



Select Committee on Science and Technology

Corrected oral evidence: Priorities for Nuclear Research and Technologies

Tuesday 7 March 2017

10.45 am

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Members present: Earl of Selborne (The Chairman); Lord Borwick; Lord Broers; Lord Cameron of Dillington; Lord Fox; Lord Hennessy of Nympsfield; Lord Mair; Lord Maxton; Baroness Neville-Jones; Lord Oxburgh; Viscount Ridley; Lord Vallance of Tummel; Baroness Young of Old Scone.

Evidence Session No. 5

Heard in Public

Questions 38 - 49

Witnesses

Professor Paul Howarth, Chief Executive Officer, National Nuclear Laboratory (NNL); Professor Ian Chapman, Chief Executive Officer, UK Atomic Energy Authority (UKAEA).

USE OF THE TRANSCRIPT

This is a corrected transcript of evidence taken in public and webcast on www.parliamentlive.tv.

Examination of witnesses

Professor Paul Howarth and Professor Ian Chapman.

Q38 The Chairman: Good morning, gentlemen. We are most grateful to you for joining us today. I have to start with an apology. As you know, there are other, even more important, matters going on in this building today and there may well be Divisions during this evidence session—if not this one then certainly in the next session. If that happens we will suspend proceedings for about 10 minutes to give us a chance to vote. We are being broadcast, so would you, for the record, like to introduce yourselves? If you would like to make an introductory statement before we get into the questions, feel free to do so. I do not know whether Professor Howarth would like to start.

Professor Paul Howarth: My name is Paul Howarth; I am the Chief Executive of the National Nuclear Laboratory. By way of introduction, I would like to say many thanks for the opportunity to give evidence today. The timing of this inquiry is a great benefit given where we are in the UK in our nuclear industry policy and strategy. The announcement of a Nuclear Industry Council to support the development of the industry strategy and the prospect of having a nuclear sector deal means that, potentially, we are in a strong position as a country, looking at the future of our nuclear industry as a whole. From my point of view in setting out to support that vision, science, technology, research and innovation play a key role.

This inquiry is not just about research and technology, certainly as far as the National Nuclear Laboratory is concerned, in the fission industry; it is also about innovation and how the UK can be in a forefront position with regards to both the domestic and the international nuclear agenda. As far as NNL is concerned, we sit at the heart of that. We sit between industry and academia. We strongly support industry. We add significant value to our industry, as it stands, and we are in a position to strongly support the Government's aims and aspirations, and indeed the industry's aims and aspirations, as far as the future nuclear industry strategy is concerned. I think the timing of this is very beneficial. It is a once-in-a-generation opportunity for us to align an industry strategy with a sector deal with a strong partnership between government and industry, and we can see research and technology at the forefront of that. As government's National Nuclear Laboratory, we strongly support and stand ready to support those aims and objectives.

The Chairman: Thank you. Professor Chapman.

Professor Ian Chapman: My name is Ian Chapman and I am the Chief Executive of the UK Atomic Energy Authority. I would like to echo a lot of what Paul has said. Right now is a very transformative time for the nuclear industry; there is a lot going on, both good and bad. The nascent industrial strategy within BEIS at the moment offers the opportunity for a nuclear deal, and I think there is a big onus on us, as a community

working with government, to come up with a nuclear deal that is the right thing for the sector. There is the formation of UKRI, a new body to look at research and innovation, and how the nuclear bodies play into that is important as that body is formed. There is the recent merger between DECC and BIS, which is bringing together a lot of the constituent parts of the nuclear industry that were fragmented between the two departments and have now been united, which again gives us a way to look at that landscape and try to benefit from the complementarity and synergies that exist. At the same time it looks as if we are exiting Euratom, which will have a significant effect on the nuclear industry.

In conclusion to my introductory remarks I wanted to, parochially, make a point about fusion. A large fraction of the questions of this inquiry were focused on nuclear fission. I think it is important that we recognise that the UK is genuinely a world leader in the research and development of nuclear fusion. We have a great asset—a jewel in the crown of UK science—Culham, and the UK Atomic Energy Authority has a key role to play within the formation of a nuclear sector deal.

Q39 The Chairman: Thank you very much. That is a very helpful start. You will recollect that previous reports from this Committee called for a long-term policy. Having set up NIRAB, which has fulfilled its role for the limited period it was established, what steps do the Government now need to take to ensure that the United Kingdom has a consistent long-term policy for civil nuclear activities? Where do we go from here?

Professor Paul Howarth: I will give you my perspective, as far as the fission industry is concerned. To date we have lacked a clear vision and strategy as far as the nuclear industry is concerned. We are a country that has all the right components as a major nuclear nation to be at the top table. We have not played our cards well to date. It is not lost; I think we are still recognised internationally as a leading country and I think that that can support our domestic programme as well as our international activities, both thought leadership and the export opportunity for UK industry. We now need to set out a long-term vision, and this requires a partnership between industry and government to get agreement on what that long-term vision looks like. We had the first Nuclear Industry Council meeting about a fortnight ago, and I was quite keen to see that we set that vision out for about 30 to 40 years' time and that we clearly articulate what that looks like across the nuclear fuel cycle as far as fission is concerned—I am sure Ian will comment on where fusion sits in there as well. For me that is the first thing we need to do: set out the vision.

The second thing is that we need to look at the organisation and the structure we have in place of the various bodies that have responsibility in this area. Do we have the landscape right? Do we have all the organisations doing exactly the right thing they should be doing? Are any organisations constrained? Are we missing anything? A key activity is to make sure that the landscape is right as far as the organisations are concerned.

The third aspect is one of developing the public-private partnership and what needs to be put in place between industry and academia. This is not about an ask of industry as far as financing is concerned but about the mechanisms, the infrastructure and supporting the skill base—for example, supporting research and technology—setting the right climate for delivering that long-term vision. For me those are the things we need to put in place, and we have a good opportunity now to be able to do that and get us into position for the next 30 to 40 years.

Professor Ian Chapman: I will start by commenting on the fact that while we have inquiries such as this and we spend a lot of time thinking about the direction of the nuclear industry, it is important to start with the fact that we have a very healthy nuclear industry and a great deal of capability in this country. We are genuinely world-leading in a number of aspects: in decommissioning, in regulation and in aspects such as our research and innovation. We start from a pretty healthy bedrock. I agree with all that Paul has said in that I think it is important that we have ambition and we show a vision for the future, not just a future on a five-year timescale but a long-term vision where, by the middle of the century, we are aspiring to be world-leading in a number of aspects—in next generation SMRs, perhaps, and, I would hope, in fusion. I do not think we are going to be in a position where we become a world leader in delivery of gen III but we have a very capable supply chain, we have a very capable research and innovation infrastructure and we can, with ambition, return to being a world leader in the next generation of nuclear plants.

Q40 **Lord Oxburgh:** It is well known that we have half a dozen or more bodies within the UK supporting nuclear research in one way or another. At the moment, a number of people offering us evidence have pointed out that while NIRAB was there, there was a degree of co-ordination between these, limited by the authority that NIRAB had. What ought to be in place to get the best from our national investment in this diverse group of interested organisations going forward? You have both been reasonably optimistic in your look forward. Does that depend on—if I may put it this way—getting our act together internally?

Professor Ian Chapman: The formation of BEIS offers some opportunity, in that previously those organisations were fragmented between two government departments. Now having them under the same roof will certainly help. Personally, I am not a huge advocate of conglomeration, of merging all these different entities into one overarching very large nuclear organisation. Those organisations, I think, function highly and well because they have clarity of purpose. In large part, they know what they are there for. Putting them all within one organisation may not help; it gives multiple goals to one head.

Lord Oxburgh: We can pursue that a little. I am not sure that anyone has proposed putting them all within one organisation. You describe a series of separate bodies which are clear about their goals, but is there anyone looking to see whether those goals, put together, amount to a national strategy?

Professor Ian Chapman: Yes, I agree with you that that is still lacking. The Nuclear Industry Council will help in that regard and, as I say, I think the formation of BEIS offers an opportunity because you now have a government department tasked with this. I would hope and advocate that there is a successor to NIRAB, a body such as that, which has representation from these different bodies and is brought together under one government department with an onus to develop that vision.

Lord Oxburgh: Is there sufficient capability in BEIS—and you might want to comment on this separately—to fulfil the governmental role, if you like, being an intelligent customer for what these different organisations might provide?

Professor Ian Chapman: Within the Civil Service I would say no, but within the partner organisations very much yes. I would encourage the department to use its partner organisations to the fullest extent and benefit from the expertise that resides there.

Lord Oxburgh: What partner organisations are you thinking of?

Professor Ian Chapman: The two of us to start with but others as well.

The Chairman: Professor Howarth, would you like to come in on this?

Professor Paul Howarth: Yes, thank you. I agree with everything that Ian has said, and he makes a very valid point that the starting perspective is the fact that the departments have come together in BEIS. As the National Nuclear Laboratory, we felt that we were almost between two departments. While we reported to DECC, we obviously had strong links into BIS. Bringing everything together, in BEIS, sets the agenda nicely. As far as the advice and competence within government departments is concerned, we run differently from other countries and we interface with our counterparts in other Governments. One way of doing it is that you put a lot of that expertise into the Government as staff. The disadvantage in that model is that those individuals are not necessarily up-to-date practitioners as far as what is happening in the particular field.

In the UK we have some capability within the Civil Service that can interface with, as Ian refers to, the partner organisations. The key thing is to properly engage those partner organisations and recognise the capability there. Today, I would say, from National Nuclear Laboratory's perspective, because of our model and how that has changed and evolved over time, there has been, perhaps, a reluctance to fully engage us and use the full competency that exists within our organisation to be able to advise the Government over the right way forward. That, however, is changing, and over the past year or so we have been working more closely with the department; there is a strong team there now and we are looking at how we interface with that department as well as support all the delivery. The great advantage of the model we have at the moment, and it will be similar for Ian, is that in these partner organisations we have world-class nuclear capability. We are practitioners; we are doing it day in, day out; we are handling material—we are handling nuclear material and Ian's team is similarly doing high-

tech science—and that is a valuable asset that can be utilised to advise government over the right trajectory and input to policy. However, we need to improve that and so it is a refinement of the model of the National Nuclear Laboratory we are looking at to be able to realise that.

Lord Mair: Can I follow up on Lord Oxburgh's question about this difficult issue of co-ordinating all the different bodies involved in research in the nuclear space? To ask>NNL about this, you said earlier that you are bridging between academia and industry. Do you have a difficulty prioritising when it comes to research? Is your funding model such that you are having to do industry-driven research? You talked about your relationship with academia. Can you say a bit more about that?

Professor Paul Howarth: Sure. I find that our model works when we balance off a number of things. We have to balance off three things. One is revenue, the second is margin and the third is value. I will explain those further. First of all, revenue is about the size of the organisation. We need to be a certain size because we operate some absolutely state-of-the-art critical assets. The value of these, to rebuild tomorrow, is going to be a few billion pounds and they are recognised as absolutely world-leading facilities for nuclear research. We have a certain fixed cost base.

We also have within the organisation subject matter experts across the nuclear fuel cycle, and we maintain and develop that expertise and capability. That makes us a high fixed cost base industry. We retain these experts; we do not just cycle them up and down as a consultancy depending on the volume of work we do. We retain and develop them on behalf of the UK when they are needed to support the programmes of research.

The second aspect is that we deliver that effectively by a means which is efficient and effective. We deliver to time, cost and quality. We do the research that the industry absolutely needs in order to deliver its programmes. That brings me on to one of the other aspects, which is value. We always look at what we do in terms of value to support the industry. Typically, over the past 12 months—annually—we probably added circa £1 billion-worth of value by reducing costs to various programmes at Sellafield, EDF Energy or other generators or for Ministry of Defence programmes, to name some of our main customers. Value is a key thing. We only look at what we do that adds value to the UK's national programmes.

The third aspect I mentioned is margin. Because we run a commercial model that keeps us lean, efficient and effective, we make a surplus, but in the model that we have at the moment through government all that surplus goes straight back into the business. None is taken out as a dividend by government; we put that back into developing our facilities platform or reinvesting in our staff, in terms of science, technology and engineering. Those are the three things I balance off.

We sit in the middle space of technology-readiness levels 4, 5 and 6 for technology development. This is a unique space. Previously in the UK we probably have not put as much emphasis on this area as other countries have. I need to make sure that I have subject matter experts who

understand the latest developments in academia but, equally, can point at industry. I have people who one day will be working on a plant in Sellafield and the next day will be lecturing or undertaking PhD-level research within a university. Having people who run up and down that spectrum is absolutely invaluable, so I need a strong link in a strategic manner with key universities that provide a pipeline of people but, also, undertake the necessary research to support aims and aspirations. Effectively, I help to provide that link between industry's aims and objectives and academia.

Q41 Lord Hennessy of Nympsfield: As a country we are in our seventh decade as a civil nuclear power nation. In your different ways, you are the lineal successors of the great founding fathers, Penney, Hinton and Cockcroft, are you not? Why is it that we are still agonising about the question of co-ordination? It must be very frustrating. You have devoted your professional lives to nuclear R&D and the commercialising of it. What is it about us that means we cannot crack this problem even after 70 years?

Professor Paul Howarth: I will start but I am sure Ian can contribute as well. We have been through, over that period, quite a transformation in our nuclear capability. A lot of the organisations originated from the Atomic Energy Authority, then came organisations such as British Nuclear Fuels that I was involved with, and then we have come to where we sit now as the National Nuclear Laboratory on the fission side where we look after that strategic capability. Ian has a similar story with the history of the UKAEA and the Culham programme. We have been through a big transition.

Even if we look 10 years ago, we were not clear over the direction of travel of nuclear within the UK. We did not know whether we were phasing out or building new nuclear reactors. In 2007, obviously, the consultation was launched on new nuclear build. Not only have the organisations changed but the trajectory has changed in terms of the nuclear programmes within the UK. This is where I think we have a real opportunity over the next 30 to 40 years. We can set out that vision and we can aim for the UK to be a top-table nuclear nation. We have all the right pieces of the jigsaw; we just have to build the picture appropriately.

Professor Ian Chapman: I could not agree more. I do not think the problem exists within the co-ordination of those organisations; it is consistency and high-level support from government about the direction they want for the industry. If the Government consistently back the nuclear industry and hold to a long-term vision, the organisations will interact in an appropriate way to support that vision. Personally, I do not think the fundamental problem lies within co-ordination between the different bodies and organisations; I think it is an overarching direction of travel set at a high government level.

Lord Maxton: Neither of you mentioned the word "politics". Is not the political situation part of the problem that you have been facing and that Lord Hennessy has raised? Even now, there is a part of the United Kingdom, which I live in, Scotland, which does not take part in this

programme at all. In fact, the party in power has openly said there will not be any nuclear power stations built in Scotland.

Professor Paul Howarth: My perspective on that is nuclear moves on a very long time cycle, much longer than politics.

Lord Maxton: Politics does not, no.

Professor Paul Howarth: Political positions will come and go but, from my point of view, whichever way you do the calculations in looking at how we address the energy trilemma in the future, in terms of affordable energy, security of supply and low-carbon emissions, you get back to one answer, and that is you need every tool in the toolbox: nuclear, fossil fuels and renewables. A component of nuclear is, without doubt, needed. I recognise that politics will change and will come and go but I think the time constant that I am working on is over a longer period.

Lord Maxton: I am with you, but there are politicians who are not with you. That is one of the major problems we face.

Professor Ian Chapman: I agree with that. In some of your previous evidence sessions you have had a discussion about the French model and whether having big organisations which overarch is a success. The difference with France is that it has had a very high-level consistent government line that it backs nuclear, not that it has had the CEA, AREVA and EDF. The difference is that it has consistently said, "Nuclear power is a big part of our portfolio", and there are no fluctuations in that line over decades. It is that consistency which enables the industry.

Q42 **Baroness Young of Old Scone:** Could I add one supplementary to that? If lack of a consistent backbone is one of the issues, what body do you see inserting that backbone on an ongoing basis, if you cannot depend on politicians?

Professor Paul Howarth: It comes back to the advisory input to the Civil Service from partner organisations. Certainly as far as National Nuclear Laboratory is concerned, while we focus heavily on adding value to industry and supporting those programmes, it is how we can utilise that capability to support what might come up as potential need for advice within government. Take, for example, the recent interest in small modular reactors or generation IV systems, or whatever they may be; we need to ensure we are drawing down on the expertise. I do not look at the National Nuclear Laboratory as being the only source of providing that advice and input. We supported NIRAB by setting up the Nuclear Innovation and Research Office, and that model was successful. I opened it up to enable academics and other industry bodies to provide resource into that part of the organisation; I do not think that I should restrict that advice purely to the National Nuclear Laboratory. I think there is a vehicle there and there is a model that we can use that has supported NIRAB to date. It is possible that there could be an extension and a development of that and that we utilise that model to bring in expertise from different organisations—as I say, not just NNL—and use that as the conduit to provide advice into the government department.

Baroness Young of Old Scone: You are unique in the world in the way that you are funded. Some commentators have said that means that you are very good at what you are funded to do by your commercial funders but are less well-resourced, for obvious reasons, in other areas. Would you like to see a change in the funding basis?

Professor Paul Howarth: I am very proud of the model we have. We are unique. I have worked in national laboratories in Europe, Japan and the United States, and this is a unique model. I know that other countries are extremely interested in the fact that we run a national laboratory which does not rely on grants from government but relies on sources of funding from industry. I do not think it needs a wholehearted change. There is a refinement to the model that is needed. To date our work has been focused on supporting and delivering to industry, but what has happened is that the government department, BEIS, has been looking at how it interfaces with this capability such that there is not a perception in any way that there is any conflict of interest. We have been working with the department for the past 12 months now to address this. I believe there is a solution to this. We can put an ethical barrier within the organisation and I can have a team of people sitting away from delivery-for-customer work on a day-to-day basis who are directly providing advice, guidance and support to government which sits on the other side of the ethical barrier. For me it is a refinement.

The issue is that that needs to be effectively funded, and so we need to look at a mechanism for how government draws down on that technical advice. As I mentioned, that model is not restricted to NNL people sitting the other side of that barrier; we can second people in from other organisations, from academia and from industry—Ian's team. Whatever it is, other people can be seconded in to provide that advice to government. For me it is a refinement rather than a wholehearted change.

Baroness Young of Old Scone: Before I finish, could I ask Professor Chapman for his view on the backbone issue?

Professor Ian Chapman: I agree with Paul. There is a great deal of expertise within the partner organisations of BEIS and the Government should draw down on that capacity. That probably means there should be a successor to NIRAB, or some body such as that, which is responsible for setting strategy in that arena.

Baroness Young of Old Scone: Do you see that as a stand-alone independent body, much in the way that NIRAB was?

Professor Ian Chapman: The way Paul described it makes sense: you second people from the capable organisations—the NDA, ONR—into an organisation so that you then have the technical expertise to set strategy and direction, but you have a sort of ethical barrier between them and their host organisations, so that they are providing impartial advice to government on policy.

Professor Paul Howarth: Perhaps I could add to that, Baroness Young. We talked earlier about where other countries might have that capability sitting in the Civil Service. The advantage of this model is that it keeps

the capability fresh and alive because you move people to and fro across that barrier. They may be doing some work on handling plutonium, for example, in one of the facilities; the Government may require some advice and, effectively, they are the other side of the ethical barrier and directly provide that advice. The Government are drawing down on people who are absolute practitioners. If you go into a hospital and have a consultation appointment, you want it with someone who you know is practising and has not just read a book on it. This is what we are able to do. This is the means by which the Government can draw down on state-of-the-art nuclear expertise and capability that exists within our organisation and that Ian has.

- Q43 **Lord Oxburgh:** You talk about this transfer of expertise internally. To what extent do you make use of overseas experts? I do a lot of work in Singapore, which is a small country with a number of big projects and big ambitions, and they totally depend on external advisers. Are we without these, or to what extent do we use them?

Professor Ian Chapman: I can speak from my organisation. We are completely embedded in the international arena. We were reviewed last year quite nicely; an independent panel said something like, "The current UK fusion programme is completely central to the international effort". We place great value in that collaboration and being central to that international effort. That is at all levels. At the working level we have reciprocal secondments and then, at high levels within our advisory committees, we sit on advisory boards elsewhere and we have international people coming to us. It is completely embedded in our culture.

Lord Oxburgh: What about>NNL?

Professor Paul Howarth: It is interesting that other countries take the view that, if we are the national laboratory then we must look like the national laboratories in other countries. Therefore, there is a strong degree of engagement with the key nuclear countries. That is a healthy link and we are recognised as one of those top-table nuclear nations because of our nuclear capability in fission, just as much as fusion, as Ian describes. The role of the national laboratory is, again, to bring in that expertise and capability. If I am undertaking support work for Sellafield, for EDF Energy, or for whoever it is as a customer, my job is to look at the current state of the art of that technology. That does not mean I am looking just internally within my organisation; I am looking across a whole plethora of different organisations and international bodies to bring that capability. Take, for example, solving a challenge at Sellafield. To make sure that we deliver on that, I would say that it is my job to bring in world-class capability from wherever it is. Ian might have certain capability that could be brought in—it could be SMEs, it could be innovators or it could be other national labs overseas. That is the role I see of the national lab.

Lord Oxburgh: You do not, as a matter of routine, have external people on your advisory committees?

Professor Paul Howarth: We are developing a new advisory committee that we have set up, the technical advisory board, which reports to the main board of NNL. At the moment, we do not have any overseas representatives, but we can, if we need to, draw down on overseas expertise. For example, going back to Fukushima, in some of the analysis and calculations we did to support government we were directly interfacing with counterparts in CEA and the Idaho National Laboratory to share and exchange our models.

Q44 **Lord Fox:** You have both made it clear, as partner organisations, that you are ready to do more with BEIS. What do you think stands in the way of them drawing down on your available services and expertise? You have talked about ethical barriers. Is there, in some sense, a concern on the BEIS side that you are on both sides of the argument? If it is not that, what is it that is, perhaps, inhibiting BEIS?

Professor Ian Chapman: From my point of view, it is just that it is an embryonic department and they have not established a body yet. NIRAB had a term, it reached the end of its term and BEIS is still in a state of formation. I expect that they will put in place a successor organisation akin to that to make use of the expertise within partner organisations. I must say that, from my point of view, the engagement with BEIS is very good at the moment.

The Chairman: Would you have expected the organisation you were looking for to be in place by now, at the moment NIRAB ceased?

Professor Ian Chapman: Or soon thereafter, yes. There has been momentum developed from the NIRAB process and the interactions associated with that. I think it would be prudent to make use of that momentum. As I say, the nascent industrial strategy definitely offers an opportunity in that regard.

Q45 **Lord Hennessy of Nympsfield:** Could I ask Professor Chapman a specific question? What lessons could NNL and the fission community learn from the way you have tackled fusion at Culham? You were director of tokamak research before doing this, were you not? Is there something you can put across?

Professor Ian Chapman: Sure. Our model is very different from NNL's in that the way we are structured is that we win competitively research funding from the research councils. With that research funding, we try to knowledge-transfer into the supply chain so that the supply chain makes profit. We are not seen as competing with the supply chain, and certainly it is not our *raison d'être*—our way of thinking. We do not have the commercial acumen that sits within an organisation such as NNL; we are not operating in that space. We do not think about the bottom line. We think about pushing the boundaries, we think about doing cutting-edge R&D and facilitating the supply chain to do commercial work in fusion. Based on that history of R&D in fusion, fusion is now moving into what I call the delivery era with the advent of the project ITER in the south of France, and of the order of half a billion in commercial contracts have come into the UK supply chain. We partner on almost all of those, and we

provide the fusion expertise. We do not make any money out of it; the supply chain makes money out of it. We have a very different set-up but are equally effective in different ways.

- Q46 **Lord Broers:** What are the potential benefits, disadvantages and risks from the deployment of SMRs in the UK and more widely? If your conclusion is that they have a place, which I suspect it may be, how on earth do we get on with this thing and succeed as a nation that supplies the world with SMRs?

Professor Paul Howarth: There is a lot of debate around SMRs at the moment, and there has been a lot of vendor interest over proposing SMR systems. A lot of those vendors have recognised that the UK could be a potential market for SMR technology. I think it comes down to what we were talking about earlier, which is providing that advice and guidance into government. I think that still more needs to be done to bottom out the market opportunity for that technology. Again, I would say, the national lab and the Nuclear Innovation and Research Office stand ready to support government in being able to determine the market assessment and how effectively we move into that market.

If I were to say, "Let us short-circuit that and say, yes, there is a market opportunity, so what does that look like and how would we progress?" the options are—and I describe this as a spectrum—on the one hand, we can develop a fully indigenous, UK system. I am talking light-water reactor, at the moment; I will come on to gen IV in a minute. For a light-water system we could develop a fully indigenous UK system. Right across at the other end of the spectrum we simply buy a system from overseas. If you are at the former end of the spectrum it is potentially higher risk but the rewards could be higher because of the benefit to UK domestic industry and supply chain and the export potential. It is high risk but it is potentially a higher return.

At the other end of the spectrum, where we simply buy a system from overseas, there is less return and benefit to the UK but greater certainty as far as meeting our energy policy aims and objectives. Effectively, we need to do work to balance off the benefits between hitting our energy policy aims and objectives and the commercial opportunities for UK plc in developing that technology. There are, of course, options in the middle of that spectrum where we could partner with a potential vendor. A piece of work, in my view, needs to be done to bottom this out. Once we have done that we can work out how to effectively implement that programme. Gen IV is a slightly different debate, and we will probably come on to that later, but that is the work that needs to be done for SMRs.

Lord Broers: Who should do it?

Professor Paul Howarth: Who should do the assessment work?

Lord Broers: Yes.

Professor Paul Howarth: I would like to offer the National Nuclear Laboratory and the capability there, bringing in expertise from private sector sitting on the other side of the ethical barrier, effectively, to

provide that independent impartial advice to government to determine the best way forward.

Lord Broers: How much would it cost?

Professor Paul Howarth: It would be difficult for me to give a figure off the top of my head, but this is an assessment exercise done by a small team of people that we should be able to get done in a relatively short amount of time. If we are going to do this we need to get on with it because SMR is raising interest in a number of countries. There is potentially a significant market opportunity out there, but it is a race. The first to market will then be in an extremely strong position. It comes back to one of the things I was saying earlier, that we have all the right pieces; we just have to play our cards better as a country. For example, our regulator, as I am sure you are aware, is recognised as absolutely gold standard. We need to think about how we play giving a licence to a reactor system that would be recognised overseas; it would be an extremely competitive advantage—a unique selling point—to have had that reactor go through the UK licensing system. Again, I would turn to the Nuclear Industry Council to then determine how best we go about implementing it in a public-private partnership.

Lord Broers: How does this relate to the competition?

Professor Paul Howarth: A competition has been undertaken. I still think we need to review the outcome of that, and do so in the context of the Nuclear Industry Council. We need to sit down and look at that long-term vision and determine whether, as a country, we see the opportunity for SMRs fitting within that vision. I think it does; I think you can move through that fairly quickly and then we can look at how we can implement it.

Lord Broers: That competition has been lost in the wilderness somewhere, has it not, for the last six months?

Professor Paul Howarth: It would not be for me to comment on where that competition is up to or the outcome associated with it. I would take the view, using ourselves as the national laboratory, that we can substantially support the Government in defining a way forward. We can put that to the Nuclear Industry Council for ratification.

I recently came from a meeting in Washington where the United States is doing everything but in name to set up a nuclear industry council and an industry strategy. They are looking at the role that the national laboratories play as technology testbeds and demonstrators for future reactor systems. There is a lot of interest in generation IV systems, high-temperature gas-cooled reactors. Again, as a country, we have an absolutely unique capability in graphite-moderated high-temperature gas-cooled reactors. While we should look at light-water reactors, we absolutely could progress the UK as a top-table nuclear nation for looking at advanced reactor systems. Again, we need to do the work, and I would turn to the partner organisations, such as ourselves, to undertake that and to do it quickly.

Lord Vallance of Tummel: Can we come back to the indigenous end of

your spectrum with SMRs? We have had quite a bit of evidence which suggests that the UK market is not large enough to sustain on its own a development and manufacturing base and, therefore, we would be highly dependent on secure international markets. Even with international markets, we would probably be dependent on partnerships of one kind or another. That is moving to the middle of your spectrum. Is that analysis right? If so, where do we stand on the partnerships? Given that this is a race, if it is a three-legged race you need to have your partner in place early on. Who should be seeking the buyers? Is this a commercial thing for industry or is it for government, or what?

Professor Paul Howarth: Those are all extremely valid questions and those are the exact questions we need to answer. I think a definitive piece of work needs to be done to address those. I started by saying there is an industry strategy, there is the Nuclear Industry Council, there is a sector deal to be put in place; we need that piece of work to be done to answer those questions and then we can look at how it fits with the strategy. Is it endorsed by the council? Is there a public-private partnership that then is put in place to enable that to happen?

Q47 **Lord Hennessy of Nympsfield:** Listening to the witnesses we have had so far—I can only speak for myself—there is a distinct pattern among the researchers and developers which you follow, which is a sense of zest and enthusiasm about a possible renaissance; “top table”, is your phrase. That is quite a contrast to the officials from BEIS and, indeed, the Minister, Jesse Norman. It is as if they have scrambled; it is as if it is not happening. This is worrying because the contrast is palpable. I know you do not want to be drawn into it, but you are close enough to the people involved in BEIS. What is sapping their zest and energy for this top-table impulse that you have been so eloquent about?

Professor Paul Howarth: That is difficult for me to answer.

Lord Hennessy of Nympsfield: Have a go. Break loose.

Professor Paul Howarth: I can understand their position, in that they perhaps need to present a more measured position.

Lord Hennessy of Nympsfield: Why?

Professor Paul Howarth: It is difficult for me to answer that.

Lord Hennessy of Nympsfield: Have a go. I know you have thoughts; you just do not want to say what they are.

Professor Paul Howarth: The thing that needs to be addressed is how the department engages in getting the right input to its policy advice. As we have referred to, that comes from the partner organisations. I would say that that link, at the moment, is still tenuous. We simply have not been operating in that mode long enough to have a strong degree of engagement where we can help to advise the department on the direction of travel. It is still early days for them to move into that way of working. The intentions seem to be good and we are getting good signals that that is how they wish to engage with us.

The Chairman: Before we move on to gen IV, did Lord Ridley want to come in on this?

Viscount Ridley: I think the point I was going to make has been covered by Lord Hennessy.

Lord Oxburgh: You have not told us why anyone would want to buy an SMR.

Professor Paul Howarth: I go back to the meeting I was at in Washington. A senator was there from Alaska and she said that most of her communities in Alaska are off-grid and the cost of energy generation in Alaska is extremely high because, effectively, it is oil coming in on ice road trucks. It is extremely expensive. For a community such as Alaska they are interested in small reactors that can be deployed in remote locations.

Lord Oxburgh: This is small, distributed sources of power.

Professor Paul Howarth: That is one of the potential uses. That is probably the extreme case. There are countries that do not have the grid infrastructure to support large monolithic gigawatt plants that can cope with hundreds of megawatts.

Lord Oxburgh: That does not apply in the UK, which we are focusing on here.

Professor Paul Howarth: I come back to our Magnox reactors. They would be classed as medium-sized reactors. Some of those sites in the UK are not appropriate for large gigawatt plants but could be appropriate for modular reactor construction.

Lord Oxburgh: Do you think modular would be less expensive?

Professor Paul Howarth: It depends which way you look at it. The financing is more palpable than the cost and the outlay associated with large gigawatt plants in certain circumstances, depending on which other countries we are referring to.

Lord Oxburgh: The alternative is to think the Magnox sites might be suitable for more conventional things, if you like, gen III+, of 500 megawatts or a bit bigger.

Professor Paul Howarth: It could be. In terms of the move into this, we have sites that potentially could be utilised for small modular reactors, or medium-sized reactors, and we have a licensing system which other countries are very interested in, so it looks as if, on that spectrum, there could be a number of ways of addressing this that could be attractive to the UK and to UK supply chain companies.

Lord Fox: You said the financing is "more palpable". Can you explain what you mean by that?

Professor Paul Howarth: The capital cost outlay for large plants of gigawatt-plus; it is the financing cost which dominates the levelised generation cost of electricity.

Lord Fox: You are talking about a quicker return.

Professor Paul Howarth: It is a quicker return. It is less immediate outlay and a faster return. You might still build a gigawatt in total but you can stage it over time.

Lord Broers: My observation is that the political uncertainty is based on the fact that the public, overall, are still worried about the safety of nuclear power—incorrectly, probably. I have heard arguments either way but I come out with the feeling that SMRs could be easier to reach a certain level of safety than the larger plants. Would you agree with that?

Professor Paul Howarth: There are certain safety features for SMRs that make them, essentially, attractive compared to existing conventional plants. Again, we need to do a definitive study that helps to address these, as we were talking about earlier. It is criteria we need to go into.

Q48 **Viscount Ridley:** You have both touched on the point that we may not be able to lead in gen III but we have a golden opportunity to lead in gen IV because of the experience of gas-cooled reactors and because of the strength of our research depth. Can you elaborate on that a bit more and explain why the UK should, perhaps, leapfrog but certainly be ready to go on generation IV? Particularly, can you narrow down the aspects of generation IV that are of interest to you?

Professor Paul Howarth: Again, it is a very valid question. Have we definitively answered this in order to inform our strategic vision for nuclear in the UK? The answer is, definitively, that has not been done. I come back to saying that this is the sort of question that we are able to answer for government to determine whether generation IV reactor systems should feature as part of the future landscape within the UK.

Viscount Ridley: Can you specify? Do you mean molten salt, liquid metal, pebble bed? What do you think?

Professor Paul Howarth: There is a whole range of different reactor systems out there. In particular in the UK, our experience is there is a lot of international interest in high-temperature gas-cooled reactors that are graphite moderated at present. We could look at how we utilise that capability in the future. Equally, we have experience in more advanced generation IV systems—sodium-cooled fast reactor systems—and so working in partnership, for example, with France on the ASTRID programme could be attractive to us. The issue here is that it is easy for developers to propose what would be referred to as a paper-based reactor system, but to get through to a delivered system is difficult. You have big error bars associated with a paper-based reactor system; there is a huge amount of uncertainty. The claims are unfounded as far as whether it is a safety-related issue or an economic issue. You need to get those error bars down as quickly as possible so you are absolutely certain over the cost of that reactor system and the merits. That is the work that, effectively, national laboratories do. We sit in the technology-readiness level space that can determine how you get those error bars down and what work needs to be done. Effectively, Ian is doing that on the fusion programme. It is a long programme but it is to reduce those error bars to get to certainty. That is exactly what we need to do.

Viscount Ridley: There is one big difference, which is that we do not yet know that fusion can be made to work commercially, or even physically, for long enough.

Professor Ian Chapman: Physically, we know that fusion happens because we have achieved it in JET. I am extremely confident that ITER will reach its goals and will demonstrate fusion on a commercial scale. Fusion has been waiting for that demonstration.

Viscount Ridley: Why go to gen IV? Why not forget all this and let us just do fusion in 40 years' time or 30 years' time, or whatever it is?

Professor Ian Chapman: My personal feeling is that we need a mixed portfolio and we should be tackling both things. I do not think it is either/or and to have a policy which is either/or is dangerous because it is eggs in one basket. You should tackle both.

Viscount Ridley: How much of a problem is it that we are bystanders at the Generation IV International Forum? Should we be paid-up full-time members?

Professor Paul Howarth: As far as gen IV is concerned, historically we were active in that programme. Personally, I think we should be involved in that programme and we should be involved for various reasons. As a country looking to deliver its energy challenge, let alone whether there is industry benefit here, we need to understand whether these systems are appropriate or not and how quickly other countries are moving through this spectrum. We should not absent ourselves from that; we need to be at the table and we need to understand that capability. In terms of the national programmes in nuclear at the moment that we support, as far as the national lab is concerned—legacy waste management, decommissioning, continued operation—the one programme missing when the House of Lords looked at this a number of years ago was in advanced reactor and advanced fuel cycle technology; hence the setting-up of NIRAB to undertake the piece of work to identify the programme that needs to be delivered. I would say that the national lab can deliver that programme of work and maintain our national capability. It is not just about the national lab delivering it, though; we can help to orchestrate it and bring in other players in academia and industry who can support that programme. Ian has relevant capability as well that we can bring in, so we can assemble a generation IV technology programme.

Q49 **Lord Fox:** What effect do you assess leaving Euratom will have on the UK's participation in long-term research and collaboration? How do you think the Government should be going about replacing that relationship?

Professor Paul Howarth: Should I go first on this one as well?

Professor Ian Chapman: It is probably more transformative for us. There are three main things we get from our participation in Euratom at the moment. The first is participation in ITER. ITER is the next-step fusion reactor which will prove on a commercial basis that fusion works. The second is our operation of JET. JET, essentially, is what ITER is based on. We operate JET on behalf of the Euratom community here in the UK.

That is worth about £50 million to us, at the moment, which comes from the Commission. We pay into the fusion R&D programme around £20 million and we withdraw around £60 million, so we are a huge net beneficiary. The third thing that we benefit from is participation in what is called the EUROfusion programme, which is a conglomeration of all the European fusion laboratories working together to produce a design for a reactor which follows ITER.

We need to find a way to sustain the benefits that we get from those programmes. How do the Government go about doing that? I think there is a range of options, which go from associate membership to the UK funding all of this independently, still having open doors and collaborating openly. There are points in between those two extremes where you participate in some parts of Euratom and not others but you do not need to be an associate member. I think there is a panoply of options. As part of the negotiation for leaving Euratom we should absolutely try to get the best deal not just for the UK but for our partners, and work out the best deal to make sure that that collaboration continues to be strong.

Baroness Neville-Jones: Are you able to say what you think a best deal would be? Are there models already in existence? Are there countries that have some kind of associate status? Are they suitable for us?

Professor Ian Chapman: There are associate members. Those are bespoke models, which are negotiated with the Commission between those partners. Are they suitable for us? That depends entirely on what the Government want to get out of the negotiation.

Baroness Neville-Jones: In your view?

Professor Ian Chapman: In my view there is a best path, which may not be associate membership, but this is absolutely a spectrum of options and we need to negotiate and find the best route through that. I cannot prejudice which direction we should go in but I think there is a range of options we can take.

The Chairman: Clearly, an early decision would be helpful for everyone.

Professor Ian Chapman: An early decision would be helpful for us, certainly, and involvement in that negotiation. I must say, BEIS is involving us in that policy formation.

The Chairman: Some of us did our best on the Floor of the Chamber to prod the Government into declaring their hand on this, with perhaps limited success. We could have continued for much longer. In all fairness to the next two witnesses, we must conclude this session. We are most grateful to you for helping us in our deliberations. If, when the record is circulated, there are any minor amendments you wish to make, please return them. We were a bit rushed at the end. If you feel you did not have an opportunity to adequately respond, please send any supplementary evidence or further thoughts to the clerk, if you so wish. Once more, thank you both for your oral evidence today and for the written evidence, which has all been most helpful.