am sure aware. You have the "World Energy Outlook". There is a separate group called the ETP, the "Energy Technologies Perspective", and their perspective is that in fact the renewable costs both at the household level and at the industrial-scale level will fall much faster than is presented in that report. There are different views, as there should be, about the potential for renewable energy to scale up and to come down in cost, and those different views play out within the IEA itself.

A last observation, if I might. It is one thing to talk about this at the level of wholesale costs, which is often where the conversation happens. It is also important to recognise that in fact, for all of us as individual household consumers, it is the retail cost that matters, not the wholesale cost. Solar is the "poster child" on this, but it is not the only technology coming through. It is the electric heat pumps and the potential, by the mid-2030s for fuel cells to be coming through.

There is a whole range of distributed generation and energy-saving technologies that are coming through at a retail level and, if you compare the retail economics of those technologies, they turn out to be highly attractive because of the way in which the price structure between wholesale and retail leads to the opportunities for technologies such as solar in southern California and the like to penetrate the market. As it begins to penetrate the market and new technologies come around, come through around smart-grid management, I think we are going to see a very different model of energy consumption, production and management emerging in some absolutely key hotspots around the world.

Q16 Mr Lilley: Google is rated by Greenpeace and so on as the greenest technology company and is also at the forefront of developing new technologies. One of their projects was to look for renewable energies that were cheaper than carbon. They have now closed it down and those who were running it said, “At the start of the project we had shared the attitude of many stalwart environmentalists. We felt that with the steady improvements to today’s renewable energy technologies our society would stave off catastrophic climate change. We know that to be a false hope. Renewable energy technologies simply will not work. We need a fundamentally different approach.” Have you seen or discussed with them at all their findings?

Jeremy Oppenheim: We know their views on this. We also know they invest extremely heavily in a range of different forms of technology that relate precisely to our agenda. Let me give you two examples. As you know they bought Nest, spending over \$2.5 billion on it. They bought Nest to be a demand management system, and what Google is looking to do on the back of that platform is to essentially build a very sophisticated approach to energy management systems that will dramatically improve and cut the effect of consumption of energy. They see that as one platform where the ultimate first fuel, which is energy efficiency, is cheaper than carbon-intensive energy. That is step one that they are taking.

Step two that they are taking is they putting tremendous amounts of money, as you are again aware, into autonomous vehicles. Autonomous vehicles have the potential to generate a dramatic improvement in the efficiency with which we use roads but also the efficiency with which cars are driven. As those technologies come through, we are going to find again that it is another angle into, from their perspective, using energy in a dramatically better, more efficient and smarter way. They will connect the technology that they have around transport with the technology they are developing around households to create the kind of grid integration and smart-grid integration that I think will transform energy use. That is their angle on using big data and data analytics to drive an approach to the transition to a low-carbon economy fundamentally off the back of technologies that play into efficiency and demand management that is exactly in line with their “if you are renewable energy, less than the cost of coal”, because their view is that the first fuel in all of this should be efficiency.

Professor Lord Stern: Can I just add one or two things very quickly on this specific question about the cost of renewables and how they may go? The first thing is, if you take other costs properly into account, as we have just been discussing, including air pollution and greenhouse gases, you already see very strong competitiveness facing proper pricing around the world in many places. Jeremy gave the examples, without the charging, of the way we describe. We know we should be charging—that has been shared round this table—for air pollution and for greenhouse gases. That would make the cost comparison very different and, indeed, now you would see renewables much cheaper, properly measured costs in many places, not everywhere but in many places.

The second is that technical progress is not just in the narrow sense of renewables themselves but also in storage, for example. We are seeing very rapid change in storage and that will transform the story. We cannot predict exactly how, but we can see immense work and immense progress in storage, and that would change this whole thing radically.

Finally, £200 billion 20 years from now is a lot of money. £500 billion now, in terms of fossil fuel subsidies, is a great deal of money. If we price properly for carbon and air pollution, you would not need anywhere that kind of money. In fact, you would be, quite properly, making revenue out of proper pricing for externalities. £200 billion in what would be probably about £200 trillion in the world economy 20 years from now is 0.1% of GDP. Even if all the other things went bad on you, that is a pretty modest price to pay for a transformation in the prospects of the climate, but the first part of our argument says that it is unlikely you would have to pay that.

Q17 Chair: I and most of the Committee are great enthusiasts and perhaps optimists for the development of a carbon price that might start to drive decisions in a different sort of way, but it still may be some time off. Given what we know about the effects of coal consumption now, not just on climate change but the health effects—I know the report refers to the fact that more than 10,000 people a day are suffering premature death as a result of principally air pollution, which in turn is quite closely associated with coal consumption—do you find it surprising that we are not making more use of regulation through emissions performance standards and so on? In contrast with the nuclear industry, which quite rightly has to meet the most rigorous standards for its operations, we do not seem to apply the same concerns to coal, despite the fact we now have even clearer evidence of what the effects of consuming coal are, and waiting for a carbon price signal to be driver of a substitution of other fuels for coal may simply condemn millions of people to premature death.

Professor Lord Stern: Let me go first on this one, Jeremy, and you can come in. Leaded petrol was killing and retarding the progress of children, not only children but particularly children, and we took that, quite justifiably in my view, as a very powerful argument for insisting on unleaded petrol. We could have gone for a price of lead, but it is more efficient in this kind of example, not in every case but in many cases, and I think in that case, to give a very clear signal saying that you must stop the use of leaded petrol by such and such a date. That is clear and strong and we all know that uncertainty drives up costs.

One of the biggest problems in this whole area is Government-induced policy risk; flakiness in policy; noises off that leave people to think that you are not serious. If you are very clear, in this case that you have to go for unleaded petrol, the cost of so doing is very much smaller than might have been anticipated because you go straight to the economies of scale. There is no uncertainty. The cost of the capital comes down, and that is serious economics. Often the economics, when you bring in uncertainty and government-induced policy risk, points you to these kinds of regulation. They make economic sense and I think they make moral sense. Why would you want to let people kill other people in the way that leaded petrol was doing and in the way that coal is doing? I think, as a matter of democracy and human rights, you would take those issues extremely seriously; as well as, of course, the narrow economic view of the losses associated with people getting ill and dying.

I think regulation in this area in terms of economics and human rights makes a great deal of sense. You are seeing it in the EPA in the United States. In China they are going to go quite strongly for regulation and peak coal by 2020. Peaking coal by 2020 is a very impressive commitment. I have been working in China for 25 years. I was informally involved in some of the

discussions around the 12th Five-Year Plan. They are already talking around the 13th Five-Year Plan. The people involved in the energy area in the 13th Five-Year Plan are very much the kind of people we have been talking to in producing the “New Climate Economy” report, particularly the China version.

I think you are rightly seeing regulation in the United States, in large measure motivated by the health effects. You are seeing it in China and I think it makes sense to see it in Europe too.

Q18 Ian Lavery: Just before we move on to drivers of growth, I have never heard two more anti-coal people in my entire life, and to factor the death of miners into the cost of coal is absolutely disgraceful by the way. That is not in support of what you have said. It is in opposition to what you have said and that comes from a miner himself. I want to discuss the drivers of growth.

Professor Lord Stern: Can I just understand what you just said, Mr Lavery?

Ian Lavery: I will speak to you about it probably at a more appropriate time because time is getting on and we are only on to question 1, basically; so if I can just concentrate on the drivers of the growth and get back to the agenda. In order to build lasting economic growth and, at the same time, manage the risks of climate change, what specific market failures that we have seen and experienced do you think need to be corrected?

Professor Lord Stern: There is the basic market failure around the emissions of greenhouse gases, which we have discussed at length around carbon pricing, so I will not dwell further on that but that is basic. There is a market failure that the report does underline and which I have underlined myself in my own work around innovation. People who have ideas are producing things that are available for others to use and that is why it is important to have public support particularly for energy research and development. It is a market failure because the idea is available publicly. The returns to your work or creativity are not entirely captured by rewards to yourself. That is a market failure that is very important.

There are market failures around networks. If you build a network or you are involved in building a network, other people get a lot of benefits from that network. Networks are things like public transport, telephone systems, broadband and recycling. They are all networks, and investing in a network gives benefits to many people outside of the returns that can be captured. That is a third market failure. A fourth market failure that is very important in this area is long-term capital markets. They are bad at taking on and allocating risk. Even if the cost of capital is quite low, you get people having been forced to borrow at very high interest rates. We have something to say in the report about how the cost of capital can be brought down. A fifth market failure that is highly relevant here is the health costs of air pollution, for example.

Those are five key market failures that are all of great relevance in this area, and the policies that we marshal or recommend are all oriented around making the markets work better in the senses I have described and thus fostering growth. There are others, but those are five important ones.

Q19 Ian Lavery: What policies do you think need to be put in place to correct these market failures?

Professor Lord Stern: Greenhouse gas pricing, carbon pricing, for the first one. We recommend a tripling of public support for energy R&D. That is on the second one. We recommend investing in rapid bus systems, for example. We give the example from Bogota in Colombia. That is around the network story. I am just going through the market failures one by one.

I am personally very influenced by six years I spent as chief economist at UBRD, which was investing in the very risky areas of central Europe, eastern Europe and the former Soviet Union. On long-term capital markets, we point to bringing down the cost of capital through development banks; for example, the Green Investment Bank in the UK. The EIB or the EBRD in Europe and the Inter-American Development Bank in Latin America are other examples round the world. There are ways in which we could sensibly and quite strongly bring down the cost of capital, which makes a very big difference to renewables. Renewables are, on the whole, mostly capital cost because the marginal cost associated with the wind or the sun is very low.

I have covered all the five now with this last one. The last one is the other kinds of damages that arise, things like air pollution, where some elements of regulation, as we were just discussing, make a lot of sense. That is five sets of policies oriented around the five market failures I have described and they are all there in the report.

Q20 Ian Lavery: With regard to that, what do you think policy makers need in order to integrate climate into the core economic decision-making process?

Professor Lord Stern: Things like the climate change legislation and structures we have in the UK that give clear signals, working with our European partners to revitalise the emissions trading system and collaborating around the world, including within Europe, on energy R&D are the kinds of ways in which I think policy makers could engage much more strongly, and there are other ways as well.

Jeremy Oppenheim: I think they need information around the full costs of the choices and options available to them. I think they need to have an understanding of where renewable energy costs are going and, for particular renewable resources that are relevant to their country, they also need to understand the full costs of alternative conventional fuel sources including coal, gas and nuclear. It turns out that decision makers are overwhelmed by competing views on all of these things. I am sure this is something that we all struggle with. It is quite hard to see the signal through the noise in terms of a proper understanding of the real costs over time and the real options that are available in making decisions on the energy system, for example.

We find the same on urbanisation. We have not talked about that at all, but one of the things we see in our work is that cities grow up. They grow up organically and we understand that, and one of the things that the report does not try to argue for is perfectly planned, precise cities because that is not the real world, but we do believe some level of planning is a good thing. The right combination of planning and organic evolution of cities is at the heart of the way in which one would hope cities will evolve over the next 15 years, and that is absolutely critical to the growth story but also to the climate and environmental story more generally.

The risk is that we will see cities grow up over the next 15 to 20 years and this is a period in which we would reasonably expect to see a billion people urbanising across the world: 70 million to 80 million people a year. We will develop a set of cities without thinking them through that will turn out to be sprawling, low-density cities with very high operating costs, ranging from congestion to

all the issues that Nick has raised in terms of air pollution, which is not just related to coal to be absolutely fair.

I was in Ethiopia 10 days ago with the Cabinet. The issue around the development of their cities and the low-density nature of them, what they were most concerned about and what most hit home was the risk of traffic accidents because it is turning out that, for 15 to 25 year-olds in Ethiopia, one of the top three causes of death is road accidents. We are seeing across the world an understanding that getting the proper economics of cities and urban development right is not a climate topic. It is not where people start. They start with: what kind of lives do we want our citizens to lead? How do we build cities that work, which do not require two-hour commutes, which have air that you can breathe, and that are good places to bring up the kids?

The heart of our report is to bring together a set of propositions about the opportunities to build better cities and the way in which that can be done that also allows us to tackle climate inside. That is the same philosophy that I think we have adopted in every part of the report. It is true for cities and it is true for land use. We do not start with the climate question on land use. We start with: what is a better land use? How do we develop land use systems that develop food security, address rural poverty and preserve natural capital in multiple forms, and how, done well, does that feed into better action in terms of climate? The same is true for energy.

Our propositions and the approach that we want, internalising climate, is all around finding ways to help policy makers understand the real economics, the full economics as Nick has been describing them, and then asking, what are the policy choices, not in theory and not in some abstract way, but in examples from around the world where cities, countries, regions and businesses have already chosen to do things differently and from which we can learn?

Professor Lord Stern: Can I add this, Mr Lavery, because I believe you have gone to the heart of this? How do the politics and economics get stuck? Let me give you an example, again on cities, which links it with the public finances. I spent another big part of my life working on public finance. Chinese cities are growing rapidly, but the population density is going down. You might ask, how could this happen, that the cities are growing so rapidly but the population density of the cities is going down? For me, a big part of the answer lies in the failure of public finance because property taxation in China is weak. A lot of the local city public finances are raised through the selling of land. They have an incentive to sell the land and expand the city, and I believe that kind of observation is of great interest in this country, too. We have wrecked our property taxation in this country, in part through the misguided attempt at the poll tax but for other reasons too, and it makes the whole decentralisation of city policy and public finance around cities much more difficult.

