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3rd Report of Session 2016–17

Nuclear research and technology: Breaking the cycle of indecision

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See Appendix 1.

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Q in footnotes refers to a question in oral evidence.

SUMMARY

The undoubted potential of civil nuclear has been blighted by the indecision of successive Governments. Now, within the context of the industrial strategy and amid the challenges of Brexit, it is critical for the Government to set out a decisive future for this industry.

Urgent Government action required

The UK has long-standing and continuing commitments to civil nuclear energy. There are nuclear wastes to be managed, substantial decommissioning projects are underway and the decision has been made to replace the existing ageing fleet of civil reactors. However, we have reached a critical moment for the future of the United Kingdom as a serious nuclear nation. The UK is strategically positioned to capture coming opportunities, including the development of small modular reactors, but in order to make the most of these opportunities the Government must act now to provide underpinning strategic support to the nuclear industry. We have found that successive Governments' delays in taking civil nuclear policy decisions has seriously damaged the UK industry's potential ability both in the short and longer terms to contribute effectively to whatever national policies might ultimately be favoured.

The decision the Government must make is whether the UK should be a designer, manufacturer and operator of nuclear generation technology or alternatively whether it should restrict its interest to being an operator of equipment supplied by others from overseas. We urge the Government to take a clear and firm view. Not making a timely decision could have serious consequences.

Once the Government has made this overarching decision, other strategic decisions will flow from this to define a clear set of objectives and timescales with which the UK nuclear industry can align itself through a revitalised nuclear industry council. If the Government were to decide that the UK should be a designer and manufacturer in nuclear fission, then the following would be the minimum steps needed to achieve this:

- Development of a domestic research programme that is of sufficient scope and scale to make the UK an attractive partner for developing new technology to support new nuclear build in the UK and abroad.
- Participation in and contribution to international programmes such as the Generation IV International Forum.

The Nuclear Innovation Research Advisory Board (NIRAB) fulfilled a useful role and a successor body is urgently needed to ensure that best value is achieved from UK investment in nuclear R&D. The previously announced five year programme of £250 million for civil nuclear research should be allocated for research programmes judged to be of appropriate quality and relevance.

Small Modular Reactors

Small modular nuclear reactors (SMRs) appear likely to be globally important for the future of nuclear energy. Currently SMRs for defence applications is an area of UK technical excellence. In the absence of any clear world market leader the UK has the experience and expertise to seize the opportunity to re-enter the market as a designer and manufacturer of SMRs. However the limited size of the domestic market for SMRs and the potential for cost reduction make it

desirable that this should be a joint venture with a foreign partner. With this in mind the outcome of the Government competition on SMRs should be published without delay. Deferring a decision on SMRs amounts to forgoing an opportunity that is unlikely to occur again. The Government's failure to make a decision on its strategy for SMRs is a prime example of its inaction in the civil nuclear arena. Not keeping to the stated timetable for the competition has had a negative effect on the nuclear sector in the UK and if the Government does not act soon the necessary high level of industrial interest will not be maintained.

National Nuclear Laboratory

The National Nuclear Laboratory (NNL) is well-placed to be a source of independent advice to the Government and to support research and development in the UK nuclear sector. To do this properly, it will require dedicated core funding. Whilst acknowledging the current climate of financial restraint, we urge the Government to give early consideration to providing modest funding to the NNL, similar in magnitude to that provided to other UK national laboratories.

Euratom

The Government has announced that when the UK leaves the European Union, it will also leave Euratom. The Government should immediately convene a working group of industry and government representatives to develop a plan to preserve the essential benefits of Euratom membership, which fits into the Government policy to collaborate in science and technology in Europe and elsewhere.

There is a real urgency for Government action on this and we recognise that the Government is devoting significant resources to maintaining and, potentially, even enhancing some of the benefits that we currently achieve from Euratom membership. The UK's membership of Euratom must not be allowed to expire without a suitable replacement being in place. Such an eventuality would put the UK at risk of losing its lead in fusion research and in effect throw away decades of research. Furthermore it would put the UK at risk of losing access to the markets and skills it needs to construct new nuclear power plants and may leave existing power plants unable to acquire fuel.

Nuclear research and technology: Breaking the cycle of indecision

CHAPTER 1: INTRODUCTION

Context

1. The UK has long-standing and continuing commitments to civil nuclear energy. There are nuclear wastes to be managed, substantial decommissioning projects are underway and the decision has been made to replace the existing ageing fleet of civil reactors. The Hinkley C reactor is the first step in that process and further reactors are being considered. This was recognised in the Government Green Paper *Building our Industrial Strategy* which was published in January 2017. It identified the nuclear sector as an important element of the wider industrial strategy.[1]

Previous work on civil nuclear policy

2. This report should be seen as the latest instalment in the Committee's work on civil nuclear policy, which has included:

- A report, *Nuclear Research and Development Capabilities* (November 2011)[2] (the Government responded to this report in February 2012);[3]
- An oral evidence session with the Chief Scientific Adviser at the Department for Energy and Climate Change and the Energy Minister (July 2013);[4]
- An oral evidence session with Dame Sue Ion, Chair of NIRAB (July 2014);[5]
- A letter from the Chairman to Matthew Hancock MP, then Minister for Energy (July 2014);[6] and
- A one-off oral evidence session on Nuclear Fusion (July 2015).[7]

1 Department for Business, Energy and Industrial Strategy, *Building our Industrial Strategy* (January 2017): https://beisgovuk.citizenspace.com/strategy/industrial-strategy/supporting_documents/buildingourindustrialstrategygreenpaper.pdf [accessed 20 March 2017]

2 Science and Technology Committee, *Nuclear Research and Development Capabilities* (3rd Report, Session 2010–12, HL Paper 221)

3 Science and Technology Committee, *Nuclear Research and Development Capabilities—Government Response* (Session 2012–13)

4 Oral evidence taken on 23 July 2013 and 10 December 2013 (Session 2013–14): http://www.parliament.uk/documents/lords-committees/science-technology/Nuclearfollowup/Nuclearfollowupevidence.pdf

5 Oral evidence taken on 15 July 2014 (Session 2014–15), QQ 1–16 (Dame Sue Ion): http://www.parliament.uk/documents/lords-committees/science-technology/Nuclearfollowup/cST150714Ion.pdf

6 Letter from the Chairman, the Earl of Selborne, to the Rt Hon Matthew Hancock MP, then Minister of State for Energy, 24 July 2014: http://www.parliament.uk/documents/lords-committees/science-technology/Nuclearfollowup/NuclearfollowupHancockLtr240714.pdf

7 Oral evidence taken on 21 July 2015 (Session 2015–16), QQ 1–13 (EURATOM, the Department for Business, Innovation and Skills (BIS) and Tokamak Energy)

Recommendations in 2011 report

3. In our 2011 report, *Nuclear Research and Development Capabilities*[8] we made the following recommendations to bring about high-level changes in the Government's approach to nuclear:

   - the development of a long-term strategy for nuclear energy;
   - the development, as part of that strategy, of a nuclear research and development (R&D) roadmap; and
   - the establishment of an independent Nuclear R&D Board, as a non-departmental public body (NDPB), made up of representatives from the Government, industry and academia, chaired by an independent, expert, authoritative Chairman.

Actions following our 2011 report

4. As a result of the Committee's report the Government drew up a Nuclear Industry Strategy[9] and a Nuclear Energy Research and Development Roadmap.[10] Instead of setting up an NDPB as recommended by the Committee, the Government set up a time limited advisory board in January 2014, the Nuclear Innovation and Research Advisory Board (NIRAB). NIRAB was charged with advising Ministers on the publicly funded civil research needed to underpin industrial and energy policies (including the Nuclear Industry Strategy) and with fostering cooperation and coordination. NIRAB recently published its final report with recommendations for Government[11] (see Box 1).

Why we launched this inquiry

5. We decided to revisit our 2011 report to investigate the developments that have taken place since its publication and what more needs to be done to ensure the UK can meet its future nuclear energy requirements.

6. We decided to look specifically at the Government's strategy relating to civil nuclear energy; the coordination of civil nuclear R&D within the UK; and the upcoming decision on small modular reactor (SMR) designs for the UK.

7. The decision to conduct this inquiry was taken before the publication of the Government's White Paper, *The United Kingdom's exit from and new partnership with the European Union*.[12] This stated that, when the Government triggered Article 50 of the Treaty on European Union to begin the process of exit, the UK would leave Euratom as well as the EU. As a result of this announcement, we received written evidence relating to the UK's withdrawal from Euratom and discussed this in oral evidence.

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8 Science and Technology Committee, *Nuclear Research and Development Capabilities* (3rd Report, Session 2010–12, HL Paper 221)

9 HM Government, *The UK's Nuclear Future* (2013): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/168048/bis-13-627-nuclear-industrial-strategy-the-uks-nuclear-future.pdf [accessed 23 March 2017]

10 HM Government, *Nuclear Energy Research and Development Roadmap: Future Pathways* (2013): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/168043/bis-13-632-nuclear-energy-research-and-development-roadmap-future-pathway.pdf [accessed 21 March 2017]

11 Nuclear Innovation and Research Advisory Board (NIRAB), *NIRAB Final Report 2014 to 2016* (February 2017): http://www.nirab.org.uk/media/10139/nirab-117-3-nirab-final-report_web.pdf [accessed 16 March 2017]

12 Department for Exiting the European Union, *The United Kingdom's exit from and new partnership with the European Union,* Cm 9417, 2 February 2017: https://www.gov.uk/government/publications/the-united-kingdoms-exit-from-and-new-partnership-with-the-european-union-white-paper [accessed 20 March 2017]

Structure

8. In Chapter 2, we analyse the evidence we received on the co-ordination of civil nuclear R&D in the UK. In Chapter 3 we consider whether the UK has a coherent civil nuclear strategy and who should take the lead in delivering this. We consider the role of the newly-constituted Nuclear Industry Council (NIC) and in particular its potential leadership of a possible 'sector deal' for the nuclear industry. In Chapter 4 we look at SMRs and urgent decisions relating to these that the Government needs to take. In Chapter 5 we consider the role and funding of the National Nuclear Laboratory. In Chapter 6 we consider the UK's withdrawal from Euratom.

Working methods and acknowledgements

9. The membership of the Committee is set out in Appendix 1. We issued a call for evidence on 26 January 2017, which is contained in Appendix 3. In February and March 2017 we took oral evidence from 17 witnesses. We received 53 written submissions. A list of witnesses is included in Appendix 2.

10. We would like to thank our Specialist Adviser, Professor Tom Scott, Bristol University, for his expertise and guidance throughout this inquiry.

Government response

11. We carried out the inquiry for this report assuming that the then Government would remain in place until the next General Election which was due to take place on 7 May 2020 under the provisions of the Fixed-term Parliament Acts 2011. About a fortnight before the publication of this report, the House of Commons agreed to an early General Election to be held on 8 June 2017. We expect the new Government to take account of this report.

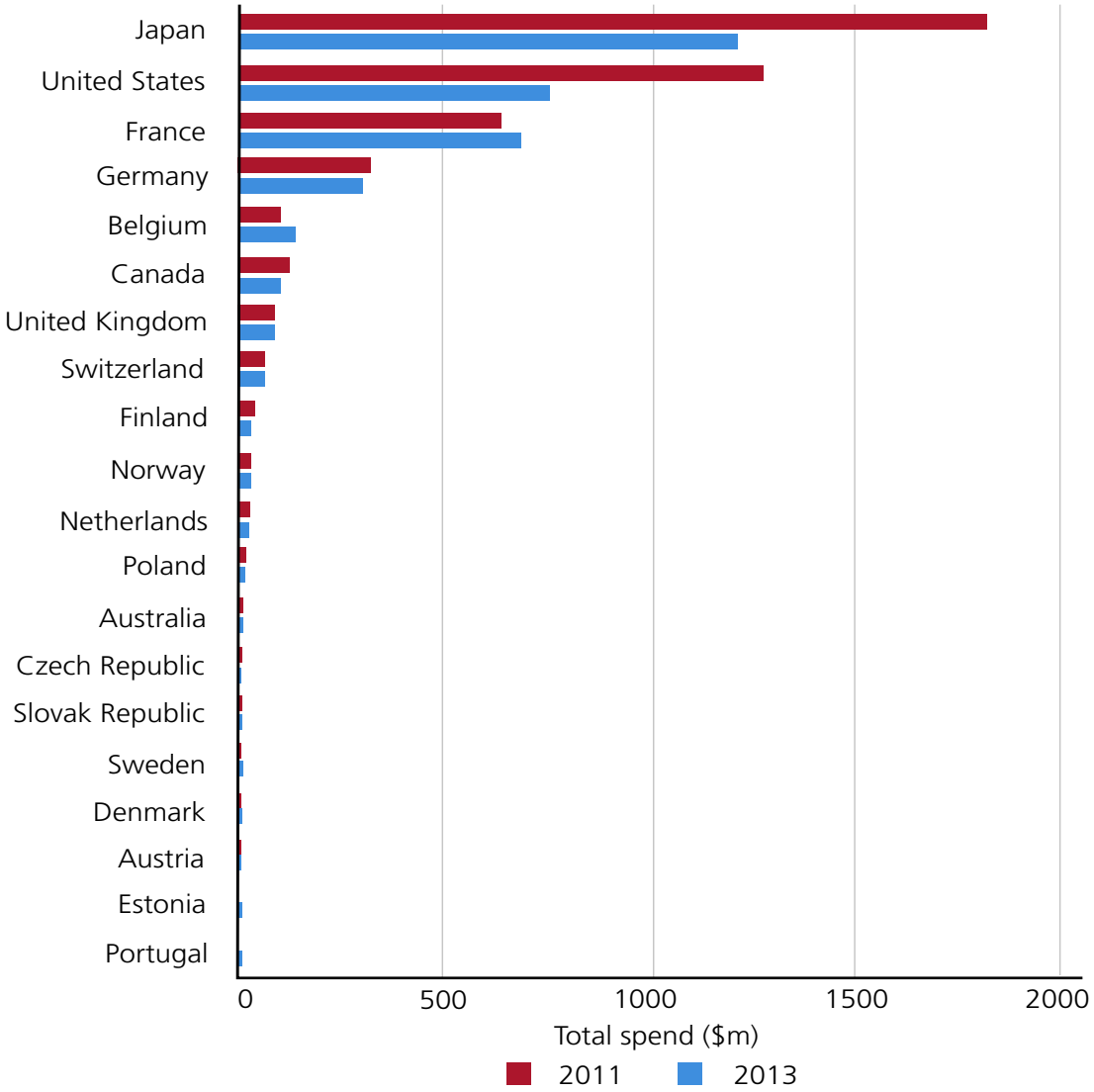
12. We look forward to receiving the Government's written response to this report and will seek a debate in the House as soon as possible thereafter.

CHAPTER 2: UK CIVIL NUCLEAR RESEARCH AND DEVELOPMENT

13. This chapter analyses the evidence we received on the co-ordination of civil nuclear R&D in the UK.

14. The UK conducts research and development in nuclear energy although the level of expenditure is low by comparison with other countries (see Figure 1), particularly those that generate nuclear power. As a minimum requirement any country with significant nuclear interests should have a sufficient level of indigenous nuclear technological competence to ensure responsible stewardship of existing nuclear assets and liabilities.

Figure 1: Public funding of nuclear R&D for OECD countries 2011 and 2013



Source: NIRAB, The UK civil nuclear R&D landscape survey (February 2017): http://www.nirab.org.uk/media/10671/nirab-123-4.pdf [accessed 24 April 2017]

15. In the UK development, as distinct from research, is largely associated with the technology of decommissioning old nuclear sites and with the long term future development of fusion power.

16. In the UK nuclear R&D is carried out by four groups:

- **National Nuclear Laboratory (NNL):** The UK's NNL is a Government-owned body, operating as a commercial business providing research and technology analysis solutions of certain aspects of nuclear fission to customers in the UK and overseas. It also provides advice to the Government but is not specifically funded for that purpose

- **UK Atomic Energy Authority (UKAEA):** UKAEA researches fusion energy and related technologies, with the aim of positioning the UK as a leader in sustainable nuclear energy. UKAEA is an executive non-departmental public body, sponsored by the Department for Business, Energy & Industrial Strategy. UKAEA is paid by Euratom to operate the JET fusion facility on behalf of a collective European R&D programme. It also has major roles in ITER, the international next generation fusion experiment. UKAEA receives some funding from EPSRC for fusion research.

- **Nuclear Decommissioning Authority (NDA):** NDA is an executive non-departmental public body, sponsored by the Department for Business, Energy & Industrial Strategy. The NDA is responsible for decommissioning 17 nuclear sites. This includes the first generation of Magnox power stations, various research and fuel facilities and its largest, most complex site, Sellafield.

- **Universities:** universities work in this area and may receive contracts from any of the agencies listed above and funding from Research Councils UK (RCUK), primarily through the Engineering and Physical Sciences Research Council (EPSRC). EPSRC is expected to spend £13.9m in 2016/17 on fission research, and this figure has grown significantly over the last 10 years. EPSRC spends an average of £28m per year on fusion research, and this has been fairly stable over the long term.[13]

17. The UK nuclear industry, including research, is highly regulated. Nuclear sites are principally regulated by the Office for Nuclear Regulation (ONR) for nuclear safety and by the Environment Agency for environmental protection. There is some overlap between these regulatory regimes, particularly around the regulation of radioactive waste. These organisations share the joint mission of delivering effective and efficient regulation of the nuclear industry in England and Wales.

Coordination of UK R&D

18. In its 2011 report *Nuclear Research and Development Capabilities* the Committee recommended that the Government should set out a long-term strategy for nuclear energy and set up an independent Nuclear R&D board as a statutory Non-Departmental Public Body (NDPB).[14] The board would advise the Government and monitor (and report on) the Government's progress against a nuclear research road-map. Instead of accepting this recommendation the Government established the NIRAB in January 2014. NIRAB was set up as a temporary advisory board for a period of three years

13 Due to the complexities of funding these figures do not necessarily catch all the detail of EPSRC expenditure on nuclear research.

14 Science and Technology Committee, *Nuclear Research and Development Capabilities* (3rd Report, Session 2010–12, HL Paper 221), para 272

under the chairmanship of Dame Sue Ion. NIRAB's role was to advise the Government on how to ensure that nuclear innovation and R&D would keep future energy options open and enable both domestic and international commercial opportunities to be realised by the UK. NIRAB was supported by a technical secretariat, the Nuclear Innovation and Research Office (NIRO). NIRO was hosted by the NNL and staffed by secondees from NNL and industry. NIRAB's term ended in December 2016.

19. Our evidence showed that, within its terms of reference, NIRAB was widely regarded as a success.[15] EDF Energy told us that "recommendations issued in 2016 present a comprehensive and prioritised programme of R&D that represents the view of the whole UK Nuclear community".[16]

20. However, this was not a universal opinion. The multinational engineering and project management consultancy, AMEC Foster Wheeler, said that because NIRAB (and NIRO) was reliant on the NNL to provide staff, it presented a distorted view of what the UK nuclear industry needs to do.[17] NSG Environmental Ltd, a company providing specialist R&D services to the nuclear industry, told us that they had no engagement with NIRAB and that the role of small and medium-sized enterprises in nuclear R&D was not adequately considered.[18] It would therefore appear that whilst there are many small and medium-sized enterprises in the UK supporting all aspects of the nuclear industry, home and abroad, they are not afforded an adequate collective voice or opportunity to contribute substantially to the future shape of the industry.

21. John Donald, Superintending Inspector, ONR, told us that NIRAB did a good job within its terms of reference but that these did not include responsibility for full co-ordination of UK civil nuclear research. Furthermore he said it helped "produce collaboration but it was not constituted to really develop co-ordination or international co-ordination".[19]

22. NIRAB published its final report containing recommendations (see Box 1) for the Government on the future of UK nuclear R&D in February 2017.[20] The final report also showed which recommendations from NIRAB's 2014 and 2015 reports had been addressed by the Government. Out of a total of 38 recommendations made in 2014, seven have been fully addressed and 18 have been partially addressed. The remaining 13 are outstanding. Of the eight recommendations made in the 2015 report one has been fully addressed and three have been partially addressed.[21]

15 Written evidence from Bristol University/SW Nuclear Hub (PNT0043), University of Leicester (PNT0022)
16 Written evidence from EDF Energy (PNT0039)
17 Written evidence from AMEC Foster Wheeler (PNT0044)
18 Written evidence from NSG Environmental Ltd (PNT0050)
19 Q 22 (John Donald)
20 NIRAB, *NIRAB Final Report 2014 to 2016* (February 2017): http://www.nirab.org.uk/media/10139/nirab-117-3-nirab-final-report_web.pdf [accessed 16 March 2017]
21 *Ibid.*

Box 1: NIRAB final recommendations for the Government

(1) Government should commission without further delay the first stages of the programme recommended by NIRAB and subsequently deliver on its commitment to fund at least £250m for an ambitious nuclear R&D programme over this spending review period.

(2) Government should put in place arrangements to integrate and review the output of publicly funded civil nuclear research programmes.

(3) Government should implement a transparent and effective mechanism to coordinate and, where necessary, direct, all publicly funded nuclear R&D activities in order to achieve the desired industrial impact and maximise value for money.

(4) Government should put in place arrangements to retain access to independent expert advice on nuclear research and innovation to inform policy decisions in this area.

(5) Government should periodically commission updates of the civil nuclear R&D landscape as a means of monitoring the health of the landscape and the effectiveness of Government interventions.

(6) Existing nuclear R&D programmes funded by Research Councils UK, the Nuclear Decommissioning Authority and Innovate UK should continue at no lower than current levels.

(7) Government should develop a plan to resume active membership of the Generation IV International Forum.

(8) Government should develop and implement a comprehensive and coordinated international collaboration strategy for nuclear research and innovation to enable research to be implemented to greatest effect.

(9) Government should assess the potential impact of the UK exiting the European Union on nuclear innovation and research activity and mitigate accordingly.

(10) Government should make clear its aims for SMR development in the UK, ensuring that these are used in evaluating the SMR competition. It will be important there is continued alignment of the wider underpinning research programmes with SMR priorities and that a strategic direction is maintained.

Source: NIRAB, Final Report 2014 to 2016 (February 2017): http://www.nirab.org.uk/media/10139/nirab-117-3-nirab-final-report_web.pdf [accessed 16 March 2017]

Future funding and coordination of Nuclear R&D

23. The evidence we received made it clear that, particularly given the number of public bodies involved in nuclear R&D (see paragraph 16), a successor body to NIRAB, with a co-ordinating role, is necessary.[22]

24. Bristol University, on behalf of the South West Nuclear Hub, explained that, with the cessation of NIRAB, "there is presently no effective oversight or sufficient coordination of the whole UK activity in nuclear engineering, science and technology, and a suitable replacement should be instituted as a matter of urgency".[23] EDF Energy suggested that the creation of a permanent successor body to NIRAB could maintain momentum and strategic alignment for R&D across the UK Nuclear Industry.[24]

25. In its final report NIRAB emphasised the importance of having an effective mechanism to coordinate public sector funding in nuclear R&D. Commissioning additional research programmes, such as the five year £250m programme announced in the spending review 2015 (see paragraph 34), will increase the complexity of the landscape of publicly funded nuclear research. In order to achieve value for money and the Government's desired outcomes effective co-ordination will be vital.[25] A similar point was made by Mr Donald, he told us:

> "[T]here is quite a lot of funding [from] different bodies. They tend … to co-ordinate at a tactical level … but there is no overarching view of it all … we [the ONR] thought that it would be a cost to produce and provide [overarching co-ordination] but the benefit from it would probably overplay the cost involved."[26]

26. Professor John Loughhead, Chief Scientific Adviser at the Department for Business, Energy and Industrial Strategy (BEIS), said that while the UK has a more distributed system of nuclear R&D, compared to other countries such as France, "it is probably not accurate to deduce that, therefore, it is totally fragmented and uncoordinated".[27]

27. In its written evidence the Government said it is currently "considering its future options for accessing independent expert advice on nuclear research and innovation and an announcement will be made in due course".[28]

28. Professor William Lee, Professor of Ceramic Science and Engineering at Imperial College London, told us that a successor body to NIRAB would need to "oversee the sector deal … link with … UK Research and Innovation … coordinate with the Nuclear Decommissioning Authority, the nuclear industry (e.g. via the Nuclear Industry Association and the Nuclear Industry Council) … and develop a coordinated global strategy".[29]

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22 Written evidence from Atkins (PNT0015), Centre for Nuclear Engineering, Imperial College London (PNT0054), EDF Energy (PNT0039), GE Hitachi Nuclear Energy (PNT0030), Gwynedd Council (PNT0011), Nuclear AMRC (PNT0026), NDA (PNT0036), NIA (PNT0041), Nuclear Institute (PNT0033), Sellafield Ltd (PNT0052), UKAEA (PNT0035) and Prof Neil Hyatt (PNT0028)

23 Written evidence from Bristol University/SW Nuclear Hub (PNT0043)

24 Written evidence from EDF Energy (PNT0039)

25 NIRAB, *NIRAB Final Report 2014 to 2016* (February 2017), recommendation 3: http://www.nirab.org.uk/media/10139/nirab-117-3-nirab-final-report_web.pdf [accessed 16 March 2017]

26 Q 22 (John Donald)

27 Q 34 (Prof John Loughhead)

28 Written evidence from HM Government (PNT0029)

29 Written evidence from Prof William Lee (PNT0004)

29. Xavier Mamo, Director R&D UK Centre at EDF Energy, highlighted that in France the Government has a close involvement in supporting the nuclear industry and providing strategic governance. The French President of State chairs the national nuclear policy council, which involves Ministers and representatives from the industry with "the clear objective of setting out strategic orientation and priorities for the nuclear sector as a whole".[30] Mr Mamo made it clear that in comparison to the plethora of UK government organisations responsible for nuclear research, the French system had a more "limited number of actors and players delivering the research and development programme".[31] He also told us that France has an existing strategic road map for nuclear R&D that identifies and delivers against important milestones.[32]

30. ***The Committee restates its recommendation from 2011 that a non-departmental public body (NDPB), distinct from the National Nuclear Laboratory (NNL), be set-up with a co-ordinating and supervising role for nuclear R&D in the UK. Such a body could work in close collaboration with the Nuclear Industry Council (NIC). It is important that any new body takes forward the important recommendations from the Nuclear Innovation and Research Advisory Board (NIRAB) as soon as possible. In an industry as long-term as nuclear a new permanent body of this kind will help ensure continuity and consistency for R&D in the UK. It could also help save money by reducing or eliminating duplication of R&D across the different bodies involved.***

31. ***The Government must make clear whether it is still working to its 2013 roadmap and, if so, what body has oversight of it and is responsible for measuring progress against it. An NDPB, as described above, would be ideally placed to measure progress against a roadmap, as recommended by the Committee in its 2011 report.***

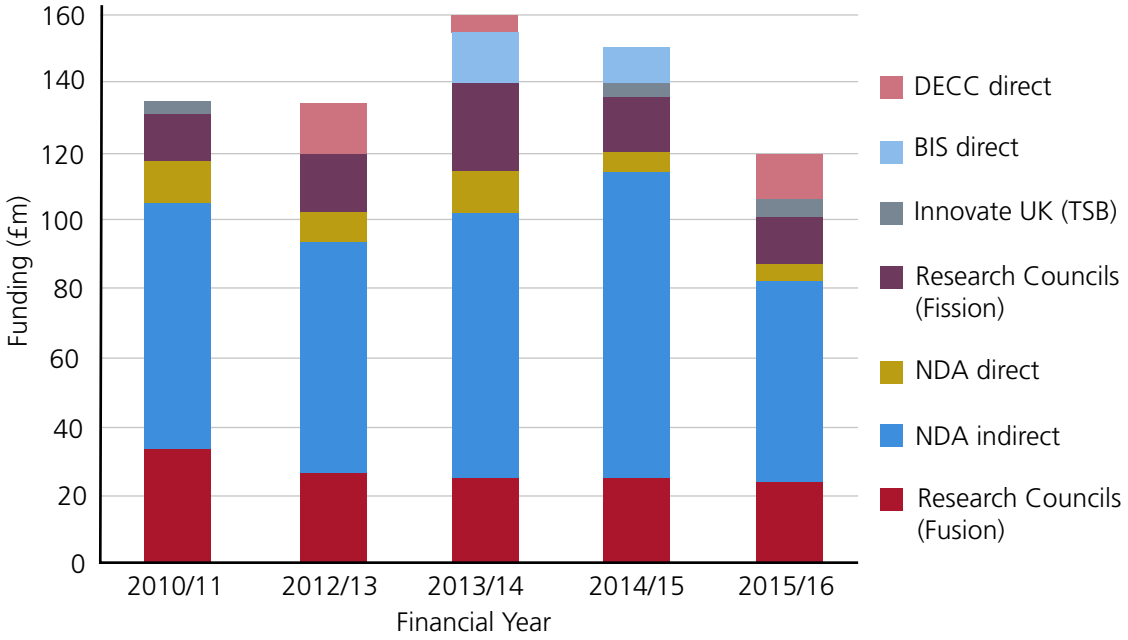
32. ***We reiterate the recommendation from our 2011 report that the new NDPB should be given a modest amount of new funding to carry out its activities. It should also have the power to attract money from industry and elsewhere.***

Future funding of nuclear R&D

33. In February 2017 NIRAB published a review of the civil nuclear R&D landscape in the UK in 2015/16. This was an update of a review carried out in 2013 and highlighted how the landscape had changed since 2013 when the Government's nuclear industry strategy and R&D roadmap were published. In particular it highlighted how public funding for nuclear R&D in the UK has remained broadly flat across this period (see Figure 2). Much of the public funding is directed through the NDA for research into dealing with nuclear waste and decommissioning. Dame Sue Ion, Chair of NIRAB, told us that the UK is world class in this area because we are performing some of the most difficult challenges globally. However, she went on to say that in those areas highlighted as lacking in funding by the Committee in its 2011 report, including advanced fuels and advanced reactors (collectively known as Generation IV technologies—see Box 2), there has been almost no investment in the five subsequent years.[33]

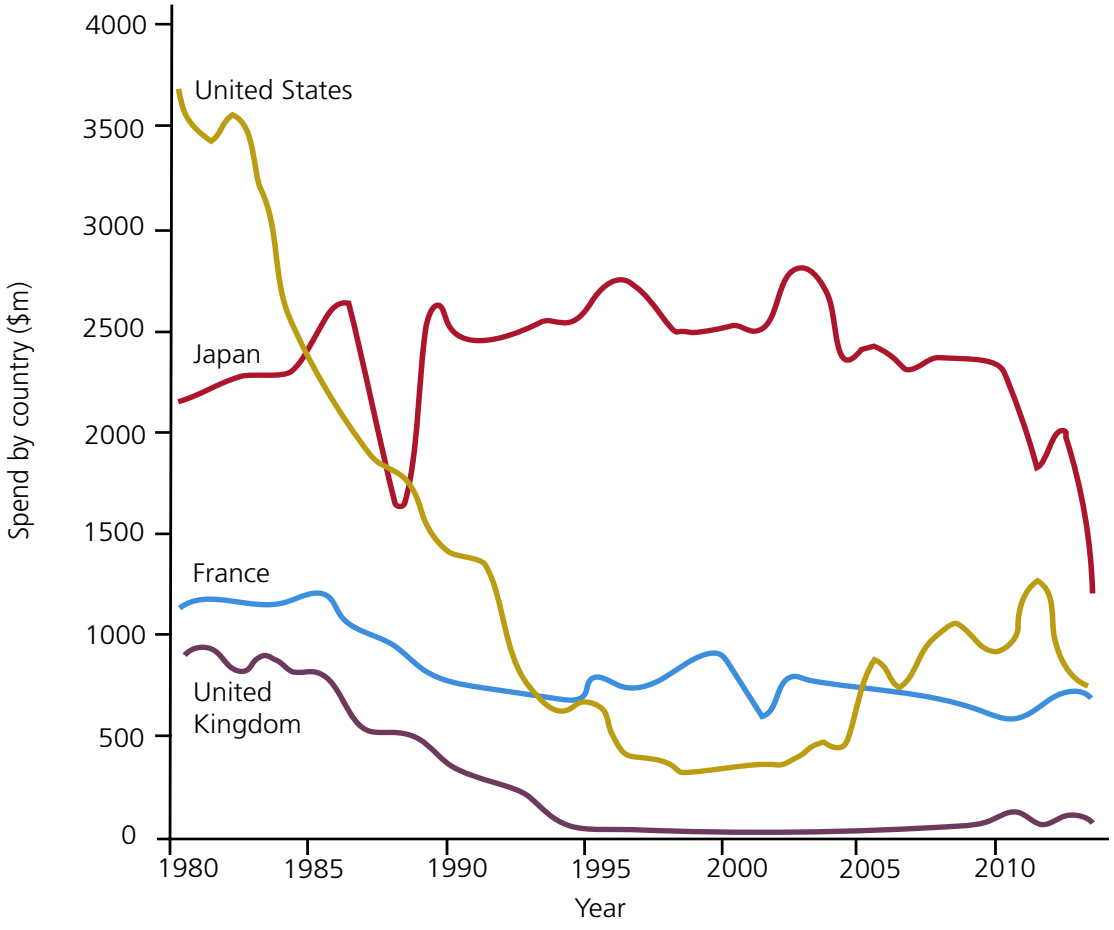
30 Q 20 (Xavier Mamo)
31 *Ibid.*
32 *Ibid.*
33 Q 54 (Dame Sue Ion)

Figure 2: Public funding on nuclear R&D in the UK broken down by source



Source: NIRAB, The UK civil nuclear R&D landscape survey (February 2017): http://www.nirab.org.uk/media/10671/nirab-123-4.pdf [accessed 24 April 2017]

Figure 3: Public funding of nuclear R&D by Country 1980–2013



Source: NIRAB, The UK civil nuclear R&D landscape survey (February 2017): http://www.nirab.org.uk/media/10671/nirab-123-4.pdf [accessed 24 April 2017]

34. In the spending review and autumn statement 2015 the then Chancellor of the Exchequer, The Rt Hon George Osborne MP, announced £250m of funding for nuclear research and development over the next five years. In the announcement Mr Osborne said the investment would "revive the UK's nuclear expertise and position the UK as a global leader in innovative nuclear technologies".[34]

35. However, only £20m of the £250m promised has been released so far.[35] Dame Sue Ion explained to the Committee: "It is a good start, but, three years down the road, we need to see the commitments fulfilled".[36]

36. Dame Sue Ion also highlighted that it is important that funding for nuclear is maintained and does not have to compete with other technologies as part of the Government's energy innovations spending. She said that the Energy Innovation Board, which co-ordinates public funders of energy research, "would not do justice to the nuclear part of it because it would not have sufficient time to give it the scrutiny that is necessary" because it has such a broad remit.[37]

37. **Despite the additional £250m over five years promised by the Government in 2015 the amount of UK funding for nuclear research, development and innovation is much lower than public funding levels in other leading nuclear nations, including the US, France and Japan.** ***If the Government's aim is for the UK to be active across the main areas of nuclear R&D and not simply to restrict its interest to being an operator of equipment supplied by others it needs to make significant investments, particularly in those areas (such as Generation IV technologies) that both NIRAB, in its final report, and this Committee, in 2011, have recommended.***

34 HM Treasury, *Spending review and autumn statement 2015* (27 November 2015): https://www.gov.uk/government/publications/spending-review-and-autumn-statement-2015-documents/spending-review-and-autumn-statement-2015 [accessed 20 March 2017]

35 Department for Business, Energy and Industrial Strategy (BEIS), *Funding for Nuclear Innovation* (3 November 2016): https://www.gov.uk/guidance/funding-for-nuclear-innovation [accessed 21 March 2017]

36 Q 53 (Dame Sue Ion)

37 Q 52 (Dame Sue Ion)

CHAPTER 3: UK CIVIL NUCLEAR STRATEGY

38. In the preceding chapter we argued that a certain level of R&D was essential for any country with nuclear assets and liabilities. The actual level of that R&D must depend on national nuclear aspirations. Nuclear energy must be viewed as part of the wider UK energy landscape. In written evidence to the House of Lords Economic Affairs Select Committee BEIS said that the Government's "overarching economic challenge for energy policy" was to ensure that the country's energy is:

    - reliable;
    - affordable; and
    - clean.[38]

39. The Economic Affairs Committee pointed out that, "it is clear though that these objectives can conflict and trade-offs are required when developing energy policies."[39]

40. UK energy demand will require significant new build of power stations in the coming years if only to replace closing nuclear and coal plants. It is current Government policy that a proportion of these power stations will be nuclear.

41. Once they are in operation nuclear power stations have minimal carbon emissions and public concern over safety following the 1986 Chernobyl accident appears to have declined.

42. Figure 4, using data from polls published by the Nuclear Industry Association (NIA), shows that more people in the UK support replacement ('new') nuclear build than oppose it. Support for replacement nuclear has remained fairly steady since the late 2000s, barring a short-lived drop in support after the Fukushima accident in March 2011. Furthermore in a December 2015 poll 70% of people believed that nuclear was a necessary part of the energy mix.[40]

43. Nuclear power is ideal for continuous baseload low-carbon electricity generation. Political and public opposition, which contributed to a long hiatus in the building of nuclear power stations in the UK and elsewhere has somewhat abated, but the nuclear sector is still struggling to gain traction in the UK. This is now largely for economic rather than political reasons—nuclear power has low operating costs and low emissions but high upfront costs. The costs of nuclear power, driven largely by increasing regulation to improve safety, have been increasing at a time when price of gas has been falling, rather than rising as predicted, while subsidies for renewable generation have created new competition and undermined the economics of base-load generation. These factors have made new (and even existing) nuclear generation uncompetitive in many parts of the world, without substantial state support or guaranteed prices. Nonetheless, nuclear appears

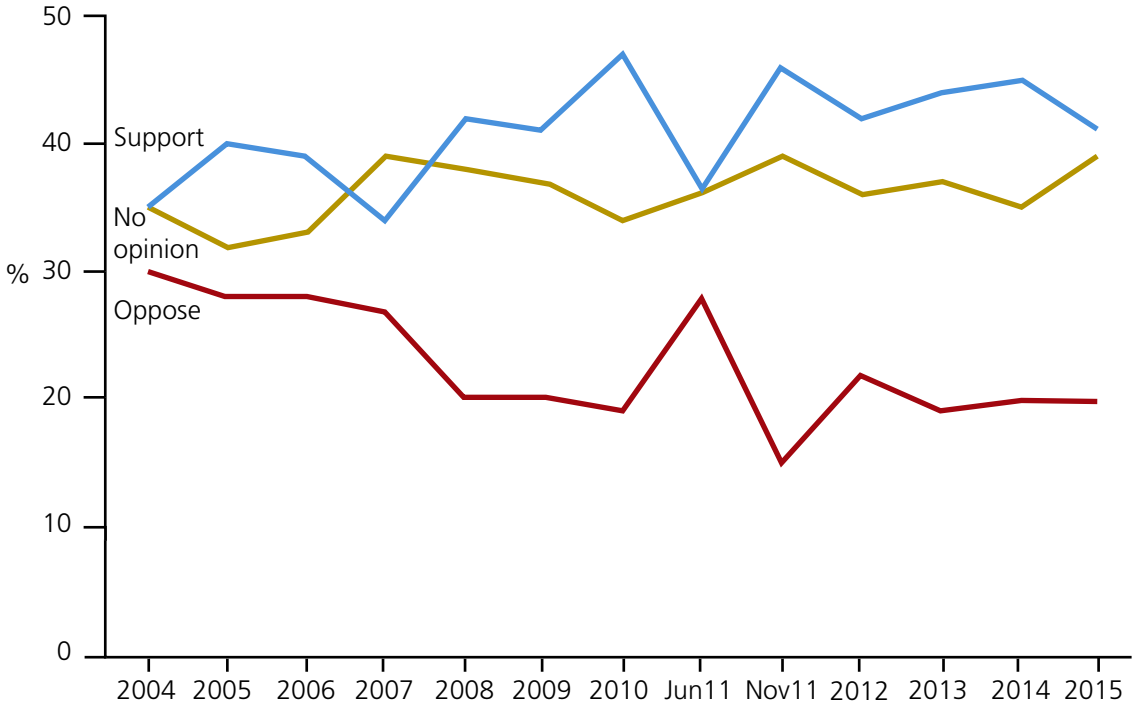
38 Written evidence to the Select Committee on Economic Affairs from the Department for Business, Energy and Industrial Strategy, 14 February 2017, (Session 2016–17) (UEM0083)

39 Economic Affairs Committee, *The Price of Power: Reforming the Electricity Market* (2nd Report, Session 2016–17, HL Paper 113), para 9

40 FORATOM, 'What people really think about nuclear energy?' (12 January 2017): https://www.foratom.org/downloads/people-really-think-nuclear-energy/ [accessed 30 March 2017]

as an important element in virtually all UK energy scenarios in the longer term.[41]

Figure 4: Public support for new nuclear in the UK



Source: FORATOM, 'What people really think about nuclear energy?' (12 January 2017): https://www.foratom.org/downloads/people-really-think-nuclear-energy/ [accessed 30 March 2017]

44. **The development of nuclear energy within the UK cannot be seen in isolation or as an end in itself. It must be seen as part of a wider energy policy which seeks to balance the competing demands of affordability, security of supply, decarbonisation and interoperability with other elements in the electricity generation mix.**

Future civil nuclear strategy

45. The Government told us that our 2011 report, *Nuclear Research and Development Capabilities*[42] "remained a key consideration in the development of the current nuclear innovation programme and its supporting actions".[43]

46. Following the Committee's report, an *ad hoc* advisory board was formed under the guidance of Sir John Beddington, the then Government Chief Scientific Adviser, to consider the report's recommendations and propose suitable actions to address them. The work of this *ad hoc* board led to the development of the 2013 Nuclear Industrial Strategy[44] and supporting

41 Committee on Climate Change, *Power sector scenarios for the fifth carbon budget* (October 2015): https://www.theccc.org.uk/wp-content/uploads/2015/10/Power-sector-scenarios-for-the-fifth-carbon-budget.pdf [accessed 24 April 2017]

42 Science and Technology Committee, *Nuclear Research and Development Capabilities* (3rd Report, Session 2010–12, HL Paper 221)

43 Written evidence from HM Government (PNT0029)

44 HM Government, *The UK's Nuclear Future* (2013): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/168048/bis-13-627-nuclear-industrial-strategy-the-uks-nuclear-future.pdf [accessed 23 March 2017]

documents including a Nuclear R&D Roadmap.[45] The strategy set out the Government's expectation that nuclear will play a significant role in the UK energy mix in the future. The strategy sets out indicative milestones and actions for the Government and industry for the UK's nuclear future. The strategy covers these main areas:

- Recognising the challenges and capturing opportunities in the home market;
- Enhancing the UK's innovation and R&D landscape;
- Government engagement to attract domestic and inward investment in nuclear projects and assistance to help firms penetrate overseas markets; and
- Ensuring the UK has the necessary skills for the future.[46]

47. Mr Norman told us that the 2013 strategy "provides a basis" for the Government's current thinking on civil nuclear policy.[47] Furthermore The Rt Hon The Lord Hutton of Furness, Chairman of the NIA, told the Committee that the NIA "have been assured … that the 2013 nuclear industry strategy remains the goal for which we are all striving".[48]

48. Dame Sue Ion told us, however, that the problem with the 2013 strategy is that it is aspirational and does not "set out how or how much it would cost to deliver all the elements that were identified."[49]

49. In spite of the Government's statement that the 2013 strategy is still in place and Lord Hutton saying that the NIC is still working to this strategy, it was not mentioned in evidence from other witnesses. In fact some witnesses told us that the UK does not have a nuclear strategy. Dr Michael Bluck, Director of the Centre for Nuclear Engineering at Imperial College London, told the Committee that the UK is missing a strategy[50] and Professor Paul Howarth, Chief Executive of the NNL, said that the UK has "lacked a clear vision and strategy as far as the nuclear industry is concerned". Prof Howarth concluded: "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".[51]

50. The evidence we received overwhelmingly stated that responsibility for overarching civil nuclear strategy lies with BEIS.[52] Some witnesses suggested that the NIC (see paragraph 64) could take the lead on actions needed for the implementation of any strategy and that bodies such as the NNL and NIRAB can provide independent, expert advice to Government as necessary.[53]

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45 HM Government, *Nuclear Energy Research and Development Roadmap: Future Pathways* (2013): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/168043/bis-13-632-nuclear-energy-research-and-development-roadmap-future-pathway.pdf [accessed 21 March 2017]

46 HM Government, *The UK's Nuclear Future* (2013), p 9: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/168048/bis-13-627-nuclear-industrial-strategy-the-uks-nuclear-future.pdf [accessed 23 March 2017]

47 Q 32 (Jesse Norman MP)

48 Q 51 (Lord Hutton of Furness)

49 Q 50 (Dame Sue Ion)

50 Q 2 (Dr Michael Bluck)

51 Q 39 (Prof Paul Howarth)

52 See for example Q 2, Q 20 and written evidence from AMEC Foster Wheeler (PNT0044), Dalton Nuclear Institute (PNT0018), EDF Energy (PNT0039), Gwynedd Council (PNT0011), Moltex Energy (PNT0037) and Westinghouse UK (PNT0027)

53 Written evidence from Dalton Nuclear Institute (PNT0018), Prof Neil Hyatt (PNT0028), Dame Sue Ion (PNT0031), National Nuclear Laboratory (PNT0046) and Rolls-Royce (PNT0006)

51. **Civil nuclear is a long term industry where changes in direction in successive Governments' policies and periods of lack of clarity have had a detrimental effect on the development of the industry, particularly in respect of civil nuclear generation over the last 20 years. The Government has highlighted the importance of the nuclear sector in its industrial strategy green paper and must develop a clear, long term vision and set of goals for civil nuclear strategy.**

52. ***In light of the strongly critical evidence we have received the Government needs to review and refresh the 2013 strategy for nuclear energy, in conjunction with the NIC and take swift and concrete steps towards its further implementation. Furthermore this strategy must be widely publicised and provide both a clear vision and consistency for the long term in conjunction with other existing or planned energy technologies.***

Strategic policy decisions

53. A refreshed civil nuclear strategy is a prerequisite of addressing specific and imminent policy decisions in the sector. One such crucial set of decisions relates to SMRs. Other strategic decisions that the Government needs to make in the short to medium term include the way forward for geological disposal and solving the issue of radioactive waste management.[54]

54. In particular, Professor Mike Tynan, Chief Executive of the Nuclear Advanced Manufacturing Research Centre (AMRC), told us that the Government needs to decide whether it wants only to be an adopter and operator of nuclear technologies or whether it wants to move back into technology ownership in nuclear as well. The latter approach would enable the UK to export that technology around the world.[55] Mr Norman, however, rejected the premise of this choice, saying that he did not see a tension between the two and that much of the value in nuclear technology lies in the ancillary services around it.[56]

55. Lord Hutton phrased the question in the following way:

> "We all have to ask ourselves the question of what sort of nuclear nation we want to be. Do we want to be a top-table nuclear nation, which is the role we have always occupied and done so brilliantly in the last 60 years, or are we going to settle for some other role which might not be the full-spectrum range of capabilities that we have got used to?"[57]

56. There is wide international recognition that the future of nuclear energy from fission is likely to depend on small modular reactors. At present there are numerous designs, some of UK origin. None is yet, however, in production. This presents the UK with an opportunity to return to the business of design and manufacture of nuclear plants.

54 Q 19 (Dr Rebecca Weston)
55 Q 7 (Prof Mike Tynan)
56 Q 32 (Jesse Norman MP)
57 Q 50 (Lord Hutton of Furness)

57. ***The Government must decide whether it wishes the UK to be a serious player in developing nuclear generation technology as a designer, manufacturer and operator or alternatively to restrict its interest to being an operator of equipment supplied by others from overseas. While this is not necessarily a binary choice, and a mixture of the two may be possible, being a technology manufacturer would require a step change in the level of Government funding and a long term commitment by the Government to providing underpinning strategic support. We urge the Government to take a clear and firm view. Not making a timely decision could have serious consequences: if the Government fails to act in a timely fashion it could end up wasting money by doing too little, too late or worse too much, too late. The Government must break the cycle of indecision.***

58. ***Once the Government has made this overarching decision, other strategic decisions will flow from this to define a clear set of objectives and timescales with which the nuclear industry can align itself. If the Government were to decide that the UK should be a serious player in nuclear fission, the following would be the minimum steps needed to achieve this:***

- ***Development of a domestic research programme that is of sufficient scope and scale to make the UK an attractive partner for developing new technology to support new nuclear build (including Small Modular Reactors) in the UK and abroad.***
- ***Participation in and contribution to international programmes (for example the Generation IV International Forum).***

International Co-operation and Generation IV

59. International collaboration offers considerable scope for reducing research costs. The UK benefits from this in development of fusion technologies through UKAEA and its partners in the Joint European Torus (JET). A similar opportunity exists in connection with the group of so-called Generation IV technologies which are expected to lead to the next generation of commercial fission reactors—safer and more efficient than those of today (See Box 2).

Box 2: Generation IV Reactor Concepts

Generation IV reactor technology is considered to represent the next generation of fission technologies improving on existing light water reactor (LWR) concepts by offering improved efficiency, safety, cost and environmental cleanliness, while also providing greater resistance to diversion of materials for weapons proliferation and greater security against terrorist attacks.

The World Nuclear Association currently lists 6 Generation IV reactor designs which are the subject of further development by an international consortium of countries. Projected R&D expenditure is about $6 billion over 15 years, targeting prototype deployment between 2020 and 2030. About 80% of the cost is being met by the USA, Japan and France. Designs include:

- Gas Cooled Fast Reactors
- Very High Temperature Gas Reactors
- Lead Cooled Fast Reactors
- Molten Salt Reactors
- Sodium Cooled Fast Reactors
- Supercritical Water Cooled Reactors

Source: World Nuclear Association, 'Generation IV nuclear reactors' (April 2017): http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/generation-iv-nuclear-reactors.aspx [accessed 24 April 2017]

60. In our 2011 report we highlighted the importance of membership of the Generation IV International Forum (GIF) to the development of these new technologies because of the scale of funding and effort required. The UK stopped being an active member of GIF in 2006 for financial reasons and although the Committee recommended the UK should re-join the forum, this has not happened.[58] The UK retains an observer membership of GIF.

61. A number of witnesses told us that it is essential that the UK joins international collaborations such as GIF. GE Hitachi Nuclear Energy told us that it would help reduce the financial risk to the UK compared with acting alone.[59] The Nuclear AMRC said the UK should be involved in Generation IV "if we want to remain a leading nuclear nation and be at the forefront of innovative technologies, manufacturing processes and materials".[60] Furthermore, in its final report NIRAB recommended that the Government develop a plan to resume active membership of GIF.[61]

58 Science and Technology Committee, *Nuclear Research and Development Capabilities* (3rd Report, Session 2010–12, HL Paper 221), para 275
59 Written evidence from GE Hitachi Nuclear Energy (PNT0030)
60 Written evidence from the Nuclear AMRC (PNT0026)
61 NIRAB, *NIRAB Final Report 2014 to 2016* (February 2017), recommendation 7, http://www.nirab.org.uk/media/10139/nirab-117-3-nirab-final-report_web.pdf [accessed 16 March 2017]

62. Jesse Norman MP, Parliamentary Under Secretary of State at BEIS, Minister for Industry and Energy, set out to the Committee the steps required for the UK to re-join the GIF:

- "Acceptance and ratification of the Framework Agreement.
- Acceptance of the system arrangements for each of the technologies we are interested in.
- Payment of annual fees, the level of which is dependent upon the number of technologies we wish to pursue an interest in.
- Active, ongoing participation in collaborative projects relevant to the work of the Forum."[62]

63. ***We re-state our 2011 recommendation that the UK should re-join the Generation IV International Forum (GIF). In 2011 the Government told us that the UK's membership of Euratom was sufficient to be involved in the development of advanced reactor designs. But, as we discuss in Chapter 6, the UK is leaving Euratom and this adds to the importance of the UK re-joining GIF. The UK cannot maintain a world leading position for fission or fusion technologies by acting in isolation.***

The Nuclear Industry Council and a Nuclear Sector Deal

64. The NIC is a partnership forum between Government and industry whose role is to provide high-level strategic direction to the UK's nuclear industry. It was originally set up in 2013 but until February 2017 it had not met since July 2014.[63] Mr Norman told us that it had recently been re-constituted with a smaller membership than previously. The first meeting of the newly reconstituted NIC[64] took place on 22 February 2017 and was co-chaired by Mr Norman and Lord Hutton.[65]

65. The NIA told us that the NIC was set up "to facilitate cooperation between the nuclear industry and Government, with an overarching role to 'tackle long term challenges facing the industry and to help realise future opportunities through strategic decision making'". It includes representatives from across the nuclear industry.

66. In its Industrial Strategy Green Paper the Government proposed 'sector deals' to support specific industries.[66] The Green Paper sets out early work that is being carried out on a nuclear sector deal. Lord Hutton told us that the main focus of the NIC in the short term will be on fleshing out plans for this sector deal:

62 Supplementary written evidence from HM Government (PNT0060)
63 HM Government, 'Nuclear Industry Council': https://www.gov.uk/government/groups/nuclear-industry-council [accessed 20 March 2017]
64 The membership and terms of reference of the NIC are available on the Government website: https://www.gov.uk/government/groups/nuclear-industry-council [accessed 29 March 2017]
65 Q 33 (Jesse Norman MP)
66 BEIS, *Building our Industrial Strategy* (January 2017): https://beisgovuk.citizenspace.com/strategy/industrial-strategy/supporting_documents/buildingourindustrialstrategygreenpaper.pdf [accessed 20 March 2017]

> "[The NIC] had a pretty extensive discussion about what, for industry, we would like to see from the sector deal … [t]he Government have made it clear to us that there is no template … we will look at issues to do largely with skills and competitiveness in the first instalment of the nuclear sector deal because we recognise that these are massive challenges."[67]

Lord Hutton went on to say that it is too early to say exactly what a deal will look like but he expects to have something agreed by summer 2017.[68]

67. **Both the Government and the nuclear industry have high hopes for the newly re-constituted NIC. However, the Committee is disappointed by the baffling hiatus between meetings of the NIC from 2014 to 2017. It must not be allowed to stall as it did in its previous incarnation. The Government now needs to square up to the outstanding decisions relating to nuclear, taking advice from the NIC.**

68. ***We recommend that the membership of the NIC should be representative of the UK nuclear industry and its aspirations for domestic and international development. The NIC should comprise both national and international experts, heads of the major UK organisations and also representation from the supply chain, especially where experience in innovation and international reach is evident.***

69. **Sector deals in sectors such as aerospace and automotive have proved effective but these industries are significantly larger than the civil nuclear industry. Nevertheless, whilst acknowledging the limitations of the nuclear sector due to its size, we believe it is desirable and sensible to proceed with a sector deal as a national priority. The proposed sector deal on skills and competitiveness for civil nuclear needs to be based on a clear, long term and sustained Government vision for the direction of the sector so that it is known what skills will be needed.**

67 Q 51 (Lord Hutton of Furness)
68 *Ibid.*

CHAPTER 4: SMALL MODULAR REACTORS

Small Modular Reactors

70. SMRs represent a new approach for civil nuclear power generation. They are smaller than conventional nuclear reactors, with power outputs of around 300MW or less.[69] The modularity of SMRs means that much of the plant can be fabricated in a factory environment and transported to site, unlike existing nuclear power plants where there is more on-site fabrication. It is believed that prefabrication of components can reduce costs, improve quality control and speed construction. Globally there are some 45 designs at various stages of development, though none as yet are ready for deployment.[70] A number of SMRs can be linked to give a particular output for a power station. The UK has experience, through Rolls-Royce, in building reactors within the SMR size range for submarine propulsion. There are, however, important structural and operational differences between these and those reactors used for generating electricity.

71. At the request of the Government the NNL, with industry partners, carried out a feasibility study of SMRs, published in December 2014.[71] The study concluded that the size of the potential global SMR market is approximately 65–85GW of base load electricity by 2035, valued at £250–£400bn. It also concluded that there could be a UK market for 7GW of power from SMRs by 2035 and that it would be desirable for the UK to partner with another country to help access the international market. Rolls-Royce told us that 7GW of power would "be of sufficient scale to provide a commercial return on investment from a UK-developed SMR, but it would not be sufficient to create a long-term, sustainable business for UK plc." Therefore, any SMR manufacturer would have to look to export markets to make a return on their investment. This point was also made to us by the NNL.[72] Furthermore, David Orr, Senior Vice-President, Future Programmes and Technology at Rolls-Royce Nuclear, commented that there is not a large enough market in the UK for more than one design to be commercially viable.[73]

72. Prof Tynan outlined some of the criteria that any SMR design would have to meet to be suitable for deployment in the UK:

> "First, the SMR has to be economically viable and bring indigenous value to the UK. To put that into context, it would have to mean value derived from significantly cheaper energy prices … It would have to create long-term, sustainable, high-value jobs. It would have to stimulate the UK supply chain, particularly for advanced manufacturing. It would have to provide intellectual property ownership for the UK. That would have to translate into value by export sales."[74]

73. A study by the Energy Technology Institute suggested that it would take around 10 years to complete the design, safety analysis, manufacturing development and construction of the first UK demonstrator SMR. Once a demonstrator SMR has been built and operated successfully, series

69 In oral evidence Rolls-Royce suggested that SMRs could be as large as 500MW; Q 12 (David Orr)
70 House of Commons Library, New nuclear power, Briefing Paper, CBP-7705, 15 September 2016
71 NNL, *Small Modular Reactors (SMR) Feasibility Study* (December 2014): http://www.nnl.co.uk/media/1627/smr-feasibility-study-december-2014.pdf [accessed 16 March 2017]
72 Written evidence from the NNL (PNT0046)
73 Q 12 (David Orr)
74 Q 5 (Prof Mike Tynan)

production of SMRs could then proceed.[75] Similarly Tom Mundy, Executive Vice-President Program Development, Managing Director UK & Europe at NuScale Power, told us that if NuScale's SMR design entered the Generic Design Assessment (GDA)[76] process in 2017 then it could be deployed by 2027 in the UK.[77] Mr Orr told us that Rolls-Royce would be looking at 2028–30 to deploy an SMR in the UK.[78]

74. The Cambridge Nuclear Energy Centre explained that SMR reactor technologies can be divided into two groups:

- Light-water technology that is used in existing reactors (albeit R&D is needed on the issues of modularisation and cost); and
- Generation IV technologies (see Box 2) that are experimental and have yet to be proven and would need significant further R&D before deployment.

They went on to say that only the first group is capable of being deployed in volume from about 2030.[79]

Potential benefits

75. The NIA told us that there is major potential in the UK for SMRs as a complementary technology to the current new nuclear build programme.[80] However, Westinghouse UK told us that "the potential benefits … will be heavily dependent on the specific reactor design in question."[81] That is to say whether the reactor design chosen is a Generation IV or light water based SMR as outlined in paragraph 74. According to the NIA, SMRs could contribute to the UK's energy security and climate change objectives while having the potential to mitigate some of the challenges associated with new large-scale nuclear power plants, such as financing, infrastructure and siting.[82]

76. Penultimate Power UK, a business developing an SMR design, outlined some of the further potential benefits of SMRs:

> "[L]ower capital costs, quick to build so faster return on investment, offsite modular construction mitigating onsite risks, new passive safety features and, depending on design, new applications for a low carbon economy such [as] electric heat and transport."[83]

77. Rolls-Royce explained that, given the absence of any established global SMR supplier, there could be substantial benefits of being the first to market. They went on to say:

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75 ETI, *Preparing for deployment of a UK small modular reactor by 2030* (September 2016): https://d2umxnkyjne36n.cloudfront.net/insightReports/Preparing-for-deployment-of-a-UK-SMR-by-2030-UPDATED.pdf?mtime=20161011145322 [accessed 20 March 2017]

76 Generic design assessment (GDA) is the process used by the nuclear regulators (ONR and the Environment Agency) to assess the new nuclear power station designs. It allows the regulators to assess the safety, security and environmental implications of new reactor designs, separately from applications to build them at specific sites.

77 Q 13 (Tom Mundy)

78 Q 13 (David Orr)

79 Written evidence from the Cambridge Nuclear Energy Centre, University of Cambridge (PNT0056)

80 Written evidence from the NIA (PNT0041)

81 Written evidence from Westinghouse UK (PNT0027)

82 Written evidence from the NIA (PNT0041)

83 Written evidence from Penultimate Power UK (PNT0013)

> "A UK SMR programme will create many highly skilled jobs in both the near and longer term and also re-establish the UK as a leading global nuclear nation. Rolls-Royce estimates that a regular production schedule of one SMR per annum would generate >10,000 jobs within the supply chain, which could increase to c.40,000 jobs on the basis of two UK plants per annum and secured export opportunities of c.9GW."[84]

78. In addition to generating low carbon electricity for distribution across a national grid, SMRs are proposed for a range of alternative or additional uses depending on the reactor design, including the generation of process heat for industrial or district heating applications, water desalination in arid regions and the production of valuable additives such as hydrogen, isotopes and certain chemicals.[85]

79. SMRs could be placed on existing nuclear sites, which are already licensed and have the necessary grid infrastructure. In particular the sites of Magnox power stations, which are in the process of being decommissioned, may be suitable for SMRs.[86] Furthermore, the local workforces at these sites have the necessary nuclear skills. North Wales Economic Ambition Board told us that the Trawsfynydd Magnox site in North Wales is ideally suited for an SMR because "it is [in] public ownership, it has the right infrastructure (cooling capacity; grid connectivity; road connections; routes to transport large loads to site), local support, support at a North Wales and Wales level [and] proximity to centres of excellence for manufacturing."[87]

Potential challenges

80. There are a number of potential challenges to be overcome before the deployment of SMRs. The NIA told us that development of an SMR would require significant Government support in terms of "an appropriate regulatory framework, including a GDA slot for licensing the design, and other … issues [such] as siting (including pubic acceptance) … and funded decommissioning arrangements."[88]

81. The NNL told us that novel fuel designs or fuel cycles will increase the time and cost of licensing and commissioning an SMR. NNL also said that, while SMRs offer a range of potential benefits, "the economic case for [SMRs] is yet to be fully demonstrated."[89]

82. Dame Sue Ion explained that "SMRs by definition will require multiple units across multiple [sites]" and therefore additional nuclear licensed sites may be needed, depending on the extent of deployment. She went on to say that:

> "[S]mall nuclear should be considered as complementary to large nuclear reactors and not simply as an alternative, given the ability of larger stations to provide the bulk of baseload requirements."[90]

83. Nuclear proliferation is defined as the spread of nuclear weapons, special fissionable material and weapons applicable nuclear technology to non-nuclear weapons states (as defined by the Treaty on the Non-Proliferation of

84 Written evidence from Rolls-Royce (PNT0006)
85 Written evidence from University of Leicester (PNT0022), Terrestrial Energy Inc. (PNT0057) and Rory Trappe (PNT0008)
86 Q 16 (David Orr)
87 Written evidence from North Wales Economic Ambition Board (PNT0059)
88 Written evidence from NIA (PNT0041)
89 Written evidence from the NNL (PNT0046)
90 Written evidence from Dame Sue Ion (PNT0031)

Nuclear Weapons (NPT))[91] or non-state actors (as covered by United Nations Security Council Resolution 1540)[92]. Under the NPT nation states have a legal responsibility to safeguard nuclear weapons, material and technology. The International Atomic Energy Agency (IAEA) has responsibility for providing a safeguards verification system for monitoring and verifying the non-proliferation obligations of member states.[93] Within Europe Euratom (see Chapter 6) also provides additional safeguards verification.

84. SMRs have the potential to increase or decrease the proliferation risk depending upon the type of SMR produced. Dame Sue Ion told us that proliferation risks "are likely to arise due to an increased number of reactor units".[94] SMR designs that intend to use relatively high enrichment fuels, will also present more of a proliferation risk. It is also possible that more countries of concern could obtain SMRs because of the lower cost of procuring them and the lower technical skills entry point required. However, there are potential opportunities to reduce the proliferation risk with SMRs such as alternative fuel designs to reduce material attractiveness or the fuel cycle being operated outside of the country of operation, including the storage of spent fuel.

Box 3: Summary of potential benefits and disadvantages of SMRs

Potential Benefits

Smaller reactor size meaning both a lower absolute capital cost and a shorter construction period than a large reactor.

The reactor system can be manufactured in a factory setting, rather than in-situ at the construction site.

The smaller size means that SMRs could be constructed on a much wider range of sites than large reactors, giving more flexibility and the option to increase the generating capacity beyond that which could be met by large reactors.

There is potentially a large international export market for SMRs, for early movers.

SMRs could be placed on existing nuclear licensed sites.

Certain SMR designs offer more value than just the production of electricity. Products such as heat, hydrogen, isotopes and high value chemicals are all additional possible outputs.

Potential Challenges

The 'first of a kind' build cost for any commercial SMR would be comparable to that of a conventional large reactor and would therefore need Government support.

Cost savings for manufacture will typically only be realised after 10 or more reactors have been built, which is likely to be bigger that the UK market for SMRs.

SMRs have the potential to both increase and decrease the proliferation risk depending upon the type of SMR produced.

91 Treaty on the Non-Proliferation of Nuclear Weapons (NPT), 1 July 1968: https://www.un.org/disarmament/wmd/nuclear/npt/text [accessed 24 April 2017]

92 United Nations Security Council Resolution 1540 (2004), 28 April 2004: http://www.un.org/ga/search/view_doc.asp?symbol=S/RES/1540%20(2004) [accessed 24 April 2017]

93 IAEA Statute (updated version of 28 December 1989): https://www.iaea.org/sites/default/files/statute.pdf [accessed 30 March 2017]

94 Written evidence from Dame Sue Ion (PNT0031)

Government inaction

85. As part of the £250m announced for nuclear R&D (see paragraph 34) in the spending review and autumn statement 2015, the then Chancellor of the Exchequer announced that part of the funding would be for a competition to "identify the best value Small Modular Reactor design for the UK".[95] The Government launched Phase One of an SMR Competition in March 2016.[96] The Government told us that Phase One provided "interested parties an opportunity to present their views on the benefits and risks of SMR deployment". Furthermore they told us that the criteria set out in Phase One were designed "to encourage a wide variety of entrants to participate, enabling the gathering of evidence from a cross-section of interested parties, including reactor vendors, specialist manufacturers and service providers".[97]

86. The Government has also stated that it intends to develop an SMR Roadmap, which will "summarise the evidence so far, set out the policy framework and assess the potential, for one or more possible pathways for SMRs to help the UK achieve its energy objectives, while delivering economic benefits".[98] The Government has stated that the roadmap will also include details of how it will identify suitable sites or types of sites for SMRs, and work it will undertake with the Office for Nuclear Regulation to ensure that appropriate provision is made within the process for regulatory approval.[99] Alongside Phase One and the SMR roadmap the Government commissioned a Techno-Economic Assessment of SMRs in May 2015. The assessment was carried out by a group of contractors led by Atkins Limited and was completed by August 2016. BEIS is yet to publish the analysis. Phase One of the Competition was expected to be completed in Autumn 2016 with the publication of the roadmap happening at the same time.[100]

87. Mr Orr told us that this has not happened yet and that Rolls-Royce were "seeking clarity" from BEIS as to when it will take place.[101] In its written evidence the Government said it "will provide further information on next steps for the programme in due course."[102] When we asked the Minister, Jesse Norman MP, for more information on the Government's timetable he was unable to provide any further information.[103] In a reply to a written question on 29 March 2017 Lord Prior of Brampton, Parliamentary Under Secretary of State at BEIS, re-stated that the Government would provide information of the next steps of the SMR competition "in due course". Furthermore he said that Phase one "does not involve the down-selection of a reactor design".[104]

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95 HM Treasury, *Spending review and autumn statement 2015* (27 November 2015), section 7.7: https://www.gov.uk/government/publications/spending-review-and-autumn-statement-2015-documents/spending-review-and-autumn-statement-2015 [accessed 20 March 2017]

96 BEIS, *Small Modular Reactors Competition Phase One* (17 March 2016): https://www.gov.uk/government/publications/small-modular-reactors-competition-phase-one [accessed 20 March 2017]

97 Written evidence from HM Government (PNT0029)

98 DECC, *Small Modular Reactors Competition: Phase One Guidance* (17 March 2016), p 5: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/508616/SMR_Competition_Phase_1_Guidance.pdf [accessed 20 March 2017]

99 BEIS, *Small Modular Reactors Competition Phase One* (17 March 2016): https://www.gov.uk/government/publications/small-modular-reactors-competition-phase-one [accessed 20 March 2017]

100 DECC, *Small Modular Reactors Competition: Phase One Guidance* (17 March 2016), p 8: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/508616/SMR_Competition_Phase_1_Guidance.pdf [accessed 20 March 2017]

101 Q 14 (David Orr)

102 Written evidence from HM Government (PNT0029)

103 Q 33 (Jesse Norman MP)

104 HL Deb, 29 March 2017, HL6114

88. The Cambridge Nuclear Energy Centre made it clear in its evidence why SMR development requires Government support:

> "It is clear that no SMRs will be developed in the UK without government involvement and support. No vendors could bear the development cost by themselves. There is no effective market in nuclear power plants—small or large. Government, as in the US, needs to be involved at least in the development of a SMR."[105]

89. NuScale Power echoed this, telling us:

> "[T]here is a key role for Government to be a part of the "first-mover solution" specifically by taking action that will reduce risk associated with SMR development and deployment."[106]

90. Professor Neil Hyatt told us that there is a lack of clarity over the national strategy on SMRs[107] and Dame Sue Ion suggested that companies that have invested significantly in preparing responses to Phase One are likely to lose interest if the Government delays any decisions on SMRs. [108]

91. Penultimate Power UK went further, telling us that ongoing delays by Government and a lack of clarity on how the competition will proceed have paralysed the market and that "without urgent action the window of opportunity for meaningful participation will soon close."[109] Plaid Cymru told us that "the failure of the Government to publish its SMR roadmap … and techno-economic assessment of SMRs is causing concern about its capacity and focus to the development of the industry at this pivotal time."[110]

92. Lord Hutton explained to us that the NIA "are, and remain, disappointed that, having kicked this off and raised expectations so much, we have not had anything back [from the Government] at the points when we were promised".[111] While he accepted that the decision to commit to SMRs is a big call, he said: "that is what Governments are there to do. They are not there to avoid the big decisions, they are there to take the big decisions … if [the Government] are going to maintain the interest of the commercial sector here, they really have to be clear about which direction they want to go in."[112]

93. When we asked the Government about the risk of paralysing work in the SMR industry by further delaying the SMR competition, Craig Lucas, Director of Science and Innovation for Climate and Energy at BEIS, told us that:

> "We are very sensitised to that risk, if you like. I would also say that this is a very complicated area and the range of things that has come forward to us has meant we have had to do a lot of thinking about the evidence presented and what is a viable proposition and what is not. The long-term nature of this decision, to some degree, justifies the level of effort we have been putting into it, I think."[113]

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105 Written evidence from the Cambridge Nuclear Energy Centre, University of Cambridge (PNT0056)
106 Written evidence from NuScale Power (PNT0049)
107 Written evidence from Prof Neil Hyatt, University of Sheffield (PNT0028)
108 Written evidence from Dame Sue Ion (PNT0031)
109 Written evidence from Penultimate Power UK (PNT0013)
110 Written evidence from Plaid Cymru (PNT0042)
111 Q 57 (Lord Hutton of Furness)
112 *Ibid.*
113 Q 33 (Craig Lucas)

94. Mr Norman told us that he did not think the SMR competition should have been named as a competition and that "it was more a … call for ideas across a much wider spectrum".[114]

95. Mr Lucas said that BEIS "have done an extensive piece of evidence work to look at the state of maturity of the different technologies and the likely level of costs they might achieve" and that this showed "that the possible technology outcomes are of a very wide range" and therefore the Government needs to look at "the question of investability … and the question of the amount of value that UK plc could capture".[115] This piece of work is the techno-economic assessment of SMRs commissioned by the Government (see paragraph 86). In response to an oral question in the House of Lords on 24 April 2017 Lord Prior said:

> "[W]e simply do not yet know whether small modular reactors will represent a cheap source of low-carbon energy for the future. We just do not know what the economics are, which is why in due course we will be publishing a technical and economic evaluation, based on assessing the 32 proposals that have been put to us for SMRs. The only truthful answer at the moment is that the jury is still out."[116]

96. In order to make a decision about SMRs the Government needs access to the best possible independent expert advice. We were concerned when Prof Howarth told us that the NNL "stand ready to support government in being able to determine the market assessment and how effectively we move into [the SMR] market",[117] implying that the Government was not already seeking the NNL's advice. ***The Government should seek technical advice from NNL as a matter of routine, as well as other industry experts, when considering technical decisions such as the development of SMRs.***

97. **It is important to recognise that there are several distinct questions that arise from the consideration of SMRs. Perhaps the most important, given that deployment before the late 2020s is unlikely, is what role they could be expected to play alongside the other elements in the UK energy mix at that time. In principle a number of SMRs on a single site could replace a single large reactor. Alternatively SMRs could be more widely distributed with attendant advantages and disadvantages. Both public acceptability and availability of finance, public and private, will be very important. Although a UK role for SMRs would be important, alone it would be unlikely to justify major investment. A joint venture between manufacturers with different and substantial home markets would be welcome.**

98. **We are disappointed that the Government launched a competition for SMRs and has not kept to its stated timetable. This has had a negative effect on the nuclear sector in the UK and if the Government does not act soon the necessary high level of industrial interest will not be maintained. It is particularly alarming that the results of Phase One of the competition, which does not involve the selection of an SMR design, have yet to be announced by the Government.**

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114 Q 33 (Jesse Norman MP)
115 Q 33 (Craig Lucas)
116 HL Deb, 24 April 2017, col 1212
117 Q 46 (Prof Paul Howarth)

99. ***We did not detect any urgency from the Government to make a decision on the SMR competition. Whilst acknowledging the need for due care, the Government must publish its strategy for SMRs without delay if industrial interest is to be maintained and if commercial opportunities are not to be missed. We have reached a critical moment for the future of the United Kingdom as a serious nuclear power strategically positioned to capture coming opportunities.***

100. ***The Government should also publish its techno-economic assessment of SMRs immediately and make clear whether it believes there is a sound economic case for the UK to make a substantial strategic investment.***

CHAPTER 5: NATIONAL NUCLEAR LABORATORY

101. In this Chapter we consider the remit of and funding arrangements for the NNL.

102. The NNL is a Government-owned body, operating as a commercial business providing research, nuclear fission analysis and technology solutions to customers in the UK and overseas. Although it is owned and operated by the Government, it receives no direct Government funding but instead delivers products and services on a commercial basis to customers—most notably Sellafield Ltd (owned by the Government through the NDA), EDF Energy and the Ministry of Defence (the latter delivered via a contract with Rolls-Royce). Its turnover—around £100M per annum—comes entirely from customer funded projects. The NNL re-invests any surplus generated from commercial work into R&D programmes, facilities development, skills and policy advice to the Government. Its written submission to us emphasised that its "input and advice are always based on robust scientific and technical analysis, and are independent of Government policy."[118]

103. The NNL describes its mission as:

> "To be the key UK civil nuclear fission R&D provider by:
>
> - Delivering high value independent, authoritative advice and a quality service to our customers;
> - Creating value for stakeholders by maintaining the commercial basis for our business and sustaining a strong positive cash flow for reinvestment in programmes and capabilities; and
> - Increasing our influence on the UK nuclear research agenda."[119]

Assessment of the work of the NNL

104. We heard considerable praise for the staff and work of the NNL. Prof Tynan had found the NNL to be "supportive, collaborative and professional".[120] The Cambridge Nuclear Energy Centre praised the knowledge and experience of the staff and Prof Hyatt said it was making a positive contribution to the overall UK strategy and research effort.[121] Mr Norman said it was a great success.[122]

105. Whilst the work and staff of the NNL were widely praised, our evidence was overwhelmingly critical of its remit and its current funding and governance model. On the one hand it is a Government-owned laboratory with publicly owned assets; but on the other hand it is also a commercial organisation, competing with many private companies.

118 Written evidence from the NNL (PNT0046)
119 *Ibid.*
120 Q 4 (Prof Mike Tynan)
121 Written evidence from Prof Neil Hyatt (PNT0028)
122 Q 35 (Jesse Norman)

106. This criticism was concisely expressed by Professor Chris Grovenor, Professor of Materials at the University of Oxford:

> "As currently constituted the NNL can operate neither as an independent advisor to the government on nuclear strategy nor as the leader of research to support the UK's future energy policies. This is because the current funding (or more properly lack of funding) model means (a) that it has to generate most of its income from contract research, so it is beholden to those funders and cannot generate a truly independent view, and (b) that a world leading research culture cannot be built when the priority is servicing short term, low level research contracts to earn a living."[123]

107. The tension between the two main arms of its work can, we heard, make it difficult for stakeholders to work with the NNL. The Cambridge Nuclear Energy Centre claimed that the short-term commercial imperatives under which the NNL scientists and engineers worked made it difficult and expensive to work with the NNL and provided compelling, specific examples to illustrate this.[124] NSG Environmental Ltd, a company providing specialist R&D services to the nuclear industry, told us that the NNL has a reputation for being late, expensive and poor quality compared with the competition.[125]

108. Dame Sue Ion claimed that the NNL's present commercial funding and governance model prevented it from fully acting to support future national energy policy.[126] In paragraph 96 we noted that it seemed that the Government had not sought the NNL's advice on moving into the SMR market.

109. The NNL defended its hybrid model (a national lab providing impartial advice to the Government, yet also a commercial provider of services to the nuclear sector). It acknowledged that it had sometimes led to a perception of confusion of mission or of a hampered ability to deliver the remit. But the NNL told us that the model brings considerable benefits including:

- The need to operate and compete commercially leads to discipline and efficiency, and incentivises innovation and good customer service;
- The NNL's ongoing commercial work keeps its experts up to date with industry practice and developments, grounding their advice to government in real-life experience; and
- Cost to the taxpayer is minimised.[127]

Comparison with the national laboratories of other countries

110. We heard that the NNL's funding and governance model compared unfavourably with that of the national nuclear laboratories of other nuclear nations and that this could create difficulties in international work.

111. Professor Grovenor said that the NNL was not funded to undertake the full range of activities one would normally associate with an organisation called the National Nuclear Laboratory.[128]

123 Written evidence from Prof Chris Grovenor, University of Oxford (PNT0034)
124 Written evidence from the Cambridge Nuclear Energy Centre (PNT0056)
125 Written evidence from NSG Environmental Ltd. (PNT0050)
126 Written evidence from Dame Sue Ion (PNT0031)
127 Written evidence from the NNL (PNT0046)
128 Written evidence from Prof Chris Grovenor, University of Oxford (PNT0034)

112. The Centre for Nuclear Engineering at Imperial College London told us that other countries, particularly those with nuclear programmes of their own, "possess national laboratories free from this narrow commercial focus, with a full spread of capabilities necessary for the support of nuclear activities. They are able to deal with the unique challenges of nuclear research (active materials, licensing, security and safeguards, etc) and engage with industry and academia, in particular with regard to facilities access."[129] Moltex Energy, a UK reactor developer, went further and told us the NNL is not remotely comparable in scope, capability or mission to other national nuclear laboratories and that the UK currently lacks any organisation capable of taking on a comparable role to the Canadian and US laboratories.[130]

113. The NNL itself said that its commercial operating model, which recycles earnings into national laboratory activities with no direct Government funding, is unique.[131] Prof Howarth said that whilst the NNL was different from overseas national nuclear laboratories in terms of its operating model, nonetheless it fulfilled many of the same functions as the overseas organisations.

114. Perhaps it is a consequence of its wholly commercial method of operation but it emerged in questioning that the NNL makes little or no use of advisory groups with members from abroad to steer its policy.[132]

Possible improvements to the NNL's model

Merging the NNL and the UKAEA

115. We received several suggestions for improvement to the NNL's funding and governance model. Prof Lee said that he would, "merge [the] NNL with the Culham Centre for Fusion Energy (CCFE) [the UK's national laboratory for fusion research which is owned and operated by the UKAEA] under a UKAEA type umbrella organisation bringing fission and fusion research together. This would align the NNL's industrial context and contacts with CCFE's world leading research and infrastructure (e.g. MAST and JET)."[133]

116. UKAEA were not in favour of such a merger:

> "The two organisations' present missions are substantially separate such that merger would not be beneficial, at least in the short/medium term. UKAEA is … focussed on R&D, while still supporting the industrial supply chain to win and deliver commercial work in fusion. [The] NNL … is far more commercially-oriented, with a much smaller R&D programme. Furthermore, [the] NNL is focussed on fission technologies, largely focussed in near-term operations and decommissioning. UKAEA meanwhile, is focussed on fusion and looking to a future reactor market. … Finally, it would be unwise to seek to implement a change of status at present given the very large perturbations that exiting Euratom will incur for UKAEA (and to a lesser extent [the] NNL)."[134]

129 Written evidence from the Centre for Nuclear Engineering, Imperial College, London (PNT0054)
130 Written evidence from Moltex Energy (PNT0037)
131 Written evidence from the NNL (PNT0046)
132 Q 43 (Prof Paul Howarth)
133 Written evidence from Prof William E Lee (PNT0004)
134 Written evidence from UKAEA (PNT0035)

117. **We do not see any great advantage at present in the merging of the UKAEA and the NNL which are two organisations of a very different character.**

Review of remit of the NNL

118. As explored in earlier paragraphs, there was agreement amongst most of our witnesses that the NNL's remit was having a negative effect on its work and relationships with stakeholders, including Government departments. Several suggested that the remit and model of the NNL should be reviewed.

119. Nuclear AMRC said that the remit could be clarified because its commercial and public functions can sometimes come into conflict and displace each other. Given the impact this could have on the NNL's customers, Nuclear AMRC recommended that this risk should be reviewed and addressed.[135] Prof Hyatt agreed that the possible tension between the two arms of its work warranted a review.[136]

Government provision of core funding to the NNL

120. Some witnesses pointed to the National Physical Laboratory (NPL) model as a possible template for the NNL. The NPL is the national measurement standards laboratory which provides the scientific resources for the National Measurement System (financed by BEIS). The NPL also offers a range of commercial services, applying scientific skills to industrial measurement problems. Like the NNL, it provides a service to the Government alongside its commercial activities. Unlike the NNL, it receives Government funding.[137]

121. Professor Grace Burke, Director of Materials Performance Centre at the University of Manchester, suggested that "in an ideal world it [the NNL] would be solely funded and not have to rely on soliciting commercial contracts."[138] Mr Orr agreed that if the Government wished the NNL to play a role as a formal adviser, it would require funding.[139] Lord Hutton also pointed to the need to resource properly the NNL if the Government wants it to have an advisory role and to be a source of independent advice to government.[140] Dame Sue Ion told us there was a case for provision of core funding to the NNL.[141]

122. We asked the Government whether the NNL should receive core funding. Mr Lucas said the Government was actively considering this issue.

135 Written evidence from Nuclear AMRC (PNT0026)
136 Written evidence from Prof Neil Hyatt (PNT0028)
137 In 2016 BEIS contracted work with NPL to a value of £54 million related to the UK's National Measurement System; maintenance and development of the core capability and activities to deliver impact directly to beneficiaries. Although single tender, the work was contracted and not grant-funded. All other revenue for NPL (£35 million from national and international, public and private sector customers) was competitively bid for and won. In the same year BEIS charged £14 million in rent for the NPL site—hence the net cost of the NPL's work to BEIS was £40 million.
138 Q 4 (Prof Grace Burke)
139 Q 19 (David Orr)
140 Q 55 (Lord Hutton of Furness)
141 Q 55 (Dame Sue Ion)

123. In 2011 we heard evidence from the then Chief Scientific Adviser at DECC, Professor David MacKay. We asked him whether he thought that DECC should be giving funding to NNL, he said that the arguments for doing so were "strong".[142] We concluded that providing NNL with a modest sum of money to fund strategic research of national importance need not, in our view interfere with its ability to generate money through commercial contracts, as other national laboratories do. It would, however, allow it to carry out R&D of national strategic need that is not commercially viable, which at present it is not able to. We stand by this conclusion.

124. ***The NNL is well-placed to be a source of independent advice to the Government and to support and deliver research and development in the UK nuclear sector. To do this properly, it will require dedicated core funding. Whilst acknowledging the current climate of financial stringency, we urge the Government to give early consideration to providing modest funding to the NNL commensurate with that provided to other UK national laboratories and similar bodies.***

142 Science and Technology Committee, *Nuclear Research and Development Capabilities* (3rd Report, Session 2010–12, HL Paper 221), para 247

CHAPTER 6: EURATOM

Exiting Euratom

125. The European Atomic Energy Community (Euratom) is an international organisation founded in 1957 with the purpose of creating a specialist market for nuclear power in Europe, developing nuclear energy and distributing it to its member states while selling the surplus to non-member states. The Euratom Treaty[143] provides the legal framework for civil nuclear power generation and radioactive waste management for members of the Euratom Community, all of whom are EU Member States.[144]

126. Following on from the EU referendum result, on 2 February 2017 the Government published a White Paper, *The United Kingdom's exit from and new partnership with the European Union*.[145] This stated that when the Government triggered Article 50 of the Treaty on European Union, the UK would leave Euratom as well as the EU:

> "Although Euratom was established in a treaty separate to EU agreements and treaties, it uses the same institutions as the EU including the Commission, Council of Ministers and the Court of Justice. The European Union (Amendment) Act 2008 makes clear that, in UK law, references to the EU include Euratom. The Euratom Treaty imports Article 50 into its provisions."[146]

127. The Government stressed repeatedly in the period after the publication of the White Paper that, whilst as a consequence of leaving the EU the UK would leave Euratom, the Government was "committed to maintaining the highest standards of nuclear safety and safeguards" and that its aim was "to maintain our mutually successful civil nuclear co-operation with Euratom."[147]

128. Mr Norman told us that leaving Euratom was "a regrettable necessity from our point of view".[148] Lord Hutton accepted, "the Government's argument that we have no choice in this context, given that we have made a decision to leave [the EU], because these two treaties have become so closely bound up together it would be perverse to leave the European Union but still find ourselves with membership of the Council of Ministers and seats in the European Parliament and all the other things that go with membership of the European Union."[149]

143 Treaty establishing the European Atