



Energy and Climate Change Committee

Oral evidence: [Low carbon innovation](#), HC 747

Tuesday 14 January 2014

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Written evidence from witnesses:

- [Technology Strategy Board](#)
- [Energy Technologies Institute](#)
- [Research Councils UK](#)
- [Chartered Institution for Building Services Engineers](#)

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Members present: Mr Tim Yeo (Chair); Mr Peter Lilley; Albert Owen; Christopher Pincher; John Robertson; Sir Robert Smith; Graham Stringer; Dr Alan Whitehead

Questions 1-44

Witnesses: **Rob Saunders**, Head of Energy, Technology Strategy Board, **David Clarke**, CEO, Energy Technologies Institute, **Professor Jim Skea**, Research Councils UK, and **Professor David Fisk**, Chartered Institution for Building Services Engineers, gave evidence.

Q1 Chair: Good morning. Such is our enthusiasm, we are starting four minutes early. Would you like to introduce yourselves very briefly so we know exactly who you are, where you come from and so forth?

Rob Saunders: Good morning, everyone. I am Rob Saunders, Head of Energy at the Technology Strategy Board. The Technology Strategy Board is a non-departmental public body sponsored by BIS and our aim is to accelerate economic growth in the UK by stimulating innovation in innovative UK companies. We operate across the economy, and energy is one of our focus areas.

David Clarke: David Clarke. I am the Chief Executive for the Energy Technologies Institute, ETI. We are a public-private partnership investing in technology demonstration, technology development and underpinning knowledge base around low carbon energy systems.

Professor Skea: I am Jim Skea and I am Research Councils Energy Strategy Fellow based at Imperial College. I was commissioned to produce independently by the Research Councils prospectus for energy research and training. I would like to emphasise that I am not here to represent the Research Councils, but I can talk about them.

Professor Fisk: I am Professor David Fisk, Imperial College, but I am here as the immediate past president of the Chartered Institution of Building Services Engineers, which is an engineering professional body that is probably accountable for about 30% of the country's carbon emissions.

Q2 Chair: Thank you very much. Could I start with a general question? What do you think have been the successes and the challenges of the Government's approach to low carbon innovation generally?

Professor Skea: Stepping up the level of support for innovation and making it more compatible with the long-term policy aims is a major part of it. If you go back 10 years we were spending £30 million a year on energy innovation, which was incredibly low historically and in comparison with our international peers. With the institutional arrangements we have at the moment we are beginning to get some of the critical mass and scale needed to make a difference in terms of energy innovation. As the NAO report flagged up, we are making steps to joining up what is now quite a complicated landscape.

Rob Saunders: Yes, I would support that. I think the approach of the Government's portfolio of energy technologies is a successful strategy and very much needed in the face of the uncertainty of the future energy system. The co-ordination of the bodies that are helping develop new technologies needed for that energy system has come on very strongly in the last few years, and that co-ordination is starting to bear fruit. The funding levels are increasing but we are still some way behind many of our developed world competitors in funding energy R&D. The Energy Research Partnership wrote a letter to the Chancellor at the back end of last year, I think, articulating that we are certainly way behind Germany, US and Japan, for example, in what we fund on a GDP basis.

David Clarke: I think there is a key issue that to some extent comes out in what Jim Skea just said, which is that there is a huge challenge in terms of focus to make sure we get value for money for the investments that we do make. The words that Jim used were "critical mass" and we have been quite successful over the last 10 years in establishing a number of focuses, or foci, for low carbon energy development and demonstration around particular technology areas and particular application areas. Rather than a shotgun approach, we have started to see funding over the last 10 years. Although funding has grown, it has been more targeted at particular problems in an active way. That has enabled us to create these critical mass centres of capability in the research centres and universities but also in industrial partnerships as well through groups like ours and the Technology Strategy Board.

Professor Fisk: I think my institution represents the sharp end of this process, Chairman. While we welcome the increase of inputs into the R&D process, I guess the engineers would really want to understand what the outputs were. A lot of the debate in the R&D community is always about increased inputs and we always worry about whether there are the outputs that we can get to.

We certainly welcome the improved co-ordination that has been represented by the group you are looking at. We also welcome the Committee's interest in what some people would view as a bit of a minutiae in the enormous wealth of problems that come in front of this Committee, but it is a really important one.

One question we would like to pose, or invite the Committee to pose, would be: is co-ordination enough? In some countries these programmes are much more directed. They may be carried out by different delivery agents but there is more coherence and there is not just the feeling perhaps that a joined-up narrative is enough to deliver a joined-up outcome. So our jury is out, I think.

Q3 Chair: I was going to ask how you think the Low Carbon Innovation Co-ordination Group has worked. Is it working well? It has a very diverse membership and looking at it from the outside it looks quite difficult to make that work.

David Clarke: The Carbon Trust, Technology Strategy Board and the Energy Technologies Institute were the initial founders of the LCICG and that was in response to the recognition that we had three major groups with public sector funding behind them who were all funding work in—I will put it generally—innovation in the low carbon space. The LCICG, initially as a group of three, was established in 2009, I think that is correct, to start to provide co-ordination, as it says in the name, around the funding space. If you look at what came out of that, we started to see the development of the Technology Innovation Needs Assessments, the TINAs, which were focused on particular areas.

We then moved on and I think there was a key recognition that those were three major groups but definitely not the only groups by a long way. Hence Research Councils UK and a number of devolved administration groups and some of the other Government Departments, and in particular DECC as a Department, became more heavily involved in the LCICG, which was then relaunched with that much broader membership.

In answer to your question about how it works now, I think what we have seen is a very strong group start to develop with a rotating chairmanship around the various bodies. It has been critical that it has been able to draw in the major funders in terms of the core groups; RCUK in particular have come into that along with DECC as an innovation funder. That core group is starting to create focus now and in the next couple of months we will see the first strategy coming out of that, but that group is responsible for the TINAs, which are now a key part of underpinning the strategic direction and focus for energy investment across all of those groups.

Rob Saunders: I agree with that. I think the TINAs in particular are providing a direction that we have not had in the past and a shared and agreed body of evidence that all the different bodies represented on the LCICG can use to direct their own individual strategies and also the strategic framework of the LCICG as a group in the future. While the LCICG has been running for a few years now, the evolution of it is driving a level of co-ordination that will enable low carbon innovation to work much better in the future as well.

Professor Skea: If the LCICG did not exist, you would need to invent it because there is a need for that function, absolutely. I think the challenge it has is the diversity of the low carbon innovation domain and the very wide range of technologies that are there, and one

single group with a large membership is not going to be able to deal with the challenges all by itself.

The key thing will be the questions of sub-groups where people get their sleeves rolled up to address particular problems and what work-streams the LCICG can develop. For example, we flagged in our written evidence that we thought international co-ordination and linkage was a priority area that LCICG might usefully look at. It also might look at more specific technology areas, because one umbrella group sitting meeting every few weeks or few months is not going to meet the challenge just with that kind of activity.

Rob Saunders: I think that is right and some of those groups are starting to emerge already, some off the back of the industrial strategies published by BIS last year. We are seeing an offshore wind group emerge as a result of that strategy really, which is a co-ordination group with industry that will feed into the LCICG, and similarly there is a nuclear group emerging. Those more working group levels are starting to happen to co-ordinate activity in particular areas.

Q4 Chair: Professor Fisk, your point about outputs is one that strikes a chord with this Committee. From the point of view of building engineers, has the Government's Low Carbon Innovation Strategy made an impact?

Professor Fisk: The needs assessments are interesting, extremely well drafted documents but what we were concerned about, which I guess provoked the tone of our evidence, was that there did not seem to be a great deal of appreciation that the difference between an innovation and an invention is that an innovation fits comfortably inside the system in which people are going to use it.

We were nervous that many of these funding things were looking at very individual small parts of a problem and not the problem as a whole. Sometimes the TINAs even explicitly say that this is an innovation but they have not sorted out the supply chain and so on. We were a little bit nervous about that. The area our evidence flagged up where we thought there was quite a difference between the UK and many other countries with low carbon concerns was the lack of procurement pull within the marketplace that we operated in. There is a very good TINA on new commercial buildings but it does not mention anywhere the prospect that maybe every new Government building would have a display energy certificate of A, for example.

Our experience—and I suspect it will be that of the industrialists and indeed the academics on this panel—is that the real innovation that goes like a rocket in the outside world is one that is commercially reasonable. To do that you need intelligent procurement and our great concern has been that we can't quite find out where the information flows that enable intelligent procurement to operate are in this system.

I fear I keep saying our jury is out, Chairman, but I think in this case we can see the rationale of TINA. We really welcome the coming together of the groups and the connection to the satellite groups, some of whom are going to be losing funding I suspect in the current environment so they need in some sense some central gravity protection, but we are concerned that the normal mechanism of commercial innovation is not being

inspired by inspired procurement strategies. There are some examples in our evidence. I need not read them out now.

Q5 Chair: If you took the Government out of this altogether and removed all the public money that is being deployed, what would happen to low carbon innovation if it was just left to the market?

David Clarke: It would depend entirely on what policy signals were sent elsewhere by Government. For instance, pick a very big industry-focused problem—offshore wind, one we invest in heavily. If you have a very clear policy signal about future pricing for offshore wind, around opportunities elsewhere for spin-offs, then industry in terms of the major suppliers and supply chains would look at that and decide whether or not that was a competitive and valuable market for them compared to other overseas priorities. If they thought it was good they would invest in innovation, which would then get delivered into the UK market. If they do not have those signals in place they will go somewhere else. It is that simple.

In terms of the low carbon innovation piece, I think there is a critical element, which is that there has to be sufficient underpinning work—and we will come back to who funds it in a second—so that the large commercial investors, whether in industry or the finance houses, can see there is a derisked base of technology they can then pull on to pull through to commercialisation, the commercialisation piece going from the bright idea, the innovation, wherever it is developed through to a real product in the market.

If you assume that the innovation piece is £1 then the commercialisation piece will be £10 or £100, and in general that is what the finance groups and the private sector are picking up. They are picking up the bill for that. There is a key piece, which is that unless the technology is reasonably low risk they will not make that investment and pull it through into commercialisation.

I think the critical role for the public sector and for groups like the Technology Strategy Board and the ETI is helping this derisking process at the front end, such that it is seen as an attractive proposition for the big commercial investors subsequently. That is where public money comes in.

Professor Skea: If you look at the locus of energy innovation between the public and the private sector, the private sector dominates in areas like oil and gas and a lot of consumer goods—for example, automotive, electrical appliances. That is where the R&D is taking place. The distinctive role of the public sector appears to be in terms of emerging technologies that are coming on to the system—the wind, the wave and so on.

Where I think that you might expect the private sector could pick it up a bit in terms of emerging technologies is small modular technologies with lower unit costs where perhaps you could see a bigger likelihood of venture capital coming in. If the public sector was not there I think the larger scaled, more engineering type innovations would not take place without some of the R&D push taking place from the public sector.

Professor Fisk: I suspect, Chairman, there is a sort of trade-off going on in the mind of the Government, which is that it could indeed take an entirely standoff position. It would then

have to have the nerve to set really prescriptive targets so that you had firm, zero risk markets in which you were selling this product, and that may be very tricky. There is a little trade-off in the sense that rather than create the enormous year-by-year certainty of carbon emissions that must be met and therefore we would all apply our private sector ingenuity to it, there is a sense in which some money is provided because probably we can't be that firm. I think the Committee has looked before at things like the Emissions Trading Scheme, which at one time was intended to provoke exactly that sort of innovation because the trading permits were going to be very scarce. In fact they have turned out to be massively plentiful and in many ways undermined the original model that you were having.

I think there is a trade-off going on here. One could stand right back but maybe the Committee would not feel too comfortable with the political consequences of driving an entirely private sector funded process to give them enough risk-free positions.

Q6 Mr Lilley: Could you give us a few concrete examples of technological advances made as a result of public funding that have resulted in commercial successes in international markets for British companies?

Rob Saunders: I can give you a couple of examples from our programme if you like. As we were discussing, we take a kind of innovation barrier approach by working with industry to understand the things that are stopping them from innovating without public help. As we were just saying, funding is one of those, but we also attempt to link people up with future partners and customers and to link up the supply chain to help pull through innovation.

One of the companies that we have supported is ITM Power based up in South Yorkshire. They develop hydrogen refuellers, among other fuel cell technologies, to help to balance the grid effectively. When power prices are low these pieces of equipment can be used to generate hydrogen that can be used in fuel cell vehicles or other stationary power applications. We supported ITM on a number of projects to develop that technology. They are now in a position where they are selling into Germany. They are making very good links in the US and Brazil in selling this technology abroad, so they are taking a real lead internationally.

Q7 Mr Lilley: I am a concrete-minded person and talking about co-ordination and co-operation does not get me very far. I like to be able to tell my constituents, "You have spent £185 million. These are some of the things you have for it".

Professor Skea: I find it easier to think of examples from countries other than the UK where people have put public money into R&D and produced results from it. I guess you could pick up the example of photovoltaics in Japan where early investment after the oil crisis has resulted in an industry that is very large globally. It may be more difficult to justify, but for example the Danish support for wind energy has also led to a large global industry. If you wanted to go into a completely different domain, for example shale gas, it was US federal funding back in the late 1970s and early 1980s that stimulated and gave the initial push to that. I think there are examples of it taking place.

Q8 Mr Lilley: You will find evidence of that in our report.

Professor Skea: I think one of the differences between the UK and these other countries, if you look at the patterns of R&D expenditure, is the consistency of support. In the 1980s every country reduced its support for energy R&D as oil prices fell but the decline was more extreme in the UK than in many other countries. It was more than an order of magnitude fall in quite a short period. I think it is that consistency of support that is one of the lessons from the global energy assessment that IIASA has just produced as an example of why it is important to be consistent if you are going to carry through and make that public funding a success.

David Clarke: To pick up that consistency point, there are a couple of good examples in the real world. Going back many years now, Research Councils UK supported Loughborough University around fuel cell technology development with a gradually building programme. It was a consistent series of relatively small grant investments and led ultimately to the spin-out of a company called Intelligent Energy, which you have probably heard of. They are now about a 20-person company, based on the Loughborough site still, but it is a full spin-out producing fuel cell power trains for a number of vehicles, including black cabs here in London.

Those vehicles are now operating here in London. They have run them worldwide. They have deals with American investors, American industrial groups and Japanese industrial groups, all of which are for co-licensing and spin-out of that technology on a global basis. They had investment from RCUK and as they grew they had investment from the Technology Strategy Board, and more latterly they have obviously had a lot of private sector finance investment from the City as well. That is one view of the world, which is a long, steady, hard plod, frankly. It takes a long time to develop these technologies and get them into the market.

A different one that was perhaps faster, which we have talked about here before, was the Rolls-Royce development, as a UK company but a big global company now, of tidal turbine technology, which was again a programme that had had Research Council support in universities and SMEs, a particular SME and then Technology Strategy Board support as it grew further. Then there was a kind of handover to ETI as a lead demonstration investment and we backed Rolls-Royce and the SME to develop that tidal turbine technology and put it in the water off north Scotland. That entire unit of Rolls-Royce as a UK entity has now been bought by a French company, Alstom, and they have an MOU to deliver the first seven machines to a Scottish project in the next couple of years. It is again a long steady handover process with increasing scales of support, whether that is public sector or private sector, right through those processes.

Q9 Mr Lilley: I wonder whether there is a lesson in both what Professor Skea and Professor Fisk were saying—Professor Skea says that we have been rather less successful in developing industrial successes out of our research effort than other countries, and Professor Fisk is saying we tend not to think in those terms. We think of expanding the knowledge base and so on.

I am a free marketer, and when I was Secretary of State for Trade and Industry I started from that prejudice, but where I had a research budget, as we did in Aerospace, I

wanted it to produce results and it was quite difficult to get civil servants to think in those terms. They said, “We can’t favour an individual company. Gosh, that would be discrimination. We must make this knowledge available to the world”. Is what I am saying total rubbish as far as you are concerned or is there any relevance to it?

Rob Saunders: I think David’s examples give a very good idea of the timescales and the costs involved in developing some of these technologies. These are decades and multi 10s of millions of pounds to develop a tidal turbine, for example, through to some degree of commercial readiness. I think the co-ordination needed for those kinds of projects is happening but these are really long timescales.

When you set out on a programme, very often the results you are going to see do not appear for quite a number of years afterwards. We measure our effectiveness in a number of way, some of them through telling stories of the companies that we support, as I gave you some examples of and David gave some more.

We also try to measure our return to the economy of every pound that we invest. We have run some studies on the value add of our programmes, which provides a very compelling reason to provide public funding for innovation. Our different programmes return different rates but some of the collaborative programmes we run return 20 times and more the investment. I think there are very good reasons for us to provide this support to UK industry. We need to learn from what goes on internationally and we also need to make the links internationally to help partner up UK companies with successful companies around the world, but I think we are in a better state to develop the right industry capability in the UK now than perhaps we were previously.

David Clarke: I think the thing that has developed, probably over the last five to eight years, has been the procurement approaches in terms of projects. The project procurement approaches that are used by groups like the Technology Strategy Board and ETI—particularly at ETI we run very targeted procurement of technology development and demonstration projects. We will issue a very defined specification for what we want from a project both in terms of the delivery of the project but also the outcomes that we expect to see as a result from that.

We run that on an open procurement basis and we are pretty ruthless on assessment of bids. We are normally only going to fund one at the end of the day in a particular project area. I think that approach—and the Technology Strategy Board are not dissimilar in the way they approach procurement of their projects in many cases—has led to a change and that type of approach is now being used more by the central Government Departments, DECC’s innovation team as well, than previously.

Professor Skea: For me the key thing is trying to minimise the element of arbitrariness in the research procurement process. These were some of the difficulties, if you go back decades, where it was perceived that individuals, companies were taking advantage. The key thing that you learn from some of the examples I have given in Japan and Denmark is the importance of having a clear idea of what your priorities are and where you get to it through road-mapping exercises, making sure that when you carry out the funding there are appropriate stage gating processes so you can exit when things are not working properly.

I think what came out of the evidence from David Fisk's group is the importance of monitoring and evaluation to see what makes for success and what does not make for success. The professionalisation of research management has improved quite considerably in recent years, especially because you are trying to do this tremendously difficult task in a time of austerity so rightly you have to justify where taxpayers' money is going.

Professor Fisk: I think the Committee needs to keep an eye on the interfaces between these funding groups. You will find our area of buildings turns up everywhere because everyone thinks if you are going to have a portfolio of low carbon performance, you must have a building. But it is not always quite clear where each role player thinks its job is finished and whether it believes it was its job to pass on what had been discovered or found or refined to the next player. It is perfectly possible to have had a marvellous innovation in buildings but it never gets into building regulations, for example.

Some other countries—and no country is ideal so I do not think we are suggesting the Committee do a global European tour—keep with the project through its entire development lifestyle and you do not have these interfaces between Research Councils having funded a two-bit man and a dog project on a campus somewhere. Somehow or other it has to be scaled up to Technology Board scale and then from there it has to be scaled up to real industrial investment. They manage that interface rather better. That is why we welcome the formation of this co-ordination group. Before that happened it was almost an entirely ad hoc process of the relationship between some of the research projects that were going on in some bits of the private sector and the later part of its lifestyle, so the group is great in that way.

The reason we were asking, or suggesting perhaps, “Why stop here, why can't it be a little bit more directive?” is that a lot of these projects can easily die. I think sometimes the Carbon Trust used to call it the valley of death. You had a feasibility demonstration for technology but all the other bits that had yet to be screwed on to make it work in the real world commercial system had not been sorted and the thing rather hung around on a bookshelf. It is good for the group to be pressed on how it manages a project from innovation on a university campus right up to something that creates a medium-sized world class company inside the UK rather than selling it to Samsung or some other global player.

David Clarke: I think there is a very important point inside that absolutely, which is that for a lot of the more innovative technologies that we are starting to see come through and that create great opportunities for the UK in terms of the energy system but also in terms of the industrial based development—and if I took energy storage as a good example, at relatively small scale energy storage—it is not a case of there being no regulation to support it.

Regulation goes against it as a commercial proposition. If you took that as an example, I think this is one of the great opportunities, and it is something the LCICG needs to grasp and make effective. The ability to sit round the table as a group with groups like Ofgem and work out what needs to be the regulatory changes to make some of these things happen and create the real benefits, to make all that happen at least as a joint understanding at the front end of the project and then to see how those groups can work to deliver it through the lifetime of the project is the opportunity we have and have not had before.

Previously, exactly as David said, it has been much more ad hoc and maybe we have realised halfway through a project development, “We now need to go and talk to Ofgem about regulation” or whatever it is. We have the opportunity to do that in a slightly more structured way and flag that some of these developments are coming through, but the benefits that come with it is a key opportunity we have to grasp through the LCICG.

Q10 Chair: That leads on to the next point, but before then I should remind the Committee about my interests in the Register of Members’ Interests, none of which I am sad to say have ever succeeded in accessing any of the money that you gentlemen are responsible for distributing.

The National Audit Office suggested that one of the weaknesses of the co-ordination group has been transparency and communication, both between the members and also to industry and the academic world. Is that a fair criticism from the NAO?

Rob Saunders: The first of those I do not recognise, I have to say. Between the members I would say that we are operating very well and the communication seems to be very clear. I think DECC have done a very good job of providing a secretariat to the LCICG that did not exist before 2011 I think. I would say the membership is communicating and working very well together.

On the second of your points about communication to the outside world, I think we have a lot more to do. Most of the progress of the LCICG has been to develop a shared evidence base and to develop a strategic framework among the group. Inherently that has been perhaps a more internal process than we will be executing in future. The next stage is going to be to publish this strategic framework and drive understanding in our industrial communities, and in the energy sector in particular, of what we are doing and what we will be doing in the period up until 2020, which is the timeframe of that strategic framework. We have more to do in terms of making the communities more aware of our activities.

Professor Skea: We have run about a dozen workshops over the last year in different areas of the energy research domain for a slight majority of academics but also people from business and other parts of Government. The main achievement for LCICG is that most of the people had heard of it, so that was quite a significant achievement for a group like that. But because they had only heard of it, there were very high and perhaps unreasonable expectations about its ability to solve all the problems of co-ordination. So it is important to develop that communication to outside groups, but also to create a realistic set of expectations about what it can achieve and what its modus operandi is so that people do understand what it is for.

Q11 Chair: Some of the private sector evidence we had raised concerns about the ETI’s governance, suggesting that sharing of knowledge is controlled to a large extent by the private ETI members. Does that ring a bell? Does that have any impact on the innovation achievements?

David Clarke: The first thing I would say is that the majority of the projects that we invest in are with third party groups outside the ETI members. But clearly these are a fairly big technology development, technology demonstration projects in the main and hence the

groups delivering them wish to control their IP because it gives them a commercial position in the future in a global market. So we do not have access to all of the knowledge that comes out of all of our projects.

But if you look at what we tend to do then the reality is a little bit, as we were saying, about expectations. There is possibly an expectation that because ETI is part-funded by the UK Government and we then invest in a project using some of that public sector money, everything that is going on in that project will immediately appear in the public domain, and that is an unrealistic expectation. What we try to do is to take the knowledge that comes out of the projects and then add to what comes out of one project with what comes out of another project to deliver something more valuable than the two independently.

What we have done over the last 12 months, for instance, in terms of communication of knowledge coming out of probably three years' worth of projects, is we have published a number of major insight papers around carbon capture and storage, for instance, which have gone out into the public domain around UK strategy for CCS, infrastructure siting, all the economic models that sit behind that rationale. That has gone out into the public domain as publications, as conference proceedings, publications in the trade press. We have run open workshops for open access in terms of what we have found there and to engage with people on it.

The reality is that most of what we do does end up in the public domain, but it may not go out the minute it appears from inside a project. There are all sorts of reasons for that, some to do with commercial controls inside the project team, nothing to do with us, and others simply because to get the real value out of it, it takes us time to analyse it, test it, add other things to it, and build that complete picture that we can then take out into the market.

If you took that CCS one and looked at where we are right now with CCS, we funded a £4.5 million project to develop a storage database for the UK for offshore storage of CO₂. The entire database is now available online through the Crown Estate and the British Geological Survey for anybody who wants it. It is a timing question, probably, rather than a control question. It is when some of this stuff comes out into the marketplace.

Professor Fisk: I think the Committee are asking a very pertinent question, however. Part of our evidence was a real concern that so much public money was being spent with so little general feedback to the engineering community of what was going on. Carbon capture and storage is not our area of expertise at all. I suspect it is an excellent project, but there are many other areas in which the write-up of the project is little more than four times the length of the press release when it was produced. There will be intellectual property within the people who conducted the programme, but if we were including it in one of our large engineering guides—which essentially are part of the innovation process because if it is not in the guide people will not risk taking it because the guide is where you will be legally challenged as an engineer—we do not have the information on the performance of these devices in the public domain in order to include those sorts of technologies in our process. We do not have enough information about fuel cells, for example, to have a proper guidance on how engineers would use fuel cells in a combined heat and power explanation.

The concern of my members is in other areas of innovation, and they live with this, but the Parliament has set a 2050 target, which this Committee itself thinks is pretty challenging.

We had expected things to be a little more well greased, more open, much more like you were doing a really fast campaign rather than, as we were saying before, before this group was formed the whole thing was almost completely ad hoc. That would be fine for some background research, but if you are trying to get really challenging targets and, probably more to the point, trying to show the rest of the world you can do it so they will sign up to these sorts of targets, we have found a lot of this stuff rather laconic, I suppose, given the otherwise challenging nature, particularly in the construction sector, of the changes we have to produce.

Q12 Chair: But if you have a situation where you have members of the group—members of the ETI, I was thinking of—who are operating competitively in the same industry, doesn't that act as a brake on how much they are prepared to share their innovative ideas?

David Clarke: No more so than any other industrial, commercial group, would be my best answer. The members of ETI are extremely challenging to each other. It is not a question of whether they share their information or not; they share an enormous amount of information with each other and they challenge each other extremely hard. The public sector, in the form of DECC and BIS and the Technology Strategy Board and EPSRC, who also are part of my governance structure, see that, and engage in that debate and challenge as well. On occasions we bring in other industrial groups to engage in that process as well.

But that is challenging each other. In terms of the innovation space, you only have to look at the spread of projects we have with over 120 project partners. This is an open model for innovation in terms of the project procurement, as I said, and the reality is that, in terms of getting information out of those projects, getting information out of an ETI member project is no different to getting information out of any other project that we do, whether it is with the academic base or the industrial base. We are working at high TRL levels, compared with the academic-based projects, and a lot of the information is commercially sensitive and it is not a question of our not sharing it. This is held within the project team and we are not allowed to share it. That is their decision.

I should say that the upside that the public sector get through the projects, in that context, is that the information may not be shared but there are products and services coming into the UK market that would not have happened otherwise.

Professor Skea: Knowledge is a capital asset, and one of the things that we worried a bit about over the last 18 months was that there were not terribly systematic approaches across the different bodies as to how knowledge data, intellectual property, was looked after. The approaches are partly dictated by the nature of the science or engineering that is being promoted, but they are also partly a function of organisational culture. I think it is possible to be more rigorous about thinking about what kind of knowledge creation is of a common good nature—David mentioned the modelling and geological work, which is clearly common good—from work where privatising the intellectual property is the appropriate way to take it forward. What we have seen across the domain—I am talking more about the Research Councils here—is less of a consistency across different bodies about how that approach is taken. I think it needs some more rigour, and this question of intellectual property and data protection might be an interesting area, for example, for LCICG to pick up.

Q13 Graham Stringer: According to the National Audit Office, DECC have underspent their budget for low carbon innovation. I am trying to find out why you think that is. Is it caution or is there some other reason?

Rob Saunders: It is probably a question for DECC. I would not like to speculate. What I would say is that getting programmes in this area up and running takes a long time. I was thinking about this this morning. If you gave me £5 million to try to spend on a particular sector in the low carbon world today, the reality is that I would not be able to spend that this financial year in any wise way, and the likelihood is that I would struggle to do it next financial year in any wise way as well. The way we develop our programmes is we spend a long time consulting with the industry trying to find the innovation barriers that exist and why companies are struggling to innovate in the free market without public intervention, and then create programmes that address those barriers. We put in place a very rigorous and transparent process by which companies can then apply for that funding, and that takes some time.

In energy, if you are supporting projects that are developing new technologies, the likelihood is that those projects will take two or three years to run through the project cycle. When you add all that up, you find that the bulk of the funding that you are spending is probably in year 3 or year 4 from when you press “go”. If a Department is given a substantial new amount of funding, it is very difficult to spend that in a very short term. That may have been what happened in DECC when they were setting up a new innovation delivery team with a substantial new amount of funding. It takes some time to deliver that money in the right way into the industry.

David Clarke: I can’t comment exactly on why DECC have underspent, but to my mind there are always two factors in big R&D projects that tend to lead to in-year underspends. The first one, as Rob said, is it takes time to set up major projects, and if you have not done one before, I can guarantee it will take you longer than you think it is going to. It takes time to get stuff set up.

The second factor is that if you are procuring a project from outside, which is what DECC are generally doing through their innovation budget—as are ETI, so I can comment from an ETI perspective—we would tend to operate on a basis where we pay a project team only on delivery of key milestones. If they do not deliver, we do not pay. I think DECC operate a similar approach, which most people tend to. The challenge there is that in big high risk R&D projects and innovation projects, the chances are milestones come in late. Things go wrong, and a project team will come to me and say, “Something has gone wrong, it is going to cost an extra million and it is going to take an extra six months”, or whatever it is, to which the answer is, “Fine, I may or may not pay the million, but if it is going to take an extra six months, we are not going to pay you until it is ready”. What has happened? In-year, you are going to underspend on that project, every time.

I can guarantee that any group that is working to a fixed, capped budget, unless they are prepared to over-commit on the budget and then cut back during the year, will underspend every year. It is just the nature of life, because you commit to a budget and what happens is stuff goes wrong and things get delayed and it slips back. I am not saying that is why DECC have gone wrong, but there is a key issue around in-year commitments. What tends to happen on high risk big projects is you spend the money eventually but it tends to be

delayed compared to when you probably thought it was going to happen, so there are planning issues.

Professor Skea: I can't speak for DECC, but one of the things that I thought the NAO report picked up was the underspend on capital budget as opposed to operating budget. One of the challenges there is probably finding sufficient capital projects to pursue in a productive way. We have noted, over the last 18 months, a number of assets around the UK relevant to research that are being under-utilised. We have had a period of relative beneficence in terms of capital budgets but austerity in terms of operating budgets. I think that is a question for the future, about how you get that capital-operating balance right.

Professor Fisk: I complete the quartet of saying that clearly is a question for DECC, but our evidence as an institution, drawing on our experience of some other Government Departments in recent times, is that the Committee may want to inquire how large the team is inside DECC now that is conducting this procurement. Clearly they have to follow good quality procurement rules. That takes time but it also takes manpower.

If the manpower is not there then, frankly, they are going to underspend for a secondary reason, and I think that needs to be pursued because this is a very high technology programme. It does use an enormously large number of external consultants, proportionally to some other schemes in Government. You might want to find out whether the underspend is partly because people are worked off their feet trying to follow through the processes that my colleagues have described.

Q14 Graham Stringer: That is an interesting point. Overall, the funding landscape is extremely complicated. How do companies find their way through this landscape? Can it be simplified, or do you have any ideas how it could be improved by simplification?

Rob Saunders: One way that companies find their way through it is through some of the knowledge networks that are supported across the landscape. We support a knowledge transfer network as part of a group of 15 knowledge transfer networks across the economy. One of those is in energy generation and supply. The intention of that is that companies can share information between each other, but it also gives us an outreach into the industrial community that enables us to let people know about opportunities that are arising, new competitions. We do that by publicising opportunities across the LCICG members. That is one example of how we make sure that the arising opportunities, irrespective of where they come from, are well communicated.

David Clarke: This is a key opportunity. My second key opportunity inside LCICG is for better communication of industrial opportunities and industrial demands, as Rob just highlighted, in terms of visibility and how they tend to arise. The ability to share some of those inside the group and then target them accordingly at the right institutions and organisations is something we need to improve on.

Q15 Graham Stringer: Sir Mark Walport, the Government Scientific Adviser, has pointed out that there have been, in the last 100 years, two huge public sector scientific projects that have succeeded—the Manhattan Project and the Human Genome Project. He believes that the threat of climate change creates the opportunity for another such project. This does not look

like it. This looks a bit all over the place. Do you think that the Government Scientific Adviser is right? Do you think we are a whole order of magnitude, or several orders of magnitude, in terms of the resources available, below what we should have? How should one respond to Sir Mark Walport's analysis?

David Clarke: If you assume that climate change is moving steadily in a direction that is going to lead to temperature rises of two, three, four degrees C over this century, we ought to be investing a considerable amount more than we are today in addressing that problem. We are all going to be affected by ignoring the kind of details of who, what and where.

Q16 Graham Stringer: Can I interrupt you? From the projections the investment looks like it is going to take place in non-traditional forms of energy production, up to between a quarter and a third of £1 trillion. I suppose what I am trying to get at is whether you think that that money would be better spent now on research and innovation rather than projecting into very expensive alternative energy sources.

David Clarke: At ETI we carry out analysis of the UK energy system. We do not look globally; we look at the UK. When we look at the UK energy system across power, heat, transport and infrastructure—so everything, if you see what I mean—when you look at those four, we can carry out an assessment, with the information that we have, of what is the cost of meeting the UK's climate change targets out to 2050, in terms of creating an energy system that will meet the targets. With the information we have available to us, most of which is out in the public domain and being used by a number of academic groups in the UK, particularly UCL, we can look at what the impact is of innovation and R&D in reaching those targets.

The incremental cost of meeting the climate change targets for the UK, in terms of the energy system development out to 2050, is about £300 billion. That is the incremental cost. In very rough numbers it is a few per cent of GDP, probably in the 2% of GDP bracket. If you take out innovation, it is an additional £600 billion, so you are going to triple it in terms of the incremental cost of meeting those targets if you do not innovate.

The reality is that a lot of innovation will happen regardless at some point or another, but the challenge is preparedness. If you look at the energy cycle—I am only talking about the UK because that is the piece we look at in detail—most of the assets in the energy system, with the exception of some of the things inside buildings, are very long-lived, and by 2025 we will be in a major replacement programme.

Any decisions you want to make about major assets, we need to be deciding and starting implementation over the next 10 years. The point about the innovation piece is that we have 10 years basically to get ready, as a nation, if we are going to meet the 2050 targets. If we do not, then the cost goes up steadily in terms of last minute retrofit, if I can put it that way, and the challenge gets harder and harder, year on year, to raise the private sector finance. My reaction would be you do need to do the R&D now because it is cheaper to do it now than to wait until you start putting those assets in place on a big rollout programme.

Professor Skea: I am not sure exactly what Sir Mark said, but probably the questions that he is posing raise some similarities with the Manhattan Project or putting a man on the moon and so on. I am not sure the answers are in the same area, because we are not

looking at such a focused problem. Low carbon energy is very diverse, a wide range of demand and supply side technologies, and there are important questions about the capacity of the innovation system to absorb funds at the moment as well. You can see areas where you might get overheating.

My view would be that the International Energy Agency analysis says we would probably need to increase our spend between a factor of three and four, perhaps, to get to the long-term targets, but it is certainly not an order of magnitude. You would need to step this up, rather than doing it in a big bang kind of way, otherwise I doubt whether the money would be spent effectively.

Professor Fisk: I did not want to lose the ETI point, which is that in 15, maybe 20, years' time, you are talking about a completely different energy system, whatever your view is about climate change, because you are talking about completely different geopolitics for energy supply for this country. The *Financial Times* was quoting a figure of about \$2 billion as the R&D record in the world's automobile industry, producing cars that have 10 million lines of code in them. Then they listed the market pulls for doing those, and about a third of those were environmental in one way or another. You are looking at enormous changes that are occurring in that.

I was one of the contributing authors to the global energy assessment that was mentioned earlier. We were looking at urban energy systems, and cities are going to change anyway. There is an enormous amount of research and development that is going to happen in the way in which cities are going to operate. The critical thing was to make sure that they did it—if the Committee will allow me to say it—in a green way rather than a brown way. It was a critical thing to capture the nature and direction of innovation. What I would be concerned about would be a country that did not understand that the world was changing technically this fast, that had rather ad hoc and slightly Victorian systems for doshing out inputs to R&D systems but did not worry too much about how they were applied.

We seem to be beginning to address that issue, but I did not want it to be entirely labelled by “if there were no climate change then you would not need to do all this”. You have enormous changes that are going to be occurring in the energy market, which the Committee have often commented on at other times. In my own sector, if we do not reduce the peak demand of buildings, the UK is going to have an energy crisis of its own anyway. We were talking about energy storage slightly earlier. If Surrey had invested in 1 kWh's worth of energy storage, it could still have had its central heating running during the floods and the storms.

There are all sorts of senses in which energy is going to have a lot of R&D pulled into it. There are some very specialist ones, and I do not mean that in a deprecating way, like carbon storage, which clearly are very directed to the low carbon agenda, but there are so many other changes that are going to be occurring. Some of the Committee's evidence has referred to things like smart cities and smart grids, all of which are contributing an enormous need for efficient, effective R&D, which ought to be part of industrial strategy.

Q17 Sir Robert Smith: I should remind the Committee of my entries in the Register of Members' Interests, in particular to do with the oil and gas industry and a shareholding in Shell.

Professor Skea and Mr Saunders, you have both mentioned the need for greater international collaboration. I wondered if you could expand. Is that need to benefit UK innovation or is that to promote greater innovation on a global platform?

Professor Skea: The motivation for our team mentioning this was to get greater effectiveness from the UK effort. UK academics are very successful in the EU framework programmes, industry a great deal less so. There has probably not been enough attention to trying to foster UK successes in these competitions, which could raise success on the industrial side but could also improve the quality of the research in the sense that we would avoid duplication with our partners in other parts of Europe. We could leverage the funding that we are putting in.

Q18 Sir Robert Smith: It was going beyond Europe as well. I was wondering whether internationally we would go beyond Europe.

Professor Skea: I know most about the Research Councils world, where the Research Councils have set priorities for specific countries to collaborate with. EPSRC has specifically targeted the US, China and India, and the greatest success has been in collaborations with China, not so much on the US side. The recommendation that we made was that the Research Councils should perhaps focus beyond these three priority countries, because there are other countries who are very good. If you were following a “best with best” principle, there are countries other than these big three that you would collaborate with.

The specific example that sprang to mind was smart grid where we are collaborating with the Chinese there, but the Chinese understand smart grid as something completely different than we do, whereas the Koreans are following quite a similar approach. That is the kind of area that we would recommend—be a bit broader church in who to collaborate with.

Rob Saunders: From an industry perspective, we are trying to help UK companies to find future markets, so that is one focus of our international efforts. It is also to find collaborators in the international world who can help to develop their products with them, bring new technologies or skills to their new technologies and skills, and create something more effective as a collaboration. The third is to be able to learn from other countries around the world about what works well and how to develop new technologies better. We are taking an approach of trying to enable collaboration internationally along those three lines.

A large focus is on Europe. The Horizon 2020 programme is beefing up its energy spend significantly, so we are very keen to enable UK companies to better access European funding in energy. We are also enabling them to do that through some bilateral programmes. We have a programme for SMEs that enables UK companies to partner with European companies, and it gets a top-up from the Commission.

Beyond Europe, we are also exploring how to do some more bilateral work with international companies, focusing particularly on the US and Korea at the moment as potential partners in those areas, and some more targeted bilateral work—for instance,

with Canada in tidal technologies. We are trying to expand our international footprint to enable better market access and partnerships for UK companies.

Professor Fisk: I was going to say that those are very interesting answers, but my end of the spectrum is almost completely unconvinced. It is extremely easy for universities to have badging liaison with universities thousands and thousands of miles away. You never get anything done, the airfares are enormous and actually, if you look at a UK campus, it is international anyway. So what was that about? If you look at the board of the TSB, it has some brilliant people but, my word, it is quite an international set of companies that are operating there. Most of the technology in my area is from companies that may be small or big but they operate internationally. To my mind, the word “internationally” has a late 1970s feel about it in some of the questions whereas most companies operate globally now.

If I were giving you just a simple example, one can easily “innovate” a product but if it does not have a CEN standard that supports it, it will never get sold in Europe. So where was the evidence that enabled British Standards or whatever to go to a CEN meeting and say, “This is exactly the sort of product that Europe should have as its standard performance process”? That is what I would count as an international strategy and I do not think doing a happy co-ordinating programme with Lithuania is anywhere near as productive as working out how the international markets work, how UK products developed in these programmes could go out into those markets, so I have gone back to jury’s out on these ones.

I certainly think the UK is quite an international research focus already. Some of these agreements really have no sign of being tremendously productive. The UK is quite a small country and the Chinese R&D system is quite enormous, so to talk about UK-China liaison strikes me as a slightly disproportionate partnership. I would be much more interested in understanding how we sell real products in the global market.

Q19 Sir Robert Smith: You do not think we could benefit from the low-cost production in China to take our innovation?

Professor Fisk: There are quite a few companies in my sector that have maintained their ability to operate internationally by having a production partner in China, but that is, in David Clarke’s area, a very natural commercial decision. It would be very unusual not to think about where you would produce the product that you have developed, but that is not quite the same as having co-ordinated programmes, particularly with countries who do not have quite the sort of largesse with their IP. It is extremely easy, as Jim said, to say that the Koreans have a smart grid programme very similar to ours in the way they regulate things, but Korean industrial strategy is very Korean-orientated. It is not generous, if I can put it that way, in terms of sharing its IP with other people. No doubt, that is how Samsung has become very powerful.

Q20 Sir Robert Smith: Is there a risk to the UK’s IP in being too internationally co-operative?

Professor Fisk: I do not want to corner the argument because I am such a small sector of the market, but there is a sense in which IP is a commercial decision by the company that has it, and most companies operate with a large map of the world on their wall. The more crucial question is, are they going to have their IP stolen—and that certainly happens with some people you could collaborate with—or is it going to be upgraded? Is it going to be overtrumped? None of that seems to me to relate to whether or not my university's vice chancellor should have some collaborative agreement with somewhere rather halfway around the globe that consumes an awful lot of airfare for me but does not necessarily produce very much extra research.

David Clarke: I think the key piece to hold on to is that certainly from the industrial perspective, as David just said, the big industrial companies in the main, with a couple of exceptions, are not interested in developing a product that is only applicable for the UK because the UK will be a minority market for most things on a global basis. So anything they do needs to be globally applicable, or at least applicable as a major part of the global market.

Possibly the only exceptions are things that are now very socially specific, so some of the things in the building space and how we all interact with energy management systems in buildings or whatever it is. For some of those things, you can see there is a sufficiently big UK market and a sufficiently tailored market, that there is merit in saying, "This is a UK problem. Can we deliver it as a UK solution?" but in the main, the major exploitation companies, the big commercial companies, are looking for innovations in IP that they can apply on a global basis. It does not mean the IP does not come from the UK and they are creating value for it, but I think you have to recognise that is the reality. It has to be globally applicable. Companies will want to use IP globally.

Professor Skea: I would never disagree with my Imperial College colleague, but I think the central theme of David's response was that intelligence gathering is the kind of priority in being more aware. I will make a very simple point that collaboration can be one of the mechanisms through which that intelligence is gathered. I think not collaborating at all would be inappropriate, but do not have unrealistic expectations about what you are getting out of it and be careful of giving away the family silver while you are there.

Q21 Sir Robert Smith: Is there more that DECC should be doing to promote international?

Rob Saunders: I would say that DECC's main focus at the moment internationally is on Europe so they are taking a very prominent role in the strategic energy technology planning.

Sir Robert Smith: But not beyond Europe?

Rob Saunders: There are elements beyond Europe, but I think it is right that their main focus is on Europe right now with the expansion of Horizon 2020.

Q22 Albert Owen: Continuing with that theme on the EU collaboration and the Horizon project that you, Mr Saunders, just mentioned, the programme has a £5 billion budget over

six years. Are we playing an active enough role in this? Are we getting a good slice of it? I know it is the first year of it, but what are the plans?

Rob Saunders: As I said, DECC are at the centre of the strategic planning in energy in the European arena. As I think Jim mentioned earlier, we know that research entities have done fairly well out of European funding in energy recently, perhaps industry less well. I think Horizon 2020 is more industry focused than the previous framework programme, so I think that we will continue to drive that through DECC. DECC fund a co-ordinating service for industry.

We fund a number of national contact points that help industry to access European funding across the economy and DECC fund the energy one of those that helps UK businesses to access that funding better. I think it is part of our role as the LCICG in the way that we communicate opportunities to make sure that European funding opportunities are front and centre of those communications in the next few years.

Q23 Albert Owen: But isn't DECC's role somewhat restricted? From what I understand from reading about their proposals, they are going to concentrate on CCS—very important—and also offshore wind, and with the other technologies perhaps they are behind the curve where its policy is to have a wide range of technologies at its disposal to bring down emissions. Is it concentrating on Europe too much, on this Horizon project and, within those projects, on certain limited technologies? That is not just for you.

Rob Saunders: I think these are questions for DECC really rather than us. DECC support a range of technologies beyond CCS and offshore wind.

David Clarke: I think there is an element that says in accessing EU funding—and Horizon 2020 should be better—there tends to be a pretty high overhead from a management viewpoint in accessing that money, both in terms of winning the funding in the first place and in then managing the relationships as you deliver the project and so on.

The straightforward logic from that is that if you are going to go after that Horizon type money, it is logical to go after it in very big chunks. Do not go after little tiny pieces. You are going for tens of millions every time at a minimum. When you do that, you inevitably need to be focusing on big major projects that have good European impact as well. In that case, you end up focusing on your national priorities where you wish to see major funding put in place. For the UK, CCS and offshore wind clearly fit that bill.

Accessing that kind of money in those big pots does potentially give you the opportunity to use, if I can put it this way, local UK money in a more flexible way in smaller amounts where the overhead is lower. The context of DECC going after CCS and offshore wind is completely logical in trying to minimise the burden of management time and overhead that comes with accessing that money in the context of UK policy priorities.

Q24 Albert Owen: I am being simplistic, but does it miss out on some of the other technologies by doing that?

David Clarke: That is why I say if you can fund your major projects by one particular route, which involves less of your own money, that gives you freedom to invest small amounts of UK money in specific projects.

Q25 Albert Owen: So to help rather than hinder the European projects focusing on certain specific technologies?

David Clarke: I treat it as a positive, yes. They have a big nationally important project.

Professor Skea: I think there are two sides to Horizon 2020. The first thing is how much money the UK gets back, and the juste retour is probably about 100 million a year. It is British taxpayers' money that is going into that.

I think the other side we have not mentioned so far is so much is shaping what the Horizon 2020 programme looks like so that it promotes UK interests to the maximum extent. There I would raise another point that I think David Fisk mentioned earlier, which is the level of human resource that the UK has within Government to do that kind of shaping. I sat on the FP7 Energy Committee in one of the two UK seats for a while. The UK delegation did not have the resource or the preparation that many of the other delegations had from smaller countries in coming into the meetings and trying to shape what the Commission was developing.

Q26 Albert Owen: Why is that?

Professor Skea: Not enough people on the ground to do it. You could get individual people who were covering the International Energy Agency and their committee on energy research and technology, covering the EU committees as well. The workload in comparison with the human resource appeared incredibly high.

Professor Fisk: I was going to endorse David Clarke's point, which he put with characteristic courtesy. The EU programmes are very bureaucratic and unless you have a seriously large programme with a dedicated staff who understand how to run these effectively inside their corporation, they are nearly death for a small firm. They take a very long time to make a decision and then it takes a lot of overhead in all of the handling of what probably to UK eyes are ineffective but nevertheless very burdensome auditing procedures. One has to place Horizon correctly in the strategy. Of course, as a taxpayer I agree with my colleague Jim Skea that we jolly well ought to try to get juste retour but do not see that as a major part of the strategy in place.

It did occur to me that there are other areas in which I do feel we could be a little bit more proactive. A really simple one is the energy efficiency products directive, which every so often picks off something that is suddenly going to be banned and another thing is the only thing that could be used. Where were we as a nation just making sure that some of our very clever innovations were in that product mix as opposed to just being some of the ones that were made obsolete? The variable speed drive, which is now sweeping Europe, could we have been ready to innovate it, capture the market, and make it cheaper? That is the commercial field that we would like to see more in this programme.

There certainly are a lot of ways of making European markets for some of the innovations that would be derived from this product but they do need a little bit of co-ordination with some of the outside players in the famous diagram that the co-ordination group have, and they need some commitment to think that they want to push these technologies as effective European markets.

I sometimes felt that some of the best contributions to the needs assessments were slightly 1970s, “The UK could not do this on its own”. A more proactive strategy, which is what most other main European economies have, would say, “We are really good at this. Now let us make sure everyone has to do it and pay us to do it”.

Q27 Albert Owen: I was interested that the two professors are having a sort of ding dong over South Korea and various things. In your paper, Professor Skea, you said that South Korea and their technology on smart metering was something that we should have greater collaboration with. Do you think we are looking too much at other countries, or have we not looked enough at what South Korea is doing? I was not quite clear of the point you were making.

Professor Skea: With limited resource in Swindon and the Research Councils to look at collaboration, the natural thing has been to focus on key international countries like China, India and the US. In fact, the best forms of collaboration would be with a wider variety of countries. There again I think the question of human resource, the ability to identify that, to have the intelligence within the system, is perhaps limited.

Q28 Albert Owen: A final point, if I may, on CCS. We talked about European projects. A number of countries were mentioned for collaboration, but Canada was not. We went there as part of our inquiry because there is something almost up and running there. We are spending all this time on the research and development but shouldn't we be focusing on countries that are taking things forward a lot quicker?

Rob Saunders: As I said previously, there are different reasons why you collaborate internationally, so it is not always to do exactly the same thing. Sometimes it is to provide partnerships that can help to accelerate innovation. Sometimes, it is to learn from countries that are ahead of the UK and are doing things differently, so I think there are different reasons in different technology areas.

I think I should also mention that the new network of catapult centres that are being set up are designed to help companies to collaborate internationally. We have a particular focus on small companies who do often find it more difficult to collaborate internationally, to deal with the slightly bureaucratic application processes for Europe and things like that. We see the catapult network as being a route into Europe and the international collaboration world.

Clearly, we have a number of initial catapults in the network, a few of which are directly energy-related but also some that are touching on the energy world, like the future cities and the transport systems catapults that are going to be really important in some of the areas that Professor David Fisk was talking about earlier in enabling the urban systems of the future to develop in a way that is cost effective and right for the future society. I think

a lot of the Horizon 2020 programmes are very well aligned with that new catapult network, so we see those as being a good point of entry for a lot of the smaller innovative businesses in the UK.

Q29 John Robertson: You have said on a number of occasions about human resource and the lack of it. Academics have always complained about lack of resources and not enough money and everything else. Is this just another way of saying that, or do you feel in effect that the UK in general have not been involved and been a major player in the game itself?

Professor Skea: I think that is most probably addressed to me. I think I mentioned human resource most. In the process we have run over the last 18 months, we have been very conscious of the fact when we have run workshops that of course academics come in and say, “We want more money and we want it for longer”. We have deliberately tried to push back on that as much as possible and tried to force people to make a solid case to justify it in terms of the science rather than the scientists, if you can make the difference.

When I have mentioned human resources, it has actually not been in respect of academics. It has been in respect of our colleagues in Government and what they are trying to do, especially in terms of international collaboration, where my experience of going to international meetings and sitting alongside colleagues from Government is that they probably are less prepared than, say, the Swedish delegation that is sitting next door or particularly countries like Germany that are very co-ordinated in the way that they approach especially European level funding.

Q30 John Robertson: I have a question on the innovation side. I think it was you, Mr Clarke, who was talking about the lack of collaboration—perhaps that is the best way to put it. Again, there was a limited resource, I think you said as well—I think you used the word “resource” there—in collaboration. It might have been Professor Skea, I am not sure.

Having said that, you both were coming from the same area. Is the UK doing what it should be doing in relation to setting up collaborative innovation and have we put enough effort into doing that? I am getting the feedback that we are not really in the same ballpark as the Germans, you just mentioned the Swedes, smaller countries than us. I would expect us to be at least in the same ballpark as the Germans, and you are basically saying no. Is this simply because the Government is in a difficult place and they are not willing to throw enough money at it?

Professor Fisk: Professor Skea mentioned the example of Sweden, which I think has a population slightly smaller than London’s. Clearly they have solved some problem and I think the problem they have solved is that they have a clear idea of what their priorities are and that is where they put that limited resource. That is why I think my institution members really do welcome the formation of the co-ordination group, but before that it was not altogether obvious what the priorities were supposed to be at some of these tables. Therefore, probably the good old UK turned up at everything and was probably too thinly spread.

It is not my area so I can be largesse with it, but if our priority really was carbon capture and storage, then probably we would be better off getting our administrative resources and international programmes focused hard on those and just simply having watching briefs at the other tables. If the resources are absolute and we are in a tight resource situation, then priorities are clearly the right way of being most productive and that seems to be what the co-ordination group has a prospect of delivering.

Q31 John Robertson: So you think we are spreading ourselves a bit thinly; we try everything rather concentrating on certain subjects. Is that what you are saying?

Professor Fisk: I am particularly concerned, as the economy rolls out and things get a little bit tighter in the public service, that even if we had enough resource before, we are not likely to have that resource to do everything now. Therefore, in some sense early maturity in prioritising what we want to do internationally and why would be a really good thing to have done. We would not have been able to do it under the previous arrangements I think, where people would have essentially worked up some priorities but it would not have been a national set.

Professor Skea: A very specific example is that the International Energy Agency runs its technology activities through a series of implementing agreements. The last report that was published showed the UK was a member of more agreements than any other country other than the US, more than the Germans if I recall. I think DECC has been trying to move out of some of these agreements since that report was collected, but at that time there was a demonstrable focus in participation.

Q32 Sir Robert Smith: In the role of monitoring the international scene, do we do enough to say, “We have missed the boat there and there is a perfectly good solution available elsewhere and we should not be focusing on that sector or that part of that sector”?

Rob Saunders: I think it is something that we are trying to do more of. The Energy Research Partnership, which is a public-private partnership group that has an analysis function as part of their organisation, has an international programme looking precisely at this, at how we focus, how we maybe ought to focus international collaboration better in the future, and where the international hotspots engagement should be. I think we will be looking to make use of that work.

David Clarke: I think we are improving at it steadily, as individual organisations, companies and central Government. It is improving steadily, I would say, and we get very good visibility of what industrial capabilities look like around the world. That leads us to not invest in certain things in terms of UK investments.

Professor Fisk: If I can give the Committee an example of that. My institution members expect to be able to win a design contract in any part of the world so they need to know the technologies available. My institution, as part of that, has a joint relationship with its American counterpart ASHRAE. In the area of very low energy data centres, we have produced joint publications that are essentially engineering guides for doing that because the data centre takes absolutely no interest in what country it is in.

It is a technology. It is driven by very high technology international firms and they write briefs for what is required. I am also the UK representative on the REHVA, which is the European body that tries to co-ordinate these design guides that are produced in different processes. That is not because of international collaboration. It is just so that we can make sure that UK designers can operate in very good projects internationally.

Technology is international. That is the nature of it. If you were thinking of the low-energy light bulb, the LED light bulb, it is produced all over the world. There are labs in nearly every major producing country trying to produce this product so that it is the competitive light source everybody will be using. One just has to be realistic. It is a global industry doing R&D and if you are in our sort of business, we have to be connected to every one of the standard-setting bodies that could define or truss up that market.

Q33 Christopher Pincher: You are all very clear about the role of public investment in innovation as far as the private sector sees it, which is to do the spadework to derisk their own investments. Given that we have something like 17 months left of this Parliament and there are precious few commitments to funding beyond 2015, what material impact do you think that is having now on the appetite of the private sector to invest in low carbon innovation? Can you give any concrete example of where the private sector is backing off or its own investment is drying up if you do not think that there are sufficient signals post-2015 of public investment?

Rob Saunders: I think from our perspective, we have broad support. We anticipate continuing to invest in energy beyond 2015-2016, so we take the approach that we will be continuing to support energy R&D into the future.

Q34 Christopher Pincher: Does the private sector take that view?

Rob Saunders: It is a very complicated question in that the reasons why the private sector invest in new technologies is clearly much broader than just public investment in their innovation programmes. There is the whole future market that dictates where they invest and whether they try to access public investment. My view is that uncertainty in R&D funding is probably less of an issue for many of the private companies than the kind of uncertainty of the future markets of their sectors. We do a lot of consultation with industry. I do not hear particular concerns about the continuity of public investment in R&D work-streams.

David Clarke: The real question that I see for these guys is exactly that, which is the first thing that most big industry groups are after in private sector investment in R&D—and recognising they are probably going to put their investment in the D, the development, more than the R—is long-term stability and assurance that there is a market in the UK in this context. Those signals are reasonably clear at the moment. They have been made clearer with the Energy Bill recently. I am not seeing any kind of major destabilisation in terms of private sector interest in working in the UK but they are focused on the markets rather than the R and innovation space.

One indication I will give, though, as to the importance of public sector money is the ETI operating agreement, the public-private partnership agreement, expires at the end of 2017,

so this is beyond 2015. It expires at the end of 2017 and the public sector in the form of BIS and DECC, as my ultimate sponsors, have signalled very strong support for continuing ETI beyond 2017 and are working right now to see how they can provide assurance for financing beyond 2017, not beyond 2015.

That signal has been very well received by the private sector, who were looking very hard at, "Is the UK a serious place about R and R&D?" I think the signal that the Government is looking at very long term around future investment in research with the private sector has been very well received. We are in the process of launching a new membership drive to get further industry engagement into ETI as a consequence of that.

Professor Skea: Can I declare an interest and say I am a non-exec on an investment trust that does invest in the energy area? Just as a perspective on that, I think it is the deployment mechanisms and signals that are far more important in establishing confidence than the actual levels of R&D funding. I very strongly agree with my two colleagues there. The other thing that I would flag up is that it depends on which parts of the energy domain you are looking at. Confidence is much more robust in energy efficiency, infrastructure, including gas infrastructure for example, than it is in renewables, which is largely driven by a climate change agenda about which people feel less certain at the moment. So I think it depends which part of the energy domain. Energy efficiency infrastructure, smart grid, people feel very confident that that is going to go ahead; renewables deployment, a little bit less even.

Professor Fisk: I think that very much concurs with my institution's experience, that is to say that energy has become a really important issue for many people procuring new buildings. They are nervous about security and very high prices, and that would be shared by much of Europe, who probably feel a little bit more dependent on Russian gas than we do, but they see a sense of being very careful with this resource. There clearly are very specific climate change-related programmes like CCS, or maybe some of the generation for nuclear power, which are slightly different.

Where I would say the influence on investment in innovation occurs, it is partly picked up by a lot of other colour, rather than just any change in administration. We have certainly been rather unnerved as an institution by apparent weakening of some of the prospective building regulations, because they are just a little bit weaker than they were apparently going to be only a little while ago. There are a couple of other areas, like the display energy certificates, which are boldly presented as you enter your other building. They seem to be very poorly enforced, as the trading standards officers have absolutely no time to make sure whether any of them are up to date. There are other requirements on reviewing your air conditioning every year, which as far as we can tell are hardly being acted out at all.

All that is a slight nervousness that beyond the grand targets, beyond the concern about energy prices, some of the deployment is beginning to look more ragged, and that if that looked tight people would have a confidence in investing in innovation. As David Clarke said, it is having a sharp vision that is the important thing. Clearly no Government or country can deliver certainty, but a sharpness of the vision and not going out of focus is

the thing that is needed. Everything else spooks the investor that Jim Skea has suddenly materialised.

Q35 Christopher Pincher: I hope you do not think I was implying that there might be a change of Administration in 2015. That certainly was not my intention.

You also made the point about the importance of consistency of funding to encourage the private sector to invest and to encourage others to innovate. This touches something on the lines of what Mr Robertson was saying, that notwithstanding Horizon funding, you have 20 projects in the portfolio worth £185 million. That is somewhere in the region of £9.5 million per project if you average it out. Do you think that it would be sensible to reduce the portfolio, which means that there would be more money for a smaller group of projects, and that would reasonably suggest that there would be more consistency in funding?

Rob Saunders: I am not sure what the 20 projects are that you are referring to. I am not quite sure what that means. The Government has taken a stance of trying to develop a portfolio of technologies. I think that is the right approach, that to deliver the—

Q36 Christopher Pincher: There are 20 projects in there. Is that correct or is that not correct?

Rob Saunders: I am not sure what you mean by a project, I am afraid.

David Clarke: Is this the Horizon project or ETI project?

Christopher Pincher: This is the ETI project.

Rob Saunders: I will let you answer this, David.

David Clarke: The reality is our projects fall into nine programme areas, which are offshore wind, marine, bioenergy, transport, CCS, smart systems, distributed energy and energy storage. I think that is nine. The balance of where that funding goes across those nine right now, the bulk is going into offshore wind, CCS and efficiency in transport. That is today.

Looking forward in the portfolio as we finish delivering offshore wind projects, which will happen over the next couple of years, what we are anticipating is the balance of the portfolio will shift, and smart systems and energy efficiency will become the single biggest programme we have. When you look into the detail of our portfolio, you may find there are 20 projects running today, but actually they will be focused in a few big areas probably and they will be areas that align with UK policy, and they will have smaller projects coming through—energy storage, for instance—which as we see value in the project, then we will ramp it up as we see value in it.

Q37 Christopher Pincher: What about the assessment of these projects? The LCICG has, as you talked about earlier, established its 11 sector assessments, TINAs, which I always thought stood for “there is no alternative” but now I know it stands for Technology

Innovation Needs Assessments. The NAO has said it will be difficult to compare returns on the investment across those sectors because there is a potentially wide range of scenarios. Do you think that is a reasonable view? Is that correct? How would that be overcome?

David Clarke: I think it is a very fair challenge. As Jim said earlier, there are a number of work-streams inside the LCICG, one of which has been set up specifically around metrics and how we evaluate projects. We are running a pilot of that at the moment, which will run over the coming months out to the middle of this year and then we will be looking at how we roll that out more effectively. The best answer I can give to your question today is to say it is recognised as a real issue and one that we need to address, and there is a very specific project in place across all of the members to find ways of evaluating projects in a broadly compatible way but critically to get metrics that apply in particular cases.

Q38 Christopher Pincher: Does that pilot relate to the LCICG's wish to introduce seven new metrics? Are they the same thing?

David Clarke: I would have to go and check that. I apologise.

Christopher Pincher: They are, or they are not?

Rob Saunders: This is one of the future work-streams that has been piloted on offshore wind, so we are taking one sector and trying to establish a number of metrics. Some of these metrics are already in existence across some of the organisations, so we are trying to drive some consistency in what is being measured across the different LCICG members and trying to develop metrics that will give us some shorter-term measures and some longer-term measures of the effectiveness of the programmes.

Some examples of those measures are the financial leverage that public funding is able to stimulate as a result of the project, the cost of energy reduction that the project generates, value-added activity, and also things like how that project stimulates collaboration and the development of networks as a result of the linkages that public funding can create.

Q39 Christopher Pincher: How long will that pilot run for?

Rob Saunders: I think, as David said, it is designed—

David Clarke: Middle of this year, I thought.

Rob Saunders: Yes.

Q40 Christopher Pincher: The information I have is that DECC is saying that it will take two or three years to implement the metrics. Is that a further year after the pilots have been run and analysed?

David Clarke: I think you have probably two issues in there. I do not have the timescales for exactly what the rollout looks like. We can get you that separately. I think there are two issues in there, one of which is time to roll out metrics on new projects as they come up. There is a kind of rolling programme of project launch and project delivery, and the metrics rollout needs to be matched to that programme.

The second piece is simply the ongoing project portfolio. It does not all deliver at the same time, so you cannot implement these things on day one on every project exactly the same. It will take time to roll out at different stages of the different projects. We can get you a specific answer on the exact rollout period.

Q41 Christopher Pincher: I wondered why DECC say it will take three years to implement if that is correct. You have different metrics being used and different processes being used to measure different projects. You have your pilot; you have the existing metrics that are being used.

Rob Saunders: No. What I was saying is that the individual organisations obviously have metrics they use, but the metrics the Technology Strategy Board uses—because we operate across the economy, we do not have a metric on the cost of energy reduction across all of our projects because most of our projects are not to do with energy. This is a matter of trying to drive consistency across the LCICG members in projects that are in the low carbon space so that we can evaluate projects more meaningfully across the group and really understand the value that is being driven across the LCICG as a public sector as a whole.

David Clarke: Whereas we, at ETI, would have very clear objectives for projects about cost of energy reduction, for instance, because that is what we are focused on in many cases.

Q42 Christopher Pincher: Are you content with the LCICG's desire to use 11 sector assessments? Do you think that is a sensible approach? The National Audit Office, as you said, Mr Clarke, thinks that measuring across those sectors will be challenging.

David Clarke: Yes, it will be challenging, because they are different types of technologies. To pick two extremes, nuclear and energy efficiency, projects in those two areas will have quite different roles. Having an absolutely uniform set of metrics used on every project that is identical is hugely challenging. I think you have to be sensible about finding certain areas where there is commonality, the cost of energy being a good example in that context, or the system cost, which is what we normally look at.

What is the system cost-benefit of a particular technology at a national level? I think it will take time to roll it out. It will be challenging, yes, but I think it is a valuable thing to do to make sure that investors, both public and private, can see what the real benefit is of particular projects, and we as the LCICG can see where it is valuable for us to be targeting investments in particular areas on a co-ordinated basis.

Professor Fisk: I think the challenge is to make sure the metrics do not distort the programme. An example we gave in our evidence was you could count the number of patents per pound on process, and then we quoted that somebody had found a much more efficient way of putting solar collectors on roofs, which would have swept the market, because that is the biggest cost of putting these things on. It is totally unpatentable, and if you are not careful we are looking at an unsuccessful product. Metrics are quite dangerous fireworks to have in a box when you have matches around. I can understand why it would

take some while to work out a system of metrics and I also realise it may turn out in the end not to be possible.

There are many other areas of Government R&D in which metrics are a second order consideration because it has been so hard to draw up metrics that people do not feel uncomfortable with. The really successful projects never needed them because they are awesomely successful and you do not really need to ask a number of questions. This is more worrying about the grey area of projects that are staggering a bit and trying to argue why they should go to the next stage, which may be just as well treated by case history studies.

Q43 Mr Lilley: I am still puzzling in my mind what the dominant purpose is of this budget you co-ordinate. Is its dominant purpose altruistic, to develop innovative ways of helping Britain and the world meet the targets of renewables and low carbon that we have set ourselves? Is it our contribution altruistically to that endeavour, and in the process, hopefully, it will generate some jobs and businesses in this country but that is a by-product? Or is it seen that we are going to spend £185 million, and the primary purpose, therefore, should be an industrial strategy to help develop industrial capacity in these areas in this country, and the by-product will be—because if they are successful companies, they must be helping us and the world meet those objectives—meeting those altruistic objectives? Which is it, or where on the spectrum is it?

David Clarke: Can I check—is this the entire LCICG budget activity you are talking about?

Mr Lilley: Yes, the entire budget.

Rob Saunders: I think the aim of the LCICG is to co-ordinate the activity of the different bodies so that that budget gets spent more effectively with better focus.

Q44 Mr Lilley: Is the dominant measure of effectiveness the altruistic purpose of helping the world meet these targets, or is the dominant measure building up industrial capacity in this country?

Rob Saunders: The aims of the different bodies in the LCICG have different focus to your question. The aim of the Technology Strategy Board is to grow the economy through innovation, so this is about growing businesses. Our focus is very much on business development through innovation, where we see that the changes that are coming in the energy system are going to provide a real opportunity to UK companies to grow their businesses by developing new products in the right way. That is our focus.

Other organisations, like David's organisation, have a different focus, and I am sure he will explain that in a second, but the LCICG is designed to co-ordinate those different bodies and make sure that what we are doing happens in a way that creates better focus as a result of all those things joined together than could happen with individual companies.

David Clarke: The ETI in this context is there to derisk new technology and new systems such that it can then go into commercial deployment faster and more effectively. It is

commercial deployment here in the UK energy system that we are interested in, to the benefit of UK energy consumers.

If you took the LCICG as a whole, I think you would have to ask: what is the goal? The goal is to invest money in support of UK policy and UK policy initiatives, whether that is DECC's view, which would be energy policy initiatives, or BIS's view around industrial development and economic development, or Treasury, DEFRA and so on. There is an overall view, which is that this is in support of policy objectives.

Professor Skea: I work mostly with Research Councils that have a different objective again, which is looking after the state of British science, providing trained scientists and engineers and so on. I think LCICG inevitably is going to be a messy process of trying to reconcile multiple objectives and keep them together. From the point of the view of the Research Councils, something that I personally would recommend is that, because their investments have a much longer-term feedback and it is going to be decades before the impacts of the training come through, it should be a little more sceptical about the direction of policy on a day-to-day basis and should be investing in the infrastructure that allows the UK to meet different needs at different points in the future.

Q45 Mr Lilley: It is a rather confused situation. If the objective were primarily industrial policy, wouldn't the obvious approach be to say where we have areas of strength in Britain's industry that are relevant to meeting the climate-low carbon objectives, let us, where possible, build on those strengths? Wouldn't one then find that actually there are remarkably few? We have a hollowed-out industrial structure, but our great weakness in the past has always been development and not research.

I remember a study that the Japanese did that 50% of the major developments since the war have been invented in the United Kingdom but almost none of them have been developed in the United Kingdom. Shouldn't we therefore be putting the emphasis on helping build up industrial capacity through implementing and applying the fruits of research, rather than doing more pure research, early research?

David Clarke: I would support that completely. You are right; there is limited home-grown, indigenous industrial capability in this area in the UK. That does not mean there is not any but the major industrial groups, in the main, that we did have in the UK have been acquired by various non-UK companies. A lot of those bases are still here but they are owned by others now, European, Far East and American.

In terms of the development piece, that is exactly where ETI sits. The opportunity with ETI is to link big industry with the public sector in terms of the policy surety and the industrial development surety, and for them jointly to pick up activity as it comes through the research chain and we then take it forward through into development. I would agree, and that is exactly what we were established to try to do, address that gap that you have articulated so correctly.

Rob Saunders: Likewise, when we look at what programmes we support in the Technology Strategy Board, one of the key criteria that we look at is the UK capability to be able to use the funding that we can provide. That is one of our key metrics when we look at what we do support both within energy and across the economy.

Professor Fisk: The evidence of my institution, which I think I have referred to before, placed a great emphasis on why isn't there more feedback coming from nascent technologies so that we as engineers could deploy them more rapidly with more confidence? It is exactly the point that Mr Lilley has just made, that if you look at the programmes on, say, energy efficiency, there is a lot about new widgets but it is very hard to find the data and very hard to find the real cost.

We have the splendid display energy certificate system, but DCLG have never worked out how to make it easy for anyone to access it without it costing them a fortune. All the technology we would be deploying in energy efficiency would be produced by globally-operating industries, some of which may be positioned here or may not be here. The critical thing is we are reducing the cost to the UK of delivering its goods, services and quality of life, and that seems to me a very good industrial policy anyway. That is why I think we would like to see a little bit more effort within this whole knowledge arena directed at making energy efficiency really work, because it seems to tick more boxes than some of the others that we have been talking about.

Chair: Thank you very much. We have covered a reasonable amount of ground this morning, I think, unless there is anything else you feel we have missed or questions we should have asked. We are always happy to ask them if you think there are some we have overlooked. Thank you very much for coming in. We look forward to our further work on this subject.