That is an example of the way in which you have to build things that for moment might look unrelated but are a key part of the politics into an understanding of how city policy gets made and can be made. I think the advance of property taxation in our country, China and elsewhere is one of the elements of trying to break that political logjam. We can do lots of things even if we do not fix that, and in our report we do not rely on fixing that, but that is how you have to look at it to understand the political economy and how politics and economics get interwoven in difficult ways. I should add, I have been talking directly to the Minister of Finance in China about these issues.

Q21 Ian Lavery: With regard to encouraging investment in low-carbon technologies, what sort of stronger incentives do you think Governments can give to potential investors in firms to make that shift?

Professor Lord Stern: Let me start with one or two things and I will pass over to Jeremy. I think the Green Investment Bank is a very good idea. I would expand the balance sheet of the Green Investment Bank, allow it to borrow. It could borrow at very low rates. That is one area where you can bring down the cost of capital to firms and give them a partner investor with a long-term view.

We keep coming back to the carbon price because we should keep coming back to the carbon price. That is a key part of the right kind of investment: an incentive on stopping doing the things that are doing so much damage, which are the greenhouse gases and the carbon price, and on the other side of the story help with bringing down the cost of capital in the way I have described and strong investment in innovation. We have already covered that and I will not repeat it, but also greatly increased energy R&D, which is extremely low in this country and elsewhere.

Those are three ways. There are many other ways. If we did the new deal properly that would be a great incentive to all kinds of small local firms in the construction industry as well.

Jeremy Oppenheim: The only think I would add is that we see astonishing market response when we put in place clear, predictable signals. To take one example that I think we have not talked about, in the auto industry there were debates in the States in particular for years about these things called CAFE standards, which are the fuel economy standards. All the auto manufacturers were pushing back and saying, "We can't possibly do that", and eventually they struck a deal and, of course, the auto industry is outperforming those standards. What is happening at the moment in the auto industry, on the basis of not just CAFE standards in the States but energy efficiency standards in Europe and now in China, is that we are seeing this phenomenal speeding up of the rate of innovation as it comes to market; not just in the lab but as it gets translated into products and services in the market.

There has never been a period, at least in my professional experience, of as fast innovation in the auto industry ranging from developments of the internal combustion engine, through to developments of hybrid vehicles with electrification, through to the fact that I was in Japan last week and they are putting as much emphasis on hydrogen and fuel cells as we are on hybrids and electrics. All of a sudden, on the back of not just climate policy but policies that are encouraging real fuel economy and more innovation in the sector, we are seeing a proliferation of choice. I think that that is tremendously exciting.

One of the perspectives that I think we hold within the work of Global Commission is that this agenda is not an agenda about narrowing choices, limiting the way in which one can get around or how the private sector should play, but it is about expanding choices so that we get more options in terms of either personal or public transportation and then the digitised systems that allow these things to be stitched together so that you have much more mobility on demand going forward. That is the kind of world economy that we should be looking to build.

Professor Lord Stern: Above all, clarity on the sense of direction of public policy. Government-induced policy risk, vacillating, mucking about, not looking reliable, those are the biggest disincentive to investment worldwide wherever you go.

Q22 Ian Lavery: Do you think EMR is an appropriate tool to drive down low-carbon investment?

Professor Lord Stern: Coupled with the right kinds of regulations and market prices for carbon, appropriate pricing for capital margins, I think that is something that could help, yes.

Q23 Ian Lavery: Finally, the report notes that, of over 100 countries labelled middle-income half a century ago, only 13 have since achieved high-income status. Do you think other factors such as the removal of more trade barriers would be a more effective driver of growth than a transition to a low-carbon economy?

Professor Lord Stern: It is not an either/or. It is not a horse race between those two things. I believe most of the returns from liberalising world trade in terms of growth have probably been realised and that has been very important. There is a margin still, particularly non-tariff barriers on trade that the WTO rightly identified. That will be the margin and that will be helpful, and I think that is a direction that we should go in, but there is absolutely no suggestion in logic or in our report or anywhere else that you should have one or the other. You should have both. Because we are in a far earlier stage with the whole learning and discovery processes in the low-carbon story I suspect that is now a bigger driver of growth than further trade relaxation, but we do not have to choose between them because trade has gone so far already, and rightly so.

Q24 Dr Whitehead: Could we return to what you are saying in the report on energy systems and particularly how some of that relates to the UK? You have already talked this morning and indeed in the report about shifting the burden of proof away from coal in energy systems in general, so looking at the full externalities in terms of what the comparative pricing and so on of coal might look like. How would that play out in the UK in your view? What would the particular instruments in the UK to achieve that look like?

Jeremy Oppenheim: Fortunately, we have put in place a number of instruments already and, as Mr Lavery was describing, the electricity market reform policy settings are an attempt to do precisely that. We have the mechanism for contracts for difference, which appear to be providing the predictable framework that can attract large-scale investment into the sector. Let us also remind ourselves, it is also a mechanism that prevents the generators capturing windfall gains from price spikes. I think this is a good thing from an overall taxpayer perspective.

We have a set of mechanisms that have come in to help us develop capacity markets, which are critical to a system that needs to combine traditional fuel sources with renewable energy sources. We have put in place a floor price for carbon, although I know that we are removing it. Nonetheless it is those kinds of integrated policy settings that can provide the environment within which we can attract large-scale financial capital. It is interesting to see that capital is coming from all over the world to invest in the UK energy system. It is not just domestic institutions, but the UK is becoming a place to invest in energy for institutional investors across the world who want to see long-term predictable returns for their investors that match up with their liabilities.

This is potentially a real boom in terms of the way we are attracting financial capital. It is also potentially a real opportunity in the way we are attracting technological capital. I would hope that we will take advantage of the fact that there is 30 gigawatts of power that is going to get

built over the next 15 years in a way that creates economic and technologically advanced clusters that then become the basis for service and product exports to the rest of the world.

Q25 Dr Whitehead: One of the issues right now, which may be a short-term issue, is that there is an accelerating element to coal on the UK energy supply systems in part because of the relative cheapness of coal against gas currently and, therefore, the ability of existing coal plant to bid successfully into slots in the energy supply system and, secondly, because of the role of gas as the market maker and the ability of coal to profit-take on the back of that position. There is, therefore, an apparent re-establishment of coal in the UK systems, despite the particular instruments that you have set out as a way of changing that.

Jeremy Oppenheim: We will see fluctuations like that. My assessment is that that is a relatively short-term phenomenon. It may be wrong but as the next set of directives come in around the requirements in terms of overall CO₂ intensity of power supply and non-CO₂-related health requirements on power plants, as those begin to play in, I suspect we will see a progressive shrinkage of the coal contribution to the power mix in the UK. Inevitably, while there are plants operating and if coal is cheap and given that the carbon price is low, you will get temporary periods in which the share of coal in the overall power mix will go up, but I don't think that is the long-term trend for the UK given the settings we have put in place.

Q26 Dr Whitehead: You have not mentioned emissions performance standards, which are obviously in the Energy Act here and now, albeit at rather strange level. Is that the sort of instrument that might be linked in the way Lord Stern mentioned as an implicit inclusion of externalities?

Jeremy Oppenheim: I think we have both made the point. There is both a combination of policies as opposed to a single policy, given the complexity of the transition that will be needed, but it is exactly the emissions standards that set an overall cap in terms of the CO₂ intensity of the megawatt hour that provide belt and braces to a system that, in a world with moving coal prices and carbon prices that are significantly less than the social cost of carbon, give us some reassurance and provide a signal to investors about the direction in which the system is going.

Q27 Dr Whitehead: That then leads to the longer term choice question of whether you leave coal in the ground in the longer term future, with the implications that has in terms of jobs, stranded assets and so on, or you look for technologies that may be able to continue to take it out of the ground but mitigate the externalities that we have talked about. One of those obviously is carbon capture and storage. What view have you taken in the report and what is your general view on the applicability of CCS as a method of going down that route, first worldwide and, secondly, in the UK, as an alternative to leaving the coal in the ground?

Jeremy Oppenheim: The report takes a very clear line on this, which is that we believe there needs to be a scale-up of investment in CCS technologies. As you know, the UK is a small piece of that puzzle in terms of overall use of coal, but there is a plausible view of the world in which China peaks but does not come down as fast as one hopes and that India comes through and there are other coal-based economies in the world, such as Indonesia and South Africa, that are

fast-growing. There is also the question of industrial-related emissions. There are multiple dimensions of the emissions challenge for which carbon capture and storage technology is at least one of the viable options that needs to be scaled up.

At the moment there is a level of investment in CCS and the number of demo plants moving through to pre-commercial, so you can see the pipeline. You can see the roadmap of how the cost structure of CCS could come down over the next 10 to 15 years. There is not enough of that happening. It is one of the recommendations within the energy chapter of the report where we go from talking about CCS and a set of smallish investments made around the world to creating a real option that allows us to consider whether in fact it is possible to continue using coal and gas for that matter—this is not just about coal—and being able to apply CCS as the mechanism for capturing the CO₂. We want to find out and we have to use the next 15 years wisely to figure out whether it is a real option or whether we are kidding ourselves. One of the recommendations of the report is that we put a significant scale-up and it is very consistent with the IEA recommendations.

Dr Whitehead: You mentioned the question of gas. One of the issues in the UK, of course, is that we are not, in terms of UK energy mix currently, in a comparable position to that of the US where the emergence of cheaper gas in the US has driven quite a lot of coal off the system and has enabled emissions to come down almost by accident over the period. In the UK, of course, gas may well be the problem over the next period in terms of keeping emissions higher than is acceptable, say into the 2030s. That has been argued in part as a security of supply issue, that you cannot do without gas over the period because, otherwise, you would have insecure supplies and the lights would go out. How do you see that trajectory working through in terms of the role of renewables, the intermittency of renewables and the question of the extent to which they require back-up, which may be gas, which may then take us above the emission levels that are reasonable as far as this country's energy supply is concerned over the next 20 years?

Jeremy Oppenheim: The Commission did not do a specific review of the UK's energy mix, to be clear about that. What we did was take a look at the global energy mix. One of the organisations with whom we worked most directly was the IEA and, in fact, Maria van der Hoeven was one of the commissioners and made sure that the IEA's expertise and models were available to us. The position we took on gas was that we, first of all, do see that as a necessary part of the mix over the next 20 to 30 years. The second observation is that we think that it needs to be combined with policies that continue to support other forms of low-carbon energy and that is not just renewables. It is also nuclear and hydro. Our view is that it is a good thing to have a diversified mix of low and zero-carbon energy technologies coming through.

The third observation that we make, back to CCS, is that if we are going down the route of building up the infrastructure on gas, we need to recognise that we will not just shut that off in 2030 or 2035. It is just not a realistic view of the world. Therefore, we had better build for ourselves a CCS option. The fourth component of our view on gas is that we believe there needs to be stronger regulation on fugitive methane emissions from the oil and gas industry. Some of that is easier to describe, but we suspect there are substantial methane emission releases across gas pipelines in Russia, and it is very hard to know exactly how big they are. We need to see a stronger regime in place on those methane emissions.

Finally, we do think that there needs to be a carbon price, and the reason I say that is that the gas in most of the world, the US is an exception, is more expensive than coal and if you want to have gas substituting for coal then it is either going to come on the back of a carbon price that allows

for the switching to take place and/or—and it is more of an “and”, I suspect—it will come on the back of the right regulations on coal that are predominantly directed, in most countries and in the big coal-using countries, at local air quality issues. If those are done properly and they are actually enforced, as opposed to the equipment being provided and then not switched on, that would drive up the cost of coal quite significantly.

Q28 Dr Whitehead: How might the present proposals on the gas for UK shale fit into that scenario?

Jeremy Oppenheim: If they met the criteria that I have just described. I do not think we particularly distinguish from the perspective of the Global Commission between conventional and unconventional gas. It is all part of the global gas supply, or at least in the European case it will be the European gas supply, and if we had a regime in place that was broadly consistent with the criteria I have described we would see it as just another source of gas.

Professor Lord Stern: Can I just add to this line of questioning? Jeremy was underlining the importance of diversification of sources. In an uncertain world where we are not quite sure exactly what will happen in different places diversification makes sense as the management of risk, including in energy sources, but there are three other margins for diversification that we should emphasise. The first, which we have mentioned a number of times here but it is crucial because it is probably the biggest area for emissions reductions, is energy efficiency. That is the biggest potential source of new energy in that sense. The second is a European grid. The view of many of us, understandably so in terms of integrated markets, is that a much more strongly integrated European grid would make a lot of sense and is another way of diversifying. It would bring average prices down and it would bring diversification. A third way of diversifying is storage. There looks to be tremendous potential for technical progress. When we think of diversification of sources, as we should, CCS, nuclear, gas as a bridge and all these things, those three sources of diversification, efficiency, grid and storage, are very important.

On UK shale, just to underline the point that Jeremy was making, which I hope was clear, in a world where you have fairly, but not fully, integrated gas markets then UK production of shale gas would not affect the price of gas any more than if South Africa produces more gold it brings down the price of gold in any significant way in South Africa. It would be about the profits, rents and activities generated around that activity. It should not be presented as a way of bringing down the price of gas unless we have an import/export policy that was anti-trade.

Q29 Dr Whitehead: Is there any read across in terms of capturing of externalities in that context, as in the difference between shale extraction and conventional gas extraction is clearly one of differing externalities?

Professor Lord Stern: Every technology has its issues. Nuclear, coal, onshore wind and hydro all have their issues. The deadliest sources of electricity in terms of human life are hydro and coal. You have to look at all those things. You have to look at the whole spectrum of risks. If you lose about 3% of the gas in the process of getting it out of the ground, transporting it and using it, then the whole advantage over coal goes away. As Jeremy said, how much of the imported European gas from Russia is coming from sources where leakage is important?

You have to look at any energy source in terms of all the risks that it carries. The unconventional shale is very intensive on water. There are many parts of the UK where water is scarce or even more scarce than in other parts of the UK. If you are transporting water along roads for fracking purposes, that is another externality. You have to look at the whole spectrum of risks and externalities when you look at a resource, and that is true of UK shale as well as any other.

Q30 Chair: I am conscious we have about 10 minutes before we have to wind up. There are two or three things I would like to try—

Professor Lord Stern: I have to go and chair a meeting at the British Academy on the future of economics.

Chair: You had warned us about that and I think the rest of us had built that into expectations. I have just a couple more things if we can squeeze them in. First, we have heard a lot of discussion about the need for a carbon price. Do you think there are actions that could be taken to encourage the development of carbon markets across the world? We are currently engaged in an inquiry, for example, in linking emissions trading systems. We are pleased to see the progress that has been made in China, faster than many forecasts two or three years ago. Are there steps that we could take to promote the growth of carbon markets?

Professor Lord Stern: I will make two observations and then I will hand over to Jeremy. Making the ETS work well is fundamental and we should have been taking permits out of that system to correspond with the very slow growth of those economies and thus low demand for energy. You do not have to be a professor of economics at the LSE to work out that if you load down the markets with lots of permits you are going to crash the price and that is what we did. At the European Council meeting on 23 October there was indeed a noting of the importance of the market reserve, which I hope is an indication that they are going to be taking out the permits. For me, it is vital that we do that. €5 a ton or whatever it is now for CO₂ is a ludicrously low price, way below any reasonable interpretation of the externality. The United States, for its public cost benefit analysis, uses \$35 a ton of CO₂ coming out of the work of Mike Greenstone and others in the Economic Advisory Council. It is way too low in Europe. The reason that it is way too low is blindingly obvious: they did not take out the supply of permits corresponding to the slowdown and recession. If we went back to a much more sensible price in Europe, I think that would create a very powerful signal worldwide.

The second is to recognise that a lot of firms already use quite a substantial carbon price and encouraging firms to spread that practice of using the internal carbon price would show Governments around the world that you can get on and invest in quite a strong and creative way with those prices because firms are doing just that.

Jeremy Oppenheim: The only thing I would add is there is always a question of what happens to the revenues. One of the things we looked at was, in systems that are tax-based as opposed to market-based, there are options as to the revenue recycling. Of course, the market-based model should have revenues associated as well, if we were to provide appropriate auction mechanisms for that. It seems to me a lot of it does depend on the trust that underpins a set of political choices that will drive that carbon price. It is not a market like the market for pork belly.

People have to believe that this market works well, that is delivering some meaningful results and that they see where the revenues go. “Let us put it into general taxation” is a good public finance view of this, but there are models that, for example, would encourage carbon related revenues

because we are taxing a bad to be fiscally neutrally offset by reducing taxes on other things, which could include taxes on labour. Understanding and thinking through not just carbon markets as a standalone item but carbon markets and the revenue generation within the context of good fiscal policy more broadly would seem to me to be a real opportunity.

The only other observation is that we do need to be a bit sensitive and thoughtful about the impact of carbon pricing on trade-exposed energy-intensive industries. We cannot just pretend that is not an issue. It is not the only factor that drives the location of chemicals and steel plants, and it is not the only factor that drives that profitability and performance. We should be thoughtful about the other dimensions and the other factors that drive their economies. For some of these companies it can be “the straw” that makes a real difference.

Professor Lord Stern: Could I just add a word as former Second Permanent Secretary at the Treasury and Chief Economist for the World Bank for an orthodox view of public finance, which is actually quite consistent with what Jeremy had to say? It may not have escaped the notice of this Committee that our structural deficit in the UK is something like 4% of GDP and actual deficit a bit more. If we used some of the revenues from sensible carbon pricing to tackle that deficit it would mean that the axe would fall on things like health, education and other aspects of public spending much less severely. Essentially, by raising those revenues and not having to attack public expenditure in quite the same way, you would be supporting health, education and those public services that we all rightly value, understandably. To miss the opportunity of taxing bads, to disincentivise those bads and to raise public revenue and protect public services, seems to fail Economics 101.

Q31 Graham Stringer: What will be success and failure in Paris next year and what will be the consequences of failure?

Professor Lord Stern: An agreement around reasonably strong—I will explain what I mean by “reasonably strong”—emissions reductions would be very important. If you take the already announced intended reductions, the so-called INDCs, you essentially have three big ones sketched out already in terms of China, United States and Europe. These were quite recent so I have not had a chance to do it in more detail, but a back of the envelope calculation would suggest that those kinds of commitments—and they do cover about half of the world’s emissions, US, China and Europe—might take us to the low 50s in 2030 as opposed to the high 60s but way above a 2 degree target, which would be low 40s in terms of 1 billion tons CO₂ equivalent per annum. I think it would be a major step in the right direction, but the first thing is to make that major step in the right direction in terms of intended emissions reductions. Because of the arithmetic I have just given, you have to build into that a process for reviewing and ratcheting up.

Q32 Graham Stringer: Are you talking about a legally binding agreement?

Professor Lord Stern: Can I address that in a minute? That was going to be the third point, the understanding or meaning of legally binding.

You have to think first about the overall quantities, and we are going to have recognise that there are going to be substantial reductions—we have already seen it on half the thing—but they are going to be relative to what otherwise would have happened. They are going to be nowhere near

strong enough for 2 degrees and that is why you need the second element, which is building in a process for understanding how far short they fall, which I have given an indication of already, and have a process for ramping it up. That is exactly what they have been discussing: processes where you give your targets out say 15 years but you come back every five years or so to see how you ramp those up. So the second element is to have a way of making sure there is something specific about how you close the gap. The third element is to have ways of understanding what other people are doing, which are rather transparent: monitoring and review mechanisms. On all those first three they are making quite reasonable progress.

The fourth element is understanding what we mean by legally binding. Jeremy said we have learnt quite a lot over the last seven or eight years in many different directions, including in policy, so the fourth element would be a clear and shared understanding of what we mean by legally binding. The Kyoto story, allegedly legally binding, said that if you fail in your first round to do what you said you would do, then you have to do more in the second round. Come the second round Canada had failed to do what it said it would do in the first round, so it walked. That was not a credible notion of legally binding.

The notion of legally binding that is likely to be there, and I think it is sensible, is that you bind yourself to following the procedures for making your commitments, reviewing them upwards and having them monitored. The understanding of binding of the levels themselves will be through domestic enforcement. China would embody it in the 13th, 14th and 15th five-year plans covering this period. The 13th will emerge in a year or so. The United States would work through the EPA. Europe would work through its own legal systems. The understanding of legally binding will be around the processes internationally and the understanding of the levels themselves is likely to emerge around domestic legally binding.

I gave a speech to the group organising the Paris talks on 6 November and that is likely to go up on the LSE website, the Grantham website, next week and that will give a longer description of the likely structure. I have to get out of here now, unfortunately, but I think there is a reasonable chance of a reasonably good agreement along the lines that I described. I would regard that as a modest success and a step in the right direction. Chair, would you excuse me, please?

Chair: Sure.

Jeremy Oppenheim: Just two very quick extras. First, I would hope we will see in Paris the emergence of the financing arrangements. In part this is about where the funds will come from to support developing countries in particular and the lowest income countries within to make some of the transitions. It is also how the money is going to be used. Just talking about more international finance gets you some of the way but the real question is: how do we see that money spent well to deliver the agenda described in this report?

Professor Lord Stern: I should have added that fifth element on finance. I am grateful to Jeremy.

Jeremy Oppenheim: We will not know this the day after Paris. We will know whether or not Paris has been successful if, in practice, it sends a market signal to investors. If nobody changes their investment decision, and Paris happens but everybody just keeps on doing the same thing, in particular institutional investors, the big companies and state enterprises, irrespective of the fact that there is now an agreement from Paris, then it will not have achieved what we need it to do. The thing that Paris can do, more than just the formalities of the monitoring agreements and the specifics of quantities, is to send a market signal that the direction in which the global economy is

going and the political commitment behind that, for reasons of self-interest, is toward a low-carbon world. That will start to shift flows of capital over time.

That is at the heart of what we try to describe in this report. If we get a shift in the flows of capital and if we get a shift in the flows of talent towards innovation and people can see that coming out in a directional sense from Paris, then that is a very big shift. If I can wear my McKinsey hat just for just one moment, in conversations I have had over the last two weeks since the US-China declaration, in terms of their commitments a year ahead of Paris, climate is now back on the agenda. It is that simple. People across a whole range of companies are talking about climate again and the need to think through what they should do, how this is going to play out, what it means for strategy and how we should think about our investments. It is back on the agenda in the corporate boardrooms and that is what we need to build on if we want to make a transition that is market driven to a low-carbon economy.

Q33 Chair: That is very helpful. I have to leave now. We will not be quorate without me. We have run out of people, I am afraid. Maybe you want to continue the conversation informally. I have to go. Thank you very much. There is nothing to stop you continuing your conversation.

Jeremy Oppenheim: If there are other questions that emerge after this session or in your own deliberations then please feel free to reach out to us.

Chair: That is very helpful. The meeting is now closed but the conversation continues.

Jeremy Oppenheim: I am happy to stay for another five minutes. Thank you very much indeed.