HOUSE OF LORDS

Select Committee on Science and Technology

Corrected oral evidence: Priorities for Nuclear Research and Technologies

Tuesday 21 February 2017

11.45 am

Watch the meeting

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

Evidence Session No. 2 Heard in Public Questions 9 - 19

Witnesses

Dr Rebecca Weston, Technical Director, Sellafield Ltd; David Orr, Senior Vice-President, Future Programmes and Technology, Rolls-Royce Nuclear; Tom Mundy, Executive Vice-President Program Development, Managing Director UK & Europe, NuScale Power.

USE OF THE TRANSCRIPT

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

Examination of witnesses

Dr Rebecca Weston, David Orr and Tom Mundy.

Q9 **The Chairman:** May I welcome our witnesses to the second session? As before, I alert you to the fact that we are being broadcast. Would you like to introduce yourselves for the record? If you would like to make an introductory statement, feel free to do so. Perhaps Mr Orr would like to start.

David Orr: I have been in the nuclear industry for over 30 years. I was in various senior positions in our submarines business, which I think you all know has provided 32 nuclear steam-raising plants and over 100 cores over the industrial collaboration with government, and operates three licensed sites and an operational prototype in the north of Scotland, so I have quite a lot of background experience there. I ended up leading the business for a period as president and then transferred over to the nuclear sector. I now lead technology programmes for us for the future.

Dr Rebecca Weston: Good morning. I am delighted to have been called to give evidence. I am strategy and technical director at Sellafield Limited, which is a business of some 11,000 employees with a £2 billion annual spend in the realms of cleaning up our nuclear legacy and our waste treatment and storage. It is a changing business and a remote environment. We are closing down reprocessing in the next four years and trying to become more efficient while we do that.

My specific responsibilities are the development of technical and business strategy and leading 600 technical staff with a budget of circa £100 million, equivalent to that of the National Nuclear Laboratory, supporting the facilities on one of the most complex industrial sites in Europe and, indeed, the innovation and the R&D that supports a 100-year mission. Sellafield is very much an anchor business, if you like, as described in the Green Paper. My experience in the nuclear sector spans some 15 years, particularly in fuel manufacturing and operation, plutonium reuse and other commercial and operational activities in decommissioning and waste management.

Tom Mundy: My name is Tom Mundy. I am the managing director for NuScale Power for operations here in the UK and Europe and chief commercial officer for the company. I will say a bit about NuScale and who we are. We are a small modular reactor development company. We are developing an SMR based on tried and tested pressurised light-water reactor technology that has been around for many, many years. Our programme in the US is at an advanced stage of bringing our technology to market with the financial backing of the US Department of Energy and our primary investor, Fluor Corporation. We are the first SMR vendor to submit a design certification application to the US NRC, the Nuclear Regulatory Commission. That was finished at the end of last year and submitted at the beginning of this year. That supports our first deployment project, which will see our first unit deployed in the state of Idaho for our first customer, a municipal power company known as UAMPS, with that facility generating electricity in 2026.

In terms of our participation in this market, we have been actively engaged in the SMR feasibility work here in the UK since 2013. We offer an opportunity for the UK in a UK-US partnership on SMR development. For example, as a technology development company we have no manufacturing capability and we are looking to partner, and have been partnering with, British companies to achieve multiple long-term deployments here in the UK.

Q10 **The Chairman:** Thank you very much. If I may I will start the questioning, and refer to the recent industrial strategy Green Paper, which held out the possibility of a sector deal for the nuclear sector rather along the lines of the aerospace sector, which seems to have been very much welcomed. Thank you to Rolls-Royce for the written evidence we have received, where you say that a sector deal for nuclear could be transformational to the UK's long-term nuclear projects. Starting with Mr Orr, could you elaborate on that? How might the nuclear sector benefit from such a sector deal, and what might a deal usefully involve? Would you like to start, Mr Orr?

David Orr: Yes, certainly. As Professor Tynan said, the first thing to say is that we are a nuclear nation and we are going to be with the decisions that we have made as government now for the next 70 to 80 years. We have committed to Hinkley Point C in civil nuclear and to the successor programme in defence, so we are definitively a nuclear nation. The big thing is that we think that transferring the aerospace strategy for research and technology to the Aerospace Technology Institute, and the co-ordination of such, has worked very well, as you said. It has developed road maps and plans that go towards developing products that are competitive globally. That is co-invested in programmes such as Sharing in Growth so that we get the socioeconomics for the UK: the skillsets, the supply chain and academia involvement. The entire lifecycle skillsets that we get there are exactly what we are going to need for nuclear.

It is a generational opportunity for us in SMRs, and it will be terribly difficult for us to regain the capability to produce intellectual property if we do not have a national programme or have significant involvement as a nation in the programme. In relation to the earlier questions, for example on generation IV, it would be very difficult, apart from research, to get any real tangible involvement at that time if we have not done this interim programme on light-water reactor technology.

The Aerospace Growth Partnership pulled together a model for collaboration that worked extremely well. Over and above what Professor Tynan said, I would suggest that something like an aerospace technology partnership also needs to be formed. You could say that the re-formation of the Nuclear Industry Council could take the APG's role, but we would need a subset of that body chaired by a Minister and a senior industrial participant, to look at where the deployment of that research and development should go for the best for the country, industry and academia in the entire lifecycle.

The Chairman: Would anyone else like to comment on the nuclear

sector?

Dr Rebecca Weston: Absolutely. I would very much welcome a sector deal, given the long-term challenges in the nuclear industry. I believe that a sector deal would support realising those opportunities. It would certainly be an opportunity for the industry to collaborate to increase exports and commercialise the UK nuclear expertise. I very much support David's position. I would also say, however, that it would be good to recognise the different segments of the industry, for which I believe there are many complementary aspects, particularly in skills, innovation, and research and development. But we are focusing very heavily on new nuclear build at the moment and in waste management and decommissioning there is very much an opportunity to turn what is currently largely a cost to the taxpayer into an ability to return that in exports or indeed the development of the UK supply chain and commercialisation opportunities.

The UK has leading capability in the decommissioning and waste management areas. I see leverage perhaps in the model that we have already undertaken with the likes of the National College for Nuclear, which has a south-west and a north-west base that are complementary to each other. The north-west national college is based up in Cumbria, using Sellafield in effect as a baseload for that, and there is value in clustering or having hubs of innovation expertise around those centres that are complementary to each other. Indeed, not only across the nuclear fission sector but perhaps in fusion and other sectors such as defence and oil and gas, if you are looking for complementarity between what we use in robotics, remote systems and the like, a sector deal has a lot to offer in that regard.

Tom Mundy: Some very good points have been made. I would just like to reinforce the importance of government and industry working together in a sector deal to ensure that there is the right business environment and market conditions to encourage new nuclear development, and that there is clarity on the siting, licensing and regulatory processes, as well as ensuring that UK nuclear skills and capabilities are developed and continue to be maintained for that success.

The Chairman: I take that as a positive response to the idea that there should be a sector deal. Thank you.

Q11 **Lord Mair:** We heard in the earlier session some very interesting views on how long-term energy policy is co-ordinated in the UK. Who do you think should take that responsibility? How is that best ensured?

David Orr: For me it has to be the Department for Business, Energy and Industrial Strategy. Necessarily, it cannot be on its own. There are so many other departments that have a big say in how it should go. Any developments, which I am sure we will come on to, have to be commercially selectable as well as investable by government or government assisting in the early stages. The Treasury would necessarily have to be involved. We need to have the Ministry of Defence involved, because with an SMR programme there is the ability to help to sustain

both skills and supply chain across a national nuclear programme, as opposed to just benefiting the civil nuclear programme, which is a key point.

For me, it would also involve the Department for International Trade, because we would need to look at exports and the export targets for any national SMR development that we did, as was said in the earlier session. In the submission of our design to BEIS, we said that we would expect the UK market to return only the cost for the design development programme, and on that basis our consortium would take the risk for the export market. That is how we have gone about it, but we would need assistance from them. It would also involve the Foreign and Commonwealth Office, of course, for non-proliferation and export control issues and the Department for Exiting the European Union.

You have already asked about Euratom question, and things of that nature.

Lord Mair: What do you think the role of the new Nuclear Industry Council should be in this?

David Orr: I am looking forward to the re-formation of the Nuclear Industry Council. It is very important, though, that that is the committee that assists BEIS in getting a coherent industrial strategy and a research and development committee that delivers it appropriately through road maps and plans, as well as an energy policy that looks at the forward mix. Again, as was alluded to earlier, as well as the elements that Tom mentioned, in order to get return of costs for government in a consortium we believe that there is a minimum market size for SMRs in the UK, which would be true for any set of consortia that deliver an SMR power station. There has to be agreement on that and all the other conditions, including whether we have socioeconomics as part of the requirements for the competitive process when it goes through.

All those issues will be hugely important for the Nuclear Industry Council to deal with. It might not have worked last time because the objectives were not agreed and we did not have a cohesive strategy between government and industry, and we must this time.

Lord Maxton: You missed out one element, which is the political one. The problem in this country is that there is political opposition to nuclear energy of any sort, including, I am afraid, unfortunately on the part of the leader of my own political party and certainly on the part of the Scottish National Party. How does that fit in? This is a long-term strategy that you are talking about, and the political element could come into that at some point or other.

David Orr: I agree entirely. Our belief is that there has been that position in the past. It would be nice to reopen the debate for SMRs for Scotland, if we could. On your earlier question, just so that you are aware, Strathclyde University is supporting our development, and we are using a number of our university technology centres to support it in the development.

We have always said that we see SMRs as part of the energy mix, so we supported the selection of large generation III reactors to get the nuclear programme restarted in the UK. Our issue is with the skillsets. With the vendors being predominantly foreign of course, the high-end skills will not be sustained, nor the supply chain through that. Certainly we are getting packages of supply to it, and we are very grateful for that in the interim, but we need to have a long-term sustainable, healthy and vibrant sector through the lifecycle. I am sorry that I missed that last time. I agree that in decommissioning we are one of the leads, but we need it through the lifecycle. To keep feeding the reactor designers in, we need a vibrant programme.

Q12 **Lord Oxburgh:** I wanted to ask the same question that I asked the previous group. Roughly from the Rolls-Royce point of view, what would you regard as a plausible and reasonable domestic scale of deployment of SMRs, both for our own purposes and, indeed, as a base on which one could build an export programme?

David Orr: You have to remember here that this answer is based on the design that we have proposed.

Lord Oxburgh: Sure.

David Orr: It will be different for different designs and different megawatt electrical sizes of SMR. For the one we have proposed, we believe that the Energy Technologies Institute was tasked by the Government to look at SMRs as part of the energy mix. The minimum level that it said was available for electricity generation was 7 gigawatts electric for SMRs. We believe that would be adequate to return the costs for the development, so one of our asks of government is that we should only have a singular technology choice and that the market should be enabled to 7 gigawatts electric. If you are asking about a sustainable business with exports, we are saying that we want to target at least 9 gigawatts electric over a 20-year period to make it a sustainable business, on top of the UK.

Lord Oxburgh: Are you thinking of roughly 300 megawatts electric per unit?

David Orr: The maximum for ours is a range between 220 and 440 gigawatts electric. We looked at a commercially investable unit, and when we looked at the whole grid balance, the sweet spot was between about 300 megawatts to 500 megawatts electric for a station.

Lord Hennessy of Nympsfield: Can I ask David a specific Rolls-Royce related question? You have 55-plus years' experience of pressurised water reactors, but does the 1958 mutual defence agreement with the United States get in the way of technology crossover? There is a lot of American knowhow and exchange of knowledge in our PWRs which you have manufactured for the Royal Navy. Is that a difficulty for you?

David Orr: No, not at all. We have been very careful in what we have done. As you can imagine, we asked permission from the Ministry of Defence before we entered into the civil nuclear market, which was a

number of years ago now. We are also very, very careful that we have completely separate systems for civil development. It is not based on the same technology. Although we are fully aware and we understand that the sizings might be comparable, the fuel and designs for them are in effect completely different. We keep it absolutely separate so there is no impact on the bilateral relationship. We would do nothing in our civil nuclear ambitions to affect the primary bit of the business, which is the defence delivery, nor to affect the US bilateral relationship.

Lord Hennessy of Nympsfield: Thank you very much.

Q13 **Viscount Ridley:** Mr Mundy, first, what is the realistic prospect of a NuScale SMR deployed in the UK? What is the date, scale and size and at roughly what cost in terms of electricity production?

Tom Mundy: As I mentioned, our technology is well advanced in comparison to most of the competition. At this point, we have already invested over $600 million in the development of our technology. We are now into a major licensing review with the US Nuclear Regulatory Commission. All that supports a first plant deployment in the US and seeing that technology online generating electricity in 2026.

We believe that we are well positioned to enter this market. We have a customer-client interest in seeing our technology deployed in the first instance here. Our intentions were to continue with that interest and see our technology deployed in the first instance. However, we have had to follow the competitive activities that the Government has set out in order for the chosen technology to enter the regulatory process here, and then continue with its further development. To some extent, we have been constrained by needing to follow that process.

If you were to line up all the activities that you need to do for a technology to—in our case—adapt our US design to meet UK codes and standards and to see our technology licensed here by the nuclear regulator, as well as the other approvals needed for site licensing and the work that our clients would need in order to ready themselves for deployment, we can see our technology conceivably generating electricity in this market in the 2026-27 timeframe, certainly a few years sooner than the Energy Technologies Institute's estimate of before 2030. The institute had some conservatisms in its analysis that led to that 2030 estimate, but we have a shorter construction timetable than what was assumed in that analysis.

If we start the regulatory process soon—originally BEIS told us to assume that a selected SMR technology would enter the GDA process here in 3Q17—and you line all that up, we are looking at a 2027 timeframe to see our technology deployed in this market.

Viscount Ridley: You specifically mentioned in your introduction that you were looking to partner with a UK manufacturer, at the very least. Is that realistic? Are there people out there who could do it for you?

Tom Mundy: It is not only realistic, it is our desire to do that. I have spent the last two years while I have been over in this market identifying

and working with the UK supply chain to confirm that they have the capability to manufacture the equipment that is needed for our facility. As I mentioned, we are only a technology development company; we have no manufacturing base, so for our technology to be deployed we have to identify the companies that are going to source all the equipment needed for our deployments. Our objective for this market has been clear: that we will utilise to the maximum extent we can the UK supply chain to provide the equipment needed not only for the deployments in this market but for exports beyond the borders of this market.

Viscount Ridley: Would there be any R&D benefits for the UK as well?

Tom Mundy: There is still a lot to do, particularly in figuring out how to effectively and efficiently manufacture the equipment that we have developed a safety case for at this point. We are already starting to work with UK companies to develop the IP associated with the manufacture of that equipment. For example, we are currently working with Sheffield Forgemasters for them to forge our reactor vessel head. It is a fairly complicated forging, and we are working with them under an Innovate UK cost-sharing programme in which they are performing a demonstration of the forging of that component and developing the special toolings and knowhow associated with how to develop effectively and economically that component that is needed for our technology.

Viscount Ridley: Thank you. Mr Orr, what date would you see your technology getting into the market?

David Orr: We have looked at 2028 to 2030, depending on when government makes a commitment, basically. We have asked for a set of enablers from government as assumptions before we do that. This aligns with what I said about the enabled market size, because we are necessarily talking about economy of volume as opposed to scale here. Part of your question is also about the cost. With these as the first of a kind, you would be looking for them to be in the order of those of a large reactor. I am not talking about one of the mega-gigawatt large reactors but about that sort of cost per megawatt hour. You would then look at your next of a kind to go towards competitive and drive towards a combined cycle gas turbine. I am not saying that you would get there, but it is an ambitious target and you would be driving through manufacturing, investment, material technology, factory flow, build sequencing, timeframe and certainty of regulation. The two big things that affect your delivery to grid are the regulatory process itself and certainty of regulation, as well as your build timeframe. Those are the two significant risk areas.

Lord Oxburgh: A quick question for Mr Mundy. What size of unit have you gone for licensing approval for?

Tom Mundy: Our technology is quite a bit different from what you would find in other SMR technologies, which I would generally characterise as a smaller version of a large plant. We have gone a completely different route in which we have created what is called a NuScale Power Module. That is the entirety of the nuclear steam supply system and containment all in one factory-fabricated component. Each of those modules, when

connected to a power conversion system, a turbine generator essentially, produces 50 megawatts of electricity. The facility design is scalable and can house up to 12 of those modules, so the total facility output could be as high as 600 megawatts.

Lord Oxburgh: Thank you.

Q14 **Lord Broers:** Related to timescale, et cetera, are the criteria set out by the Government for the SMR competition appropriate? What should the criteria be? Perhaps you know exactly where they are with this competition, or do you?

David Orr: I can probably answer the last part of the question first. I am unsure where we are at the moment. We are seeking clarity, because we had all understood that the competitive process was starting in November 2015. We all submitted proposals in May 2016, and we were told that a road map would be released in autumn 2016, which has not occurred yet. So we are seeking clarity at the moment from BEIS. We understand that the Government have an awful lot of loading at the moment and that a lot has changed since we all submitted our bids in May 2016 as well. Quite a broad expression of interest was put out then, so by criteria they were not that clear about the specification.

Going back to what I said before, I can tell you the Rolls-Royce view of that. Because of the economies of volume, we believe we have to select one preferred technology as a country. If we do not, we will not get the volumes to make it economical. In our view, again we have to have a UK industrial policy that supports intellectual property development in the UK and that promotes advanced manufacturing, high-value job skillsets and academia. We asked the Government for match funding up to the point of licensing the programme.

Commenting on what Tom said, we would like the delivery of the GDA, the licensing slot, the future energy market mix to give the volumes—the 7 gigawatts electric that I mentioned before for our particular design—and export support to the markets from the Department for International Trade.

We understand that as the competition progresses, the Government would quite rightly want to do due diligence on the technical maturity and on the vendors' business cases. I am sure you appreciate that we had to submit two business cases, because we needed ours to be commercially selectable in the UK. So as well as a consortium of power station provider business case for the cost per megawatt electric, we have had to do an operator utility case to see how selectable it is by an operator.

Lord Broers: You have submitted already to the competition. Tom Mundy, have you submitted also?

Tom Mundy: We have submitted quite a bit over the last few years. We made a substantial submission to the 2014 SMR feasibility study. There was a very extensive submission for the techno-economic assessment, it had hundreds of pages of information, and the maximum submission allowed under the current SMR competition Phase One, expression of

interest. We have made numerous submissions and given the Government quite a bit of information to assess our technology over time.

Q15 **Baroness Young of Old Scone:** This leads neatly on to my question. Do you think the Government have given you enough confidence that they have a framework for this? It sounds as though it is in the weeds somewhere, or am I being overcritical?

Tom Mundy: As I mentioned, not only us but many vendors have given them quite a bit of information to develop the policies. We understand that the road map they are going to set forth will take the information that they have received to date and set the overarching policy of what they ultimately want to achieve for their support of SMRs and technology, and provide additional information about how the selection process will continue. We are still optimistic that the SMR road map, once it is issued, will provide that information and will continue to advance the programme.

Baroness Young of Old Scone: Is there any white smoke on when the road map might appear?

David Orr: No, not yet.

Tom Mundy: No, not yet.

Lord Broers: I can declare that I asked a supplementary question on this and had a letter back from Lord Prior, which said that phase one of the competition remains open and plans for the future of the competition will be shared with the House in due course.

Baroness Neville-Jones: So no road map and no timetable.

The Chairman: That is not very helpful, Lord Broers, if I may say so. It is rather like saying the results will be known in the spring. "In due course" is even more elastic. Shall we move on?

Q16 **Baroness Neville-Jones:** I must declare an interest in membership of one of the research councils, the EPSRC. The question I wanted to ask you follows on the whole question of SMR development. Have you made any assessment of the effects of SMR generation on the flexibility and stability of the national grid? Has anybody? What view do you take of the pros and cons?

David Orr: We did quite a bit of work again with the Energy Technologies Institute. It has a model called the energy systems modelling environment—ESME—which you may be aware of, which again is used by government to look at the kind of scale that can be done. They also did a significant amount of siting studies on a variety of power levels that the SMRs could be used for on the grid, from the 7 gigawatts electric I mentioned up to a significant figure of greater than 60, with combined heat and power and things of that nature, also taking into account grid conditions for the 2050 decarbonisation targets, and potential things such as the electrification of automobiles for transport carbon emissions reduction. There has been quite a lot on the demand model, on the power

levels and on potential sites. If you include the ex-licensed sites, which obviously would be the preference for both speed and public acceptance—the ex-Magnox and the AGR sites are starting to decline now—they would have to be released through a phase two, of course, from the nuclear site studies. The Government have so far released phase one for the generation IIIs, and we would need another release, which is why we would all need a first-of-a-kind site identified.

You can definitely have some variability of power on an SMR; it is not necessarily significant if you want to be efficient with your fuel production and cost over a protracted period, but for short periods it is absolutely doable, and it is much more responsive than the large reactors, as was said by the professors earlier, so there is a bit more flexibility in them.

In relation to siting and losses, when you get outside larger populated areas, it makes far more sense for transmission losses to have low power levels at times. An example may be whether you would put a large generation III reactor at Heysham or Hartlepool, which are currently AGR sites. I would say probably not. So there are those sites. They would also go well on ex-Magnox sites such as Trawsfynydd in Wales. We know that the sizing of these fits well with the existing licence infrastructure in the UK and in terms of balance for the grid. At the kind of power level we have been talking about today, whichever system is used for the provision of optimum power, it also aligns very much with coal station generation levels, should we want to do that.

Q17 **Lord Oxburgh:** Looking at the future here, we have to consider the whole energy system. To what extent would either of you say that your designs were suitable or unsuitable for incorporation in district heating or indeed hydrogen generation, both of which are possibly interesting in the longer term in the UK?

Tom Mundy: As I mentioned, our technology is premised on these individual power modules, and it gives us quite a bit of flexibility to be able to provide for applications other than just electricity production. In fact, we have studied and issued a number of technical papers examining the use of our technology for combined heat and power applications and process heat applications, having the capability for extensive load following, and a design to be able to cycle the individual modules up and down at various rates depending on the need for matching existing capacity. All that can be done quite easily, because the heat that is produced in these individual modules can be directed to these other applications, which allows for very more deliberate and specific direction of that process heat for these things. We specifically build that capability into the design.

David Orr: SMRs are generically capable of doing combined heat and power. Again, a lot of SMR developers are looking at these as additional, should a customer want them, almost as a plug and play, and making sure that they can do it. You can also put in things such as battery packs, so if you are not generating fully you can be charging for the grid at peak times. There is hydrogen production; we are looking at a probability

study at the moment on hydrogen generation. All of them are entirely possible in order to improve the economics.

Lord Oxburgh: What do you mean by "a probability study for hydrogen"?

David Orr: The viability economically. That is the best way of putting it.

Lord Oxburgh: Thank you.

Q18 **The Chairman:** In the previous session you may have heard us touch on the National Nuclear Laboratory, with its range of functions, acting as strategic technical adviser to government and industry, leading the civil nuclear fission energy national programme, and relying largely on commercial funding—a company wholly owned by government. Do you think this is a suitable remit to provide research and development support for the UK nuclear sector?

Dr Rebecca Weston: I will take a stab at that one. I think it is a suitable remit for serving the nuclear industry. It is a broad-ranging remit from independent advice to government to the role the National Nuclear Lab plays with us at Sellafield, which is very much about technical support and development more than co-ordinating R&D. We are looking to establish a greater strategic relationship so that we get more co-ordination across the technology readiness scale, with NNL playing a part between early innovations and Sellafield acting as the active deployment and testbed for those technologies.

NNL is the only wholly commercially funded national lab in the world, I think. Most other labs have some form of grant funding, even others in the UK. There are a lot of strengths to that commercially funded model, in that it drives efficiency and a commercial outlook, and it puts the NNL very close to its key customers, not least us at Sellafield but also EDF and the Ministry of Defence. However, the model creates some conflict when it has to compete in the marketplace for funding through the research councils with supply chain innovators and academia. So I would certainly welcome looking at how we manage that remit.

Through the new technical services contract, a long-term agreement between Sellafield and NNL, we are looking to drive the development of the supply chain and try to manage the conflict that arises with the model as it is. There are pros and cons with any model, and it depends what support to the industry the Government want of the National Nuclear Laboratory at the moment and on a longer-term approach. The market will not drive that long-term research and development.

The Chairman: Both Sellafield Limited and the NNL have been through a transition to GoGo. How do you feel that the relationship has developed?

Dr Rebecca Weston: I feel that the relationship is developing. It is a very long-standing relationship in that both organisations came out of BNFL back in 2005 and went through the GoCo experience and have now made that transition into GoGo. It has, I think, enabled a more strategic outlook over the last year. It is early days as to how some of the challenges that I have outlined will develop.

The Chairman: Unless either of you would like to comment on the NNL, we will move on to Euratom.

Q19 **Lord Broers:** Finally—we discussed this with the previous group—how will leaving Euratom affect the UK nuclear industry?

David Orr: There are two things, which were both mentioned earlier. There are fuel movements, which is a potential issue. There is also fusion in particular but also research and development money in those arrangements. The Nuclear Industry Association has already put out a statement that the preferred position is clearly to maintain that relationship, but failing that that we have negotiated positions on the key parts of the industry before exiting the Euratom relationship. Our understanding is that that would be through export control arrangements again, or even having collaborative agreements on research and design understood, at least in formative use, before we exit that arrangement.

Dr Rebecca Weston: I would add that at the Sellafield site there would be a significant impact on leaving Euratom with regard to nuclear materials accountancy and, indeed, nuclear proliferation safeguards. There is very much a requirement for the third-party assurance to overseas customers that we currently discharge through Euratom, and the independent verification of our special nuclear materials in particular. In its absence there is the IAEA. Significant time would be likely to be required to put an appropriate system in place. It would not be without cost—of equipment—Euratom has an on-site laboratory, for instance, at the Sellafield site—and time, effort and dose in re-verification of such an inventory. Clearly, there are hugely significant impacts on the likes of the fusion programme at Culham, as has already been mentioned. Obviously, once clarity is obtained, we are very happy to support work to understand and develop the UK position.

The Chairman: Clarity is definitely needed on this one. If there is nothing else on Euratom, I would like to go back to the NNL, for a moment. You reminded us that it is quite unique for a national laboratory to rely entirely on commercial funding. Would it help if there was seed funding, platform funding, from government? Would it give it a greater degree of stability, and might some of the inhibitions be reduced?

David Orr: I agree. I think clarity and objectives are the two roles that it should be given, to be honest. I do not think it should lose its commercial position, as was said earlier, because it has been hard fought and hard won, and it is a great mentality to have anyway for an organisation structure. I do not think that should be lost. It does tremendous work, as I said before, particularly in fuel cycle decommissioning and accident-tolerant fuel for civil nuclear, so that is all a great positive.

If the Government wish it to play a role as the formal adviser, I am sure the National Nuclear Laboratory, which we all work with strongly, knows that it does not have the capability across the lifecycle to be able to do that. It understands that and has tried to support and augment it through secondees from other industrial players—in new reactor design, as an example. So there is the clarity of the two roles, and once you have an

understanding of what the government adviser role is, they will have some funding, as you have mentioned, to cope with and cover that role properly.

The Chairman: Thank you. Lord Hennessy is looking as if he wants to ask a question.

Lord Hennessy of Nympsfield: I think you were in on the earlier session when I asked the question about dawnism. Are you optimistic? Is this a new dawn for all this?

Dr Rebecca Weston: I am certainly optimistic about the future of the industry.

Lord Hennessy of Nympsfield: That is a cautious answer.

Dr Rebecca Weston: Not at all. "A new dawn" is also fairly dramatic, in that sense. There is absolutely the opportunity. However, there are always thorny questions, and I come back to the political dimension and not least key strategic decisions coming up, about geological disposal for example, and once and for all solving the issue of radioactive waste management. Not just for the UK but for the broader industry across the world. For many nations, it is a timely moment in that regard. In some ways, making policy and strategic decisions in some of those areas and demonstrating that we have cleaned up the legacy of the past starts to enable the future.

Lord Hennessy of Nympsfield: Is this the "R" of the SMR, Tom?

Tom Mundy: I have a much more optimistic view about a new dawn of the technology. The days of the gigawatt-size nuclear facilities are limited; there is just not the customer base with the financial means to deal with the costs associated with those facilities and the complexity in constructing those facilities. There is clearly movement now to advanced technologies, whether small and modular, which are based on light-water technology or the Gen IVs, which are based on non-light-water technology. That is where I see this industry is moving to. I see great opportunity over the next 20, 30, 40, 50 years to see these kinds of technologies being deployed all over the world to satisfy all kinds of objectives that the world has, both financial and in relation to the low-carbon and environmental needs.

Lord Hennessy of Nympsfield: David, are you an evangelist?

David Orr: I am. As I said at the start, we have a once-in-a-generation opportunity, and if we miss it we will regret it. It is going to decline the skill base in the UK, to an extent, on portions of the lifecycle that I think we will struggle to regain, to be honest.

Viscount Ridley: As a footnote to Tom's point, even a toaster would be extremely expensive if you made every one from scratch.

Lord Hennessy of Nympsfield: That is a very profound remark.

Tom Mundy: Probably so. I have heard numbers talked about particularly in relation to the learning on the technology: how many will it take to get down that nth-of-a-kind curve? For some of the technologies

you need multiple units to be constructed. In our technology, 7 gigawatts of generation in this market is 140 or 150 NuScale Power Modules, and in our view we need 12 to 14 of those modules to be made to get down that learning curve from first-of-a-kind to nth-of-a-kind. That is the number of modules in the first unit or first facility. After that, we are well down that curve and the savings associated with repetitive factory manufacture of those pieces of equipment. When you start making 140 or 150 or more, by that point in the process you understand how to make that toaster.

Viscount Ridley: I was not being entirely flippant, but that was the point that I thought had not come out strongly.

Baroness Young of Old Scone: In that context, if you were to operate at that scale, where do you think the costs per unit of electricity would come in the hierarchy of different forms of generation? I have only ever seen it compared with the big-scale nuclear costs rather than any of the others.

Tom Mundy: Most importantly, the customers want to know that they are buying an economic technology. It is not enough to get behind the technology on safety performance; it has to be economic. Over two years ago, we put out first-of-a-kind economic figures for our technology that are competitive with gigawatt-size advanced technologies and a number of other forms of generation on a levelised basis, even with combined-cycle gas when gas is around $5 per million BTUs or higher. We are talking about a levelised cost, on a first-of-a-kind basis, of £65 to £70 per megawatt hour for our technology, with significant opportunity to improve upon that for nth-of-a-kind deployments, so it is certainly competitive with DECC's own number for advanced nuclear. Its assessment was that it should be better than £90 per megawatt hour. We believe that on first-of-a-kind we are below that, and we certainly have the opportunity to improve upon it with multiple unit deployments.

Lord Maxton: Can I say to Viscount Ridley that I am old enough to remember the days before we had electric toasters? To some extent, the point is that the technology is moving so fast. Is there another technology that will overtake the nuclear technology that a lot of money has been invested in?

Dr Rebecca Weston: You talked in the earlier session about having to have that long-term view. Clearly, in that vein, fast reactors and fusion come into the picture. Going back to the point about the toaster, if we could improve some of the collaboration and leverage in some of the research and development that we (with perhaps some committee as part of the Nuclear Industry Council, as a successor to the likes of NIRAB) are doing, there might be more opportunity, with that in mind, to look to bridge and to make better benefit of the investment in the likes of advanced materials. For instance, we are developing boxes to store radioactive waste that are pretty complex advanced manufacturing that really do develop the skills and capabilities that would play into SMRs, generation IV and fusion development.

The Chairman: We have come to the end of our session. We rely on Lord Hennessy to give us proposals for titles of our reports, and I can see

"dawn" featuring, possibly with a question mark. We will see. Thank you to David Orr, Dr Rebecca Weston and Tom Mundy. As I said earlier, a written record will be sent to you. Please make any minor amendments that you feel appropriate. If there is anything that we have not covered and that you feel you would like to add, for the record, please send them to the clerk, who will be happy to receive them. Thank you again for giving us very helpful advice and information.