



Environmental Audit Committee

Oral evidence: Environmental risks of fracking,
HC 856

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Written evidence from witnesses:

- [Dr John Broderick, Research Fellow, Tyndall Centre, University of Manchester](#)

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Members present: Joan Walley (Chair), Peter Aldous, Martin Caton, Katy Clark, Zac Goldsmith, Mark Lazarowicz, Caroline Lucas, Mrs Caroline Spelman.

Questions 1–41

Witnesses: **Tom Burke**, Chair of E3G, **Professor Paul Stevens**, Chatham House, and **Dr John Broderick**, Research Fellow, Tyndall Centre, University of Manchester, gave evidence.

Q1 Chair: Good morning to our three witnesses this morning. At the outset, on behalf of the Committee, I would like to put our session in perspective. This is the first of two sessions that we are holding and—for your benefit as much as for the public record—I want to make it clear that we fitted in an inquiry on fracking at the very last minute because of the importance of the Infrastructure Bill before Parliament. We are very much aware that there have been previous inquiries done by other Select Committees of the House, including the Energy and Climate Change Committee, the House of Lords Economic Affairs Committee, the Welsh Affairs Committee and of course the DEFRA Select Committee, so we cannot by any means cover what those others have done. What we want to do in our brief inquiry today is to identify the environmental risks of fracking, including the risks to water supplies, biodiversity and so on, but as well how it could be accommodated alongside our climate change commitments to cut carbon emissions.

I ought to mention that we are grateful to those community groups who have sent us written evidence and submissions expressing their concerns. Our two short notice sessions today are intended to put the concerns expressed to us and to those who are either involved in fracking or are part of the regulatory or monitoring systems at issue. So we very much look forward to the debate that we shall have this morning. We are very grateful to each of you for coming along. Not all of you are strangers to this Committee, so it is good to see you back again, Tom.

Can I start by asking each of you to give us an idea of where you stand on the fracking issue and is it something that we should be pursuing in the UK and, if so, what is the rationale for doing that? I would also like to add to that your understanding of where strategic environmental appraisal fits into this and how that fits into infrastructure planning as well. Who wants to go first? Professor Stevens?

Professor Stevens: Shall I start?

Chair: Please do.

Professor Stevens: I should begin by saying that I am an economist. I am not an environmental scientist. Therefore, if I make any comments about the environment, I am very much dependent upon the scientific community of environmentalists who are producing peer reviewed work, so I am not a specialist in this.

My view on this is that, providing the process is regulated properly, there should not be a particular problem. I would also add that it is not a good idea to look at the United States' experience on these sorts of things because, largely speaking, the shale gas operations there have not been particularly well regulated. The 2005 Energy Act explicitly excluded fracking from the EPA's Clean Water Act, so an awful lot of what is being done in the United States has been done badly and done in a context of poor regulation. I refer to the Royal Society and the Royal Academy of Engineering report that came out in 2012, which basically concluded that if the thing is regulated properly, there should not be a problem, and I have sufficient confidence in the oil and gas regulatory authorities in the UK that that would be the case. That is my starting point.

Q2 Chair: How do you square that with the need, for example, in terms of the Sustainable Development Goals, for economic investment to take account of environmental and social impacts that strategic environmental assessments fit with, and the economic imperative to take forward investments?

Professor Stevens: My statement that I do not have a problem with fracking refers to the environmental consequences. The economic issues are another dimension all together, and I have to say I remain very sceptical that shale gas in the UK is going to be a viable economic option over any foreseeable time period. There are two issues here. One is the environmental consequences of hydraulic fracturing; the other is: does it make sense from an economic point of view; does it make sense from a sustainable climate change position point of view; does it make sense from a security of supply point of view?

Q3 Chair: Given your position in terms of Chatham House, how do you look at the forthcoming Paris UN negotiations on climate change? How do you factor in those issues in terms of climate change, in terms of your views, or, if you don't, who is there who is factoring in the whole picture in all of this?

Professor Stevens: It is not something I following in great detail, I have to say. What comes out of Paris is obviously going to influence the extent to which there will be constraints on greenhouse gas emissions. Then the question in terms of shale gas is raised: well, if shale gas is produced, what will it replace? For example, if it replaces coal this might be regarded as a good thing, although it depends on what assumptions you make about fugitive methane emissions there. On the other hand, if it starts to replace

renewables that is bad news. But far be it for me to try to predict what is going to come out of Paris, if anything.

Q4 Chair: I am going to move on next to Dr Broderick.

Dr Broderick: I work at the Tyndall Centre for Climate Change Research in the School of Mechanical, Aerospace and Civil Engineering at Manchester University. My interest in this topic is around carbon budgeting, and the central point there is that we need to have an appreciation of the total quantities of emissions that go into the atmosphere and understand that through time. So my concerns around the expansion of shale gas are similar to concerns around the expansion of any new fossil fuel resources—that we would be adding to the total burden that we place on the atmosphere and on the climate system.

Q5 Chair: Do you have any comments at all on the point that I raised about strategic environmental assessment and how that fits in with the economic investment decisions to go ahead with shale gas?

Dr Broderick: No, I have not worked on strategic environmental assessment.

Q6 Chair: Then if I may turn to you, Tom?

Tom Burke: Thank you, yes. I chair E3G and we have a primary focus on climate and energy policies, simply because in functional ways in terms of mitigation your energy policy is your climate policy, so the interaction between the two is a central preoccupation, and clearly gas plays a fairly important part in energy policy and therefore climate policy.

On the last question, strategic environmental impact assessment is about cumulative effects and, given that fracking would be dispersed across the United Kingdom in lots of different projects, it seems to me extremely important to do a strategic environmental impact assessment. It would be pretty important, in terms of gaining our public acceptance, that there were some publication of that assessment so that people had confidence that it had covered all the issues. I think an important part of building the public acceptability is to do that, otherwise you are left answering the question: why do you not have such an assessment? That I think immediately puts you off on the wrong foot.

In terms of the environmental impacts that are local impacts—that is, local to the United Kingdom—by definition they are local and, therefore, how much you can learn from what happened elsewhere is of relevance, but it is of limited relevance because you still have to understand the specific context. For instance, one of the things that is clearly different in the United Kingdom from the United States is the geology and that will have some impact on the extent to which environmental impacts express themselves.

I share with Paul the confidence in the regulatory authorities' ability to set standards that are acceptable and that are liveable with, in terms of the outputs. I would have no question about that. Whether the industry can perform to meet those standards I think is a very open question. We haven't seen the industry perform. Looking at the United States, what you can see is a very big difference between different operators and what they do and don't do. Not only are there differences in the regulatory requirements in different parts of the United States but, even within the same jurisdiction, there are people who do well and

people who don't do well. So it is quite difficult for us to be—at this stage in the development of what is a new industry—highly confident that it can be acceptable.

I was focusing there on the outputs. I think there is a whole other question that I think stands at the centre of the question of public acceptability, and that is the question of the surface impacts. I am not sure that, when you move from exploration to actual development and exploitation of the resource, there is a very clear picture as yet of what that would mean. In a highly dense and populated country like this, that is clearly going to be a much more pressing problem than it is in the open plains of North Dakota.

Why I bring that up, in the context of your broader question, is because the public acceptability question will also speak to the appetite of investors to go to scale on this possibility. My own sense very strongly—rather agreeing with Paul—is if you do not go to scale, it is very hard to see how the costs of any gas produced could begin to compete, and there is lots of other reasons and even then it might not. The public acceptability will be a very strong issue for investors, as you move from exploration to scale, to question whether or not the prospects and the possible benefits are actually deliverable. So there is a deliverability issue that comes out of that.

Q7 Chair: To pick you up on that point, you refer to public acceptability but if you do not have a process that is seen to be addressing all the issues before investment decisions are made, either for exploration or for drilling itself, how does that make the public feel confident in the existing regulatory system?

Tom Burke: I have spent nearly 20 years working for one of Britain's largest mining companies, so I am pretty familiar with the fact that, if you do not make the investment in public support before you make your major investment to develop, you are likely to find that your costs get much higher. That is something the mining industry has learned the hard way; at least the companies that I have worked with have learned the hard way. I think a couple of things have made the prospects of the fracking industry in Britain more difficult: the fact that this became a very high profile issue of attention from the political community, with lots of promises, alarmed people, because it looked as if there was going to be an overnight development of a very big industry in Britain that would land in their backyard. I am not sure that was a very wise way of making the entry of fracking into the United Kingdom work.

I think people have noticed very clearly the inconsistency in the behaviour of a Government that says, "We cannot have more onshore wind because people do not like it and it is not acceptable to the public, but we can have lots of fracking". That inconsistency of approach, again, it seems to me undermines people's confidence in exactly the point you are making that you do need to have.

Q8 Peter Aldous: The fracking debate is very much concentrated onshore. Do you think that is right? Do you think more regard should have been paid to the possibilities for the industry offshore, in terms of being able to develop it at scale, the environmental impact and also public acceptability?

Tom Burke: I am sorry; I do not know is the answer because I have not looked at the question of fracking offshore. I think there have been some issues with the prospect of developing offshore methane, coal-bed methane, but my sense is—and it is not very well

informed—that has not attracted the same kind of opposition or debate that onshore fracking has attracted.

Professor Stevens: It has also not attracted a great deal of interest from the investors because, by definition, if you are going offshore, it is going to be a lot more expensive than being onshore.

Q9 Caroline Lucas: I want to ask about the compatibility of fracking with the UK's climate targets, in particular in the context of the Government often highlighting benefits from fracking in terms of the lower emissions than, say, coal. What would you say to that proposal and, in particular, to what extent do you think fracking could be accommodated in the short-term without contravening the targets that the UK has signed up to in terms of our climate change commitments?

Professor Stevens: I think there are two issues here. The first is if you have fracking and produce shale gas, what is it going to substitute for? Is it going to substitute for coal or is it going to substitute for renewables? Obviously if it substitutes for coal—with a provision I will come back to—then that is going to help to move towards lower greenhouse gas emissions. If it is going to substitute for renewables, obviously that is not the case. The proviso is for me one of the big environmental issues to do with shale gas operations, and that is: what is the level of fugitive methane emissions? The reason it is a problem for me is we simply do not know. There are all sorts of estimates and guesses out there but to my knowledge I do not know. The Tyndell Centre has probably done more on this. To what extent have there been serious scientific efforts to judge the level of fugitive methane emissions, not least because it is going to be very specific to specific locations. It is very difficult to generalise. But that will be a key issue.

Q10 Mark Lazarowicz: If I can ask very much an economist's question. You were saying a lot will depend on what fracking substitutes for. Isn't there a possibility of course that fracking does not substitute for anything, all it does is lead to lower energy prices and people consuming more and, thereby, in that way threatening our commitments? Is there not a real risk that fracking would simply lead to that happening and people consume more?

Professor Stevens: In the UK context no, because there is the myth that if the UK were to have a shale gas revolution this would bring down the domestic price of gas in the UK. I find that argument extremely weak, not least because we are connected to the continent. Generally speaking—and this is a big generalisation—gas prices on the continent tend to be higher than here, so if you have an increase in gas supply from shale it is going to go to the continent rather than here. So the idea that we can reproduce the American experience, which is what the Government is so attracted to, when prices went down from \$11 in 2008 to \$2 a couple of years ago, is simply not going to happen in the UK.

Q11 Mark Lazarowicz: So that would be French and German consumers who consume more oil than UK ones, is that what you are saying?

Professor Stevens: Yes, but in terms of UK targets, not that that matters given the global issue, it does not work like that. Your logic is fine. If the price goes down, people use more, a conservation rebound effect. But I think it is very unlikely that a shale gas revolution in the UK—assuming we can even have one—is going to bring gas prices down.

Dr Broderick: There was a paper recently from the Pacific Northwest National Laboratory in association with the Potsdam Institute for Climate Change that covered this issue. They looked at whether abundant low cost gas does deliver any net climate benefit, and they found that it is very marginal because of those international scale and substitution effects that you highlighted.

The International Energy Agency said with their golden age of gas scenario that they would still anticipate a 3.5 degrees warming globally as a result of highly abundant gas. So I think that your point has been replicated in other relevant studies.

Tom Burke: The argument that is often put is that you would use shale as part of a bridging strategy to compete directly against coal. That is the argument that is often put. How credible that argument is really does depend on costs and what it costs. That is a difficulty for a new industry in the UK with no infrastructure, either financial infrastructure or supply chain infrastructure, so building an industry from scratch you are not going to find yourself likely to be the least cost operator doing that. To do that you have to go to scale. If you go to scale, you are then talking about a long lifetime not a short lifetime, and it is hard to have a bridge in which the other abutment keeps moving away from you.

In that context it is quite important to think about, as Paul was saying, what does the gas compete against? We use gas for two things, essentially, for heat and electricity. So for heat it is not a market you can expect to grow. If anything, as the pressure on bills and as the Government's own efforts to improve energy efficiency go forward then the market for heat is likely to shrink rather than increase. You have shale gas trying to compete with a European market price for gas in a market that is not growing, so not a particularly attractive prospect to investors.

Then you have the electricity market where, in a sense, you have a problem with the climate change side because your competitor there is renewables. Unless you can find a way to deliver shale gas electricity that is lower cost than coal, you are going to compete directly with renewables. Apart from the fact the costs of renewables are coming down pretty fast and so that competition might not be very likely in the view of investors, you are then very definitely going to run yourselves into problems with the existing obligations let alone anything that may grow in years to come in terms of the UK's obligations under its own Climate Change Act and under the UNFCCC.

It is important to remember if you are an investor—as they will in Britain—that it was Britain that argued very strongly for the European target for 2030 to be at least a 40% reduction, and had said in the discussions that it should be 50%. So your expectation as an investor in Britain is that these constraints on emissions will grow, at least as things currently stand, and not diminish. So we are looking at a very difficult, competitive environment for shale gas.

Dr Broderick: Yes, I think to some extent the important issue here is the timescale, and that relates to your carbon budget. So what carbon budget do you expect to be available at a time when you would have large volumes of shale gas available? To some extent that makes the comparison with coal and the issue of fugitive methane emissions secondary issues. In the UK we are phasing out existing coal plant under the Large Combustion Plant Directive and its successor the IED. If we are talking about the mid to late 2020s, when

there may be the potential of a large scale shale gas industry, we will have very much diminished coal in the UK generating system. So whether or not it is substituted in the UK I do not think is relevant and then that would be an international issue.

What we do know is that we have advised emissions reductions pathways from the Committee on Climate Change, and we can look at the quantities available within those pathways. They are premised on a 63% chance of exceeding 2 degrees Celsius, which is the threshold that is being negotiated internationally between tolerable and intolerable climate change. I hesitate to use the word “dangerous” there, specifically because there will still be dangers from a changing climate very much below that for some people around the world.

If we look at those emissions budgets, we see that there is a very strong constraint and that the energy sector receives less proportionately in future, because we find it harder to reduce emissions from non-CO₂ sources in industry and in agriculture and land use change. So what we are looking at is fundamentally a transformation of the energy sector, as both my colleagues have spoken about. That is a transformation away from fossil fuels en masse and not between different fossil fuels. This issue of higher and lower carbon intensity fossil fuels is not the one that is at stake here. The issue is between a high emissions intensity fossil fuel driven economy and one that looks very much different and is rated very low to zero carbon energy technologies.

Q12 Caroline Lucas: You have said a lot of very interesting things in a very condensed way there. Just to unpack it a little bit more, because I would love it to be minuted so that we can then come back to it in our session this afternoon, I think one of the important things that you have just reminded us is that all of the targets that the Committee on Climate Change are working to—the Government targets over successive Governments—have been this 80% by 2050, which gives us a 63% chance of exceeding.

Dr Broderick: Yes. The 80% target is not the central one from a climate change perspective, so the pathway is what matters not the ultimate endpoint, so the total quantity of emissions up to that point. That is the first thing to point out. The second is: so what are the budgets that the Committee on Climate Change have produced premised on? They are premised on this 63% chance of exceeding 2 degrees Celsius and they make assumptions about the reductions from other countries around the world, necessarily as they must. There is an assumption that there are prompt reductions from all parts of the world, and so there are not specific allowances made for long-term development from poorer parts of the world in there.

Q13 Caroline Lucas: Just to be really clear, we have two things here. One is that the climate change objectives that we are working to would by most people’s assumptions entail a realistic amount of risk. I do not think most people realise that, even though we are not meeting those targets, even if we were to meet them there is still that 63% chance that it is not going to deliver safety in any way that we would understand it. Most people would not get on an aeroplane if they had a risk of a 63% chance of it falling out of the sky. But you are also saying that, even by those pathways or standards that we are working to, fracking would not be compatible with that, not least because by the time we are getting up to a scale of fracking—we are looking at 2025 or something like that—is exactly the point when all these other targets are coming in to say we should be decarbonising our energy supply.

Dr Broderick: Yes. The UK should have a very different energy system, so then it becomes whether opening up new fossil fuel reserves is internationally compatible with avoiding dangerous climate change. I feel that if we are opening up new reserves, if we do not have a stringent and binding agreement on total carbon emissions, then I would agree with Professor David MacKay in his conclusion that adding new fossil fuel resources would tend to increase emissions in total and then that would tend to work against our commitments on climate change.

Tom Burke: You have to see that point in the overall picture. If you want to do fracking as something other than a very specialised niche and go to scale, you run into all the constraints that John is talking about. If you do not go to scale it is very difficult to get the cost down to where you could compete with existing or readily foreseeable competitors. That is likely to be a disincentive to investors, which then raises a question of if you are building your energy policy around the availability of shale gas for energy security reasons, is that a realistic prospect?

Chair: Before we move on I think both Zac and Mark want to come in.

Q14 Zac Goldsmith: Yes. I apologise for being late. If you have already addressed my question just disregard it. I have two questions. One of them is: in your assessments of the impact of fracking in relation to carbon emissions, are you making assumptions about the efficiency of the operation? I suppose the question is: if you took best practice in fracking today, as opposed to the kind of wild west stuff that has dominated in much of the States, using best practice and raising the regulatory standards to the highest possible level, would it then be possible to maintain the argument that, given that most organisations—even quite radical green organisations—see gas as a short-term bridging fuel on the road to a renewable future? Is it possible to make the case for fracking as that bridging fuel? Sorry, it is a very long-winded question, but the difference it seems is between fracking and most other forms of non-renewable energies. If you go down the nuclear route whether you like it or not you are bound in for decades. Likewise coal, to a slightly lesser extent, advanced gas reactors and so on. But with fracking is it possible to see it as a short-term bridging fuel?

Tom Burke: We did slightly address that in a previous question. If you want to get your costs down so you are competitive, you have to go to scale. Unless you are Ineos and you are looking at fracking the gas as a feedstock and you are creating a vertically integrated business, then you have to go to scale. You have to do a lot of this. So you are talking about billions of pounds of investment, which is not short life. So, as I was saying earlier, it is very difficult to have a bridging strategy when you do not know where the other end of the abutment is and it is moving away. I think that it sounds like an attractive idea but—

Q15 Zac Goldsmith: Can I pick you up on that, because when you are talking about the billions are you talking about billions by the sector as a whole or are you talking about lots and lots of pockets of smaller sums of money, literally the dash to gas by smaller operators?

Tom Burke: I do not think the smaller operators are likely to make any significant difference, either to our economy or to the climate, I mean in that sense if all you have is small operators. Leaving aside the current impact of the fall in oil prices and what that might do to perceptions, if this is to be—as was promised by the Government—a significant impact on energy bills, if it is to be a significant impact on Britain's energy security, then you have to go to scale. There are obviously different ways in which you

could go to scale but nevertheless you are talking about a lot, maybe 10% to 20% of our gas volume coming from fracking. That is billions of pounds of investment. You cannot switch that off. It is not easy to switch that on but you cannot switch it off either if you think you have reached the end of your available bridge. As investors think that point through, I think we will hear less of the idea that it is a bridging strategy.

Professor Stevens: Coming back briefly to the idea that you would get a lot of small operators, I mean that was the experience in the United States. The reason for that was that it was basically built upon a mountain of debt, so very small operators could go into the financial markets and borrow money. In the UK that is not going to be an option, so you are not going to have a lot of very small companies. As you say, it is going to have to be a big push to get the learning curve so the costs come down.

Q16 Mark Lazarowicz: Has there been any evidence from the USA that the increase in the fracking has displaced the use of conventional oil and gas or just simply led to more energy consumption?

Dr Broderick: Yes. There has been some displacement in the USA, but if you look at the net quantity of carbon going from below ground into the atmosphere—and I presented these figures in my written evidence—you see that there has been a net increase in the total flow of fossil fuel CO₂ into the atmosphere. Even as there has been a reduction in the consumption of fossil fuels in the States they have been in net terms increasing the flow of fossil fuel CO₂ into the atmosphere, through exports of coal and increased consumption of oil from their own production.

Q17 Mark Lazarowicz: Somewhat ironically, presumably, if there were restrictions on conventional oil and coal take out in the increase in fracking that would lead to a risk of a carbon bubble for the existing oil and coal producers increasing as well. Is that a fair statement?

Dr Broderick: Yes, we have known for quite some time that we have much more fossil fuel available to us in economic reserves than we have safe climate space in which to put it. There was a paper by Christophe McGlade and Paul Ekins recently from UCL that has looked to characterise where those reserves are held. It seems to me that it is counterproductive to be going looking for more fossil fuel reserves when we already know that we have to leave the majority of our existing fossil fuels underground.

Q18 Mark Lazarowicz: Interestingly, that paper, which I saw and I am sure most colleagues did as well, although it did suggest 90% of the world's fossil fuel reserves should be left in the ground, it did seem to allow some space for fracking in Europe, for example. Is that simply because they did not think it would happen anyway because of the cost or for other reasons?

Dr Broderick: They placed a constraint, so their scenario effectively assumes that you have a strict climate policy and that it causes substitution between different fossil fuels in their economically optimised world, and that is not the case at present. So the issue that we have at hand is whether opening up new reserves in an effectively uncapped economic system produces increases or decreases in ultimate greenhouse gases.

Q19 Caroline Lucas: I was going to talk about that same paper because I suspect again that will probably come up this afternoon, and I wonder if you could say anything more about the assumptions that Christophe and Paul Ekins make in that paper, because as I understand it they do not take into account, for example, emissions from deforestation and cement production and, therefore, they are assuming there is an awful lot more space for—

Dr Broderick: It would be best to speak to the authors but, as I understand it, there is some allowance for land use change and for cement production in industrial CO₂ within their models, but there are still matters of: what is their lock-in system? The model optimises itself within a climate constraint and that is not the circumstances that we have at present.

Q20 Peter Aldous: I am going to look at the economic costs and benefits related to fracking and I am conscious that as we have gone along we have covered that in passing, but I would just pose a few questions for you to consider. Looking at that particular issue, how does the situation in the UK differ from the US and whether it can have the impact there; whether there is the prospect of fracking in the UK leading to reduced gas prices for UK customers; if so, whether that will drive economic activity, which in turn might lead to an increase in emissions; and then, perhaps wrapping up, how the situation may have changed as a result of the lower oil prices we have seen in the last few months?

Professor Stevens: If I start with the US/UK comparison, one of the exercises I have been involved in is asking the question: why did the United States have a shale gas revolution? The answer to that is that there were a certain set of characteristics in the United States that favoured the development of shale gas. At the moment I am up to 17 characteristics. They range from things like the property rights issue, access to pipeline networks, access to finance and so on, also tax credits. If you apply those 17 characteristics to the UK—so you have a column with the US going tick, tick, tick, apply it to the UK and it is cross, cross, cross, question mark, question mark, cross, cross, cross. In other words, the conditions here are simply not conducive to a replication of the US experience. It does not rule it out but certainly it is not going to happen very quickly.

The other important point to make is that the US shale gas revolution was an overnight sensation but took 30 years to get there. In other words, it was not a very quick process. It is only in the last few years that you have seen the effects of this by the increase in shale gas production. But it has been 25 to 30 years in the making.

In terms of the oil price—you raise the issue—there is no real obvious connection in the sense that the gas price in the UK is not linked to the oil price except insofar as there is any competition, which is very, very limited indeed. In a European context, of course, gas prices were linked into oil prices contractually. But again that has been changing dramatically. They are now moving to hub prices.

One area that may be relevant is that the lower oil price will seriously inhibit what happens to North Sea oil. North Sea oil infrastructure is a very important part of UK gas supply. For example, the Forties pipeline system carries condensate from the gas fields. Without that pipeline you cannot produce gas from the gas fields. The difficulty there is that that infrastructure is reaching its sell-by date. You have maybe another five to 10 years before it runs out and the economics said you are not going to build new infrastructure, so there is a danger that if the oil price stays low for some time this could

cause problems in terms of UK domestic gas supply from the North Sea, which would have its own effect.

As for the impact on domestic gas prices in the UK, I have already expressed my view on that. I do not think it is going to happen, because if there is an increase in supply it is quite likely to end up into the interconnector and going into mainline Europe rather than reducing prices in the UK. Also as well one has to say, to be a little cynical, the UK energy companies have not been noted for passing on lower prices to their consumer. Sorry, I am a bit cynical.

Dr Broderick: On this scale issue. We have this figure bandied around of 10% of the Bowland shale estimate being available to the UK and that being about 50 years of the UK's present gas supply. We know that we do not have the emissions space available to burn that quantity of gas. From my own estimates I would estimate between 3% and 6%, of what is quite an uncertain gas in play system. It is by no means a reserve estimate. So, yes, the expectation of scale in the UK market is not a plausible one as far as I am concerned.

Tom Burke: I agree with what has been said. I think in particular, because it applies more broadly to the public acceptability of it, the point about the difference in the property right regime is enormously significant and to my mind puts a big question mark against the deliverability of an energy and climate policy that was in some way based on the availability of shale. Can you really think that when you move from exploration to projects that you are really going to see this come about? I am fairly sceptical about that.

Q21 Zac Goldsmith: Here in Parliament the argument on fracking has been associated in almost every sentence with cost of living arguments, and yet I have heard Lord Browne on the radio and I have seen quotes where he has said that you will not see a meaningful reduction in the cost of energy on the back of even a successful fracking industry. Is his view mainstream within the sector or is he stepping out of line?

Tom Burke: No, I think the sector as a whole has been quite responsible in that sense. They have said that, not always perhaps as loudly as they could have done, but they have said it quite clearly on many occasions and argued predominantly on the bridging strategy line and on the security of supply line. They have been the dominant arguments, not the cost of living argument.

Professor Stevens: With respect it is the politicians that have been arguing that it is going to bring down the cost of gas, not the industry.

Q22 Martin Caton: The Government's Infrastructure Bill is changing trespass laws to make fracking easier and the Chancellor has introduced tax breaks for fracking. Does this Government support change the economic equation for fracking significantly?

Professor Stevens: I would say, no. In terms of the tax breaks and coming back to the US experience, the 1980 Energy Act in the US gave 50 cents credit on unconventional oil and gas production and that was quite a significant tax break that helped to promote the industry. But it would have to be a very significant tax break to have much of an impact here on the economics of it. I really do not see that as having much effect.

As for the trespass law, I do not think that is going to make much difference either way to whether you start to see fracking going ahead and a shale gas revolution in the UK.

Tom Burke: It does not change the economics. It will change the politics marginally, in the sense that it adds to a sense of resentment and asymmetry in which the Government seems to be very keen to promote something that is pretty unpopular wherever it is likely to land and, on the other hand, keen to discourage things that are pretty popular in the form of onshore wind. What that inconsistency does is simply feed the resentments of the people who are opposed, so all that does is add to the local political difficulty. It does not make any difference to the economics. The idea that you are taking away people's rights, even though they are not rights that anybody exercises—after all the trespass piece is a technical piece so that people can drill at depth under people's land without asking them. It is not a right that gets exercised very often so I do not think the substantive right is very important, it is more—

Q23 Chair: There has not been any need to exercise that has there?

Tom Burke: It would be interesting, you could go back to coalmining—and I do not know the history—and see what happened when coalmining was developing, what was the way in which the coal industry went about it. In a sense that was a very different time. I am only simply commenting on the fact that I do not think it would make very much difference to the economics but it will make some difference to the politics.

Q24 Zac Goldsmith: I understand that there is lack of clarity around the liability in the event that things go wrong in the proximity of people's homes, so if drilling happens beneath a home and there is a contamination of some sort. I understand that as things are currently written it is not clear who would be liable for that. Is that true? That has been commented on.

Tom Burke: I am sorry, I do not know the detail of that but in terms of what Paul was saying earlier—and I was agreeing—it is not beyond us to write regulations that deal with that issue and to be confident that the regulatory authorities can do that. So I do not see that as a major constraint. Is it a real issue? Yes, it is and it is an issue that needs to be addressed.

Professor Stevens: I do not know what the current legal situation is regarding that. One point that is perhaps worth making is that one of the concerns about some of the fracking companies is they have very, very low levels of equity, which means if something goes wrong and they become liable there is not much money there to pay out for the liability. Again, this is an issue of public concern.

Tom Burke: That is a much more serious one than the one of trespass. In fact quite a lot of the companies that have expressed interest have very shallow pockets and, therefore, unable to cope very well with unforeseen circumstances.

Q25 Martin Caton: Government support does look remarkably like a subsidy and we recently undertook an inquiry into energy subsidies, and the only real justification that was put forward for energy subsidies, in most cases at least, was to allow an infant industry to grow and develop and become economic in the marketplace. Do you regard fracking as an infant industry when the technology is well established?

Professor Stevens: There is another reason for introducing subsidy and that is to internalise externalities and that has always been a legitimate reason to have a subsidy, so if you cannot internalise the externality in any other way then you introduce a subsidy in the same way that you would, for example, tax pollution. If you have a benefit then you might want to subsidise that to internalise the externality.

Q26 Caroline Lucas: As the Chair was explaining, the Infrastructure Bill is coming back to the Commons shortly with its duty to maximise economic recovery of oil and gas. When you have an actual duty then set down in law, I wonder what difference you think that will make to the future of fracking.

Tom Burke: I read that duty and the argument on that duty and thought I could see sophisticated policymakers finding a lot of escape room in the word “economic”. In other words, when there was a potential conflict it could turn out not to be economic. There is a lot of elasticity in the English language when it comes to these duties, and I know there has already been discussion on the Climate Change Committee about just how enforceable the terms of its Act are, so I think that is an interesting area but probably not an immediate cause for anxiety.

As Paul said, this is an infant industry in Britain so you could make an argument for subsidy. If you are going to make that argument for the taxpayer subsidising it you have to be very confident that the benefits to warrant the subsidy are there, and I think what all of us have been saying this morning is that is a pretty speculative case.

Q27 Chair: Can I ask how that squares with the commitment at the G8 to get rid of fossil fuel subsidies?

Tom Burke: It doesn’t directly square with it in terms of fossil fuel subsidies at all. It wouldn’t, so you would have to reconcile that but is there a case, in the sense you have an infant industry? Yes. It would be the same case in that respect as you make for renewables, which has been made for renewables, so I was picking that up. You are quite right, it conflicts directly with that obligation, which, I have to say, is observed a lot more in the breach than in the delivery by all Governments everywhere.. There has been deep reluctance on the part of all of the developed country signers up to that to apply that to production subsidies rather than consumption subsidies.

Professor Stevens: It is also debateable that what we are talking about here, as an attractive upstream fiscal regime, constitutes a subsidy. I can imagine a lot of people having a lot of fun and games with arguing that it is a subsidy when it is simply an attractive fiscal regime intended to attract investment.

Tom Burke: There is a very interesting point, the Prime Minister before the Liaison Committee introduced the idea of a difference between semi-subsidised projects like nuclear power and highly subsidised projects like renewables, and I am not sure anybody has yet explained clearly what the difference between semi-subsidies and high subsidies are.

Dr Broderick: On the issue of the duty to maximise recovery, in 2015 as we are going into the Paris negotiations, my concern around that is one that is raised in the Nature paper by

McGlade and Ekins is: which fossil fuels are going to be left in the ground if we are to avoid dangerous climate change, and then what is your political response to that? How should we go about negotiating it? If we are going into negotiations with that duty on the UK Government, that has implications for what we are saying to other parts of the world.

Tom Burke: That is a very important point about that contradiction that you have pointed to. Britain has had I think an earned reputation for being a leader, both in the international negotiations and in its own performance through the Climate Change Act. As we go forward to the important negotiations in Paris at the end of this year, Britain's ability to speak with a voice that has authority and is understood is important to the 60 million citizens of Britain who need the rest of the world to do things if their prosperity and security is to be secured. So things that undermine Britain's authority and these sorts of contradictions do undermine—and I am not picking on Britain, pretty well everyone else has similar contradictions—our authority as we—

Q28 Chair: Are you saying that the race for fracking does do that?

Tom Burke: As you were pointing out, we have announced subsidies for fracking. We have announced subsidies for North Sea oil development. As you pointed out, we are saying to the world, "You should stop subsidising fossil fuels" and now we are going into negotiations on the basis of quite contradictory pieces of our own behaviour asking everybody else to behave better, and that is not compelling. All I am saying to be clear there is that it reduces our authority at a time when our authority, given our track record on the issue internationally, is an asset that is important.

Dr Broderick: If we are saying that we ought to have a binding global agreement that restricts the quantity of CO₂ that can be put in the atmosphere, and then that implicitly restricts the quantity of fossil fuels that can be recovered, and we are saying we are seeking to recover more ourselves, so who else around the world is going to recover less of their reserves that they are expecting to?

Chair: You are nodding as well, Professor Stevens.

Professor Stevens: Yes, I agree with this. The whole unburnable carbon issue, which has crept up the agenda, I think, is extremely important. If we already have enough carbon, so that we cannot burn a fraction of it without risking serious climate change why make great efforts to find more?

Q29 Martin Caton: Tom, you mentioned the fact that the Government is pushing fracking at the same time as it is removing support for surplus forms of renewable, and you have said that sends mixed messages. That seems quite a generous interpretation to me. You could say that this is the Government seeking to change horses in midstream. Do you have any comments?

Tom Burke: I think, when you are looking at people making long-run very large investments, clarity of purpose is very important. So the damage of the mixed messages is that it confuses investors and chills investment. The result is you fall between all the stools. You do not get any of what you want because the mixed messages deter investors. So, over and above or aside from whatever political anxiety that that causes, it is a very bad signal to send to investors. There is an impression that has been created over the last

few years that energy policy quite often gets made up at the Dispatch Box, and that is not a way to make people who, as I say—I mean I worked for Rio Tinto. It is a company that makes very large investments on a very long lifetime, a 30 year lifetime typically of the order of 10s of billions of dollars. An enormous effort goes into deciding whether or not to make that investment, of which the signals from politicians are a very important part. If those signals are muddy and unclear, that is a real chill on those investments and I have seen how that works. My feeling here is that the pieces you describe have created that sort of impression. So you have the Government complaining about the fact that investors won't bring forward investments, at the same time as it is creating the kind of context in which they are reluctant to do that.

Q30 Peter Aldous: Looking at energy security issues, I think some people have highlighted possible advantages from fracking that it would increase our energy security and we would not have to rely so much on imported energy. If we ignore the question of whether our carbon budgets would allow it, do you think a fracking industry could develop in this country that can be a significant part of the energy mix, and what sort of timescale might that be? I am conscious that Professor Stevens did say that in the States it had started in 1980.

Professor Stevens: It is a 30-year time horizon, yes. Certainly in the UK the timescale we are looking at, if it happens at all—and I remain very sceptical—you are certainly looking at least 10 to 15 years before there is any significant impact. I think there is a bit of a mythology here as well that says if your energy source is domestic that is good and if it is imported it is bad. I think if you could contact Ted Heath via a Ouija board he might have a different view on that, simply because energy supplies domestic does not give you any guarantees. What keeps President Hollande awake at night is the idea his nuclear engineers will all go out on strike. If you are concerned about security of supply, then the solution lies in diversification of supply. In that sense, if we have shale gas, leaving aside the climate change issues, then that would be a contribution, but it is a bit like the yachts in the Caribbean. It might be nice to have one, but it is not essential.

Dr Broderick: Fundamentally, we are not interested, as consumers of energy, in the security of the supply of the commodities themselves. We are interested in the supply of the services and the benefits that available energy gives us, so in terms of heating, lighting, refrigeration, and transport and so on. Were we to pay attention to the security of the supply of those services then we would be looking also to substantial demand reduction, and I think that is where our priorities should be focused in terms of a sensible and effective climate policy that is compatible with a secure standard of living.

Tom Burke: If security of supply is your concern, remember again that you have two issues: heat and electricity. They are not the same, even though there is a bit of an overlap. If you are concerned about heat, then investing in making all your homes highly energy secure would give you more confident security of supply, because you would get a permanent reduction, you take all the prospects of volatility, consistent with where we are going because demand for energy has been falling pretty secularly now for almost a decade. So you would go with the wind on that. That helps your security of supply. It also lowers energy bills. It does do the point you have been making: free up money to go elsewhere in the economy. It is not immediately clear that the rebound effect is as big as some models would have you believe, but there is some risk of that. For heat, that is a much more likely way to reduce our dependence. I agree with Paul about where you get it

from, but it is the volatility that is a concern to people. That is a permanent taking out of volatility.

On electricity, if you are concerned about security of electricity supply, then building more interconnectors—and about 7.5 gigawatts of that are somewhere in the pipeline over the next 10 years or so—that is a much more reliable way of increasing your security of supply of electricity. You add renewables to that. All of the time you are then locating the management of your energy system in your own country that structurally has to be a way because it is in your control. You are reducing your vulnerability to lots of impacts that could take place outside.

Q31 Peter Aldous: Thank you for that. I think Cambridge Econometrics predicted that to have an impact on EU gas prices you need to have between 33,500 and 67,000 wells by 2050. That is to have the impact that people might be looking for. Do you feel that is practical?

Tom Burke: In my view, no. That is why I have been talking about the difficulty of going to scale, which was the sort of numbers I had in mind. What going to scale means is, if you want to get the costs down, that is what you have to go to. To do that is very high risk for the industry. The investors taking that on will run into very considerable opposition, which raises questions about deliverability as well as about the appetite of those investors for that kind of risk. My sense of that is it is not very likely to happen, which I think is what Paul said. You may well get niches, like the NELs niche for instance. I have no problem with the niches but I think the issues on that scale are very difficult and then they run head on into what John has been talking about, which is the availability of carbon space.

Professor Stevens: One of the important differences between the US and the UK and Europe, in fact, is the availability of a competitive dynamic service industry. To just put that in perspective for you, on the Barnett play in 2008 there were about 200 rigs drilling. Last year in the whole of Western Europe there were less than 30 rigs. We just do not have that sort of capability and it would take quite a long time to build up the capacity to drill that number of wells, leaving aside other issues of circuses coming to town and so on.

Q32 Caroline Lucas: I was just going back to the security of supply argument and looking at some of the things the Committee on Climate Change have said. They seem to be quite fond of the security of supply argument and make the point that currently we are a net importer of gas from Norway and Qatar. Notwithstanding everything you have explained about how efficiency and diversity are better ways of having security, could you say anything about the role of biogas to the extent you think that that could form any kind of contribution to transitional fuel?

Tom Burke: It is not something I have looked at. I suspect there is more potential there than we are developing. Completely a priori, I would not see it as going to scale, but that is an uninformed judgment.

Professor Stevens: It is not something I follow either.

Dr Broderick: The point there is that biological resources are quite finite, either in terms of land or in terms of waste, and we would have to be careful about what we would look

to. There is a paper by one of my colleagues, Andrew Welfle, that looked at the potential scale of the contribution of bioenergy resources to UK energy and the issue there is in relation to the quantities of demand. Whatever we can do to reduce the demand for energy makes it more plausible that we can have a secure and diverse supply that can meet that in a low-carbon world.

Q33 Peter Aldous: Of course, to create this significant domestic industry you need a manufacturing supply chain. Does such a supply chain exist in the UK? Is there the potential for creating one? If you look at the offshore wind, you can transfer, in many respects, the North Sea oil and gas supply chain to the wind chain. Is there such a potential with fracking?

Tom Burke: Not very quickly. Paul has already said that would be one of the ones on his list. It is also skills and the particular skills, the wildcatting skills, not just at a high level but on the project level, are not very available. We do not have a long tradition of drilling in this country. We have some places where we have done it. But you have to build those skills. You have to build the understanding in the investment community about what it is they are buying, and all of that takes time and experiment. People do not like to read studies before they make investments. They like to see things happening, so it is not quick.

Professor Stevens: It is also an industry—and I am particularly talking about oil now—that is suffering from an ageing workforce. The average age in the large multinationals is over 55 and they are not getting the input from the bright young things, who all want to go and deal with things like renewables and the sexy energy rather than dirty old oil. That is another barrier as well.

Q34 Chair: Do you think that is a message that would reach out to investors in terms of: where is the capacity going to be to develop this industry?

Professor Stevens: I honestly don't know. I am hesitating because we are talking about quite a long time period to build up the capacity, to build the rigs, to train the workforce and so on. There is quite a long lead time on this and, given the other things that are happening in the energy field, it is very difficult to see how that process would be speeded up.

Tom Burke: You are also competing with other possibilities, nuclear, renewables, HS2, for a lot of quite similar skills to do that. The way these extractive industry development works tend to operate is you have small high-risk companies who explore and sell on to bigger players, who bring in more resources, more capacity and more ability to deliver on the projects. That is the traditional pattern. Now, we are just at the very leading edge of that bit.

If you are going to go to scale, you are looking at several steps in terms of the investment appetite for doing this as you go through that process of people showing that there is a reserve there—it is one thing to talk about how much shale there is, as a resource in the Bowland shale. It is another thing again to identify where the sweet spots are, the spots where you can extract gas or oil at an economic cost. That is a much longer piece. It is another piece again to take it to the stage where you have all the permits, processes and infrastructure in place to do that and you sell on at every stage. Different investors come into play at every stage and none of that happens very quickly.

Dr Broderick: That brings us back to this central point of unburnable carbon and what quantities it would be rational to have available at a future point in time in a climate-constrained world.

Q35 Mrs Spelman: E3G has stated that without a social licence there can be no shale gas boom. I do not see very much evidence of a social licence. What could be done to address public mistrust over fracking and who would be trusted to provide an objective assessment of the pros and cons?

Tom Burke: The short answer to the question is: do not start from here.

Mrs Spelman: We are where we are.

Tom Burke: I think the message we have been saying is: starting from here, there is not much of a prospect for this industry. What I have been saying about my view of how long it would take to wind up investor appetite for investing in projects is compounded by the lack of a social licence to operate. As I pointed out in reply to Mr Caton's questions, there is an asymmetry in the way different technologies are treated, at least people feeling resentful about why they have to pay a price that others are not having to pay. I think once those issues get entrenched it is extremely difficult to undo those positions and people basically use the arguments as arsenals from which to find ammunition to fire rather than the attempt to come up with a broad view of what is acceptable.

I have had a lot of experience over the years with multi-stakeholder dialogues and you start them very early if they are to succeed. As I mentioned earlier on, it is very hard to do that when you have political leaders saying, "This is the solution to everything and you have to have it by tomorrow", because that takes existing concerns that have some value but may be just ill-informed, but it binds them all together and it binds everybody together in a way that is very hard to unpick once you have it.

The other lesson from this in the extractive industries is you make your social investments before you make your final investment decision. You have to be willing to put a lot of money into building your community relations, investing in the community that is going to be affected and doing that before you have decided you are going to spend the money on the development. Otherwise you find that you are down your decision-making cycle but it is completely out of step with the community.

I have seen that Chris Smith is going to lead a panel that is going to attempt to find—the trouble with that sort of idea is that almost anybody who has enough knowledge to be a useful contributor to that already has a position and a view. Creating real independence, in the sense of credible independence, is very difficult to do. I think, in order to try, you would have to have some very clear idea and communicate some very clear idea of what you think would be different and how the debate would be different. You would have to do that. In other areas we have seen that once you are in a much contested public space, such as with Mrs Woolf and the child abuse thing, just how difficult it is to restore public confidence once you have lost it. I fear that the Government has lost public confidence on this issue. You take a lot of time.

Professor Stevens: I agree very much with what Tom has just said. I would add one thing, however. I did say at the start of my comments that I had confidence in the regulatory

system in the UK. I think we have enough regulations there to manage it properly if we are going to do it but, in terms of assuaging public concerns, I have been arguing for some time there is a case to create a specific regulatory regime for shale operations. You would not need very much that is new. You just bring together a lot of existing legislation and, around that regulatory regime, create a very strong independent regulator; somebody that would be able to give public confidence.

The other thing would be a serious information campaign. I do not mean a public relations campaign. Public relations campaigns are when you are trying to sell something to people that is probably not true, but an information campaign from independents. Although, as Tom said, it is difficult to find independents because everybody who knows about it is involved in one shape or another, but I think that would be a way forward. I think you are looking at bolting the stable door, to be quite honest.

Tom Burke: I think you could do a lot to build public confidence and trust in the regulators. If you look at the straight local environmental issues, whether it is earthquakes or methane emissions or whatever, I think that could be done. Where it would be much harder to do is in the planning regime. I think there has been a significant undermining of public confidence in the planning regime over the last few years. That is the bit where I foresee the biggest problems with the social licence to operate. It is not on the output end. I agree with Paul; I think quite a lot could be done to build confidence in that.

Q36 Chair: I think we all want to come in but can I just say, from the Chair first of all, you opened your comments to my first question, particularly Professor Stevens, by saying, “Of course, we have the regulatory structure and we have every confidence in that. I am an economist”. Isn’t the real question that there are just huge key problems with the regulation? The current regulatory framework contains many gaps. You have a whole plethora of different organisations from the Health and Safety Executive to the Environment Agency to DCLG at a local level, never mind no platform at a national level to do that strategic starting point of monitoring and auditing even before you put the regulatory system in. How can you square these gaps in the regulation or a regulatory regime that is fit for purpose with embarking on a whole new investment programme as far as fracking is concerned?

Tom Burke: What Paul and I said was we have confidence you could build a regulatory system that will meet those requirements. I agree completely with your comments on the existing regulatory requirement but that is a solvable problem, if you want to solve it. I suspect some of the problems with the planning system are not so solvable.

Q37 Chair: The point that I am making is if that is not in place at the outset of this procedure—

Tom Burke: Then you are back at the loss of confidence. I agree with you. It should have been in place.

Chair: Therefore, it is about what needs to be in place before anything is considered and we are not at that stage yet because that does appear to be there. Am I correct?

Tom Burke: You are exactly right. It is not helped when you have redacted reports and the regulatory impact reports in other areas are published. I think that is the experience you had the other day.

Q38 Chair: You mentioned the DEFRA report and I just want to place it on record that this Committee has asked for that report in its unredacted form, but I am just confirming that we have not as yet received that.

Tom Burke: I am saying that if you are looking for a way to absolutely undermine public confidence then you have discovered it, not least because that clearly addresses the concern of a great many people who are neither one way or another on the broad principles of fracking but worry about its impact on property prices.

Dr Broderick: In terms of things that are not in place, while we do not have a strict and effective international climate regime, we have these persistent concerns of increasing fossil fuel resource availability and increasing inflow of carbon into the atmosphere. That is something that is again absent at present.

Q39 Caroline Lucas: That was to be my point in a sense because I think the question about how we build public confidence is the wrong question. I do not think we should be building public confidence because, until we can find some deus ex machina way of sorting out the climate problem, we have no grounds to feel confident, I would suggest. I know I am supposed to turn that into a question.

Chair: I think Dr Broderick is going to come in on that.

Caroline Lucas: Would you agree that, in a sense, the discussions about the regulations and so forth are secondary because we can all imagine, I dare say, a regulatory framework that would take care of the local environmental impacts that we started off talking about? We can imagine how that could be done. What I think is far harder to imagine is how we are going to square these climate change impacts, in the absence of major changes and more ambition in terms of climate policies that currently are not on the table.

Dr Broderick: Yes. The central issue is: do we want to avoid dangerous climate change and how do we go about doing that? That then speaks to the exploration of all fossil fuels and our political processes around that. As far as I am concerned, that is the central issue here.

Tom Burke: The only thing I would say is that when you build public support for anything—people have different perspectives and different senses of priorities—you are building a wall in which the major components of that wall all have to be able to stand. Without this axis, I do not think the wall of public acceptability will stand. It does not mean you do not have to explore and try to see what can be done on those other bricks that need to go into that wall.

Q40 Caroline Lucas: I suppose I am just worried that quite often, when we hear evidence from people who are very pro-fracking, they focus all the time on how we can sort out the local environmental impacts, because obviously that is a much easier question to answer, and then the implication is: well, that is job done. Whereas quite often the climate change arguments seem to be the much bigger elephant in the room but do not get the same degree of attention.

Dr Broderick: The climate change argument is not just an argument about fugitive methane emissions, which seems to garner most of the column inches. It is fundamentally gas is a high-carbon fossil fuel; we need to be getting ourselves off high-carbon fossil fuels as quickly as we can to give ourselves as best a chance as possible of avoiding dangerous climate change. That is the central point.

Tom Burke: In a way it throws the issue back into your court as the political leadership. The fossil fuel industry does not believe that Governments of the world will stick to 2 degrees. They just do not believe it. It is a very deep consensus. I have seen it close up with leaders of the industry. They simply think they can carry on anyway because Governments will wilt in the face of the difficulty of doing it. That encourages the mind-set that you are describing of just coming in and focusing on the local issues; Governments are not going to do anything about the big issues.

Dr Broderick: Exactly. As Tom says, discussions about relative comparisons between fossil fuels fuel that uncertainty and it is a distraction away from the central point of quantities of emissions into the atmosphere through time.

Professor Stevens: To give examples of that, you only have to look at the shareholder letters sent by ExxonMobil and Shell before Christmas in response to the unburnable carbon issue in which they more or less said, “Look, don’t worry about the value of these things. Nobody is going to be in a position to stop us burning this stuff”.

Tom Burke: There is an important technical issue that comes out of those letters that it might be worth the Committee understanding. The forecasts from Shell or from Exxon or from the IAA are all the same. They all broadly paint the same picture, justifying it on the grounds that demand for energy is going to grow. Not one of those models contains any impact of a change in climate on growth projections. All that methodology does: population goes up, demand goes up, production goes up, temperature goes up, and there is no interaction between the temperature going up and the growth projections. Most of the growth we are anticipating is going to come from rising real incomes in the bottom quartiles of the urban populations in emerging economies. Those are exactly the incomes that are going to be hit by food price spikes, water price spikes and extreme weather events; all the things that are described in the World Bank’s report and in the IPCC report. The industry itself has a very misleading idea of what its prospects are because of a flawed methodology that is being used to project future demand.

Q41 Caroline Lucas: I am just going back to the Committee on Climate Change because it would say—and this often gets quoted back at us—that UK shale gas production could be compatible with our carbon emission targets. I know it means repeating some of the things you said before, but if you could just, for the record, put down—

Dr Broderick: Strictly, if we have a robust and effective measurement regime before sites and after sites, we could quantify the emissions from shale gas production and from combustion and we could include them within our budgets. If the fugitive methane emissions were found to be higher than anticipated then that would have to be deducted from other sources of emissions in the economy, and I do not know anyone who is saying they are going to go above and beyond the existing the reduction commitments. We could contain in that sense, but that does not address the underlying international issue about the potential of bringing new fossil fuels on to international markets and exporting.

We know that the quantities that people have been talking about in the industry are larger than the emission space that we have in our UK budget, so that issue of expansion on to international markets is a real one if you are talking about a large industry. Then there is the political issue in negotiations and going into a 2015 climate change negotiation year as to facing up to this issue of unburnable carbon. If we are committed to delivering this carbon to international markets, who else is going to keep some in the ground and how is that going to be achieved?

Chair: I think that time has run out for us, so can I thank each of you for coming along this morning and we will see where we go with our further sessions this afternoon. Thank you very much indeed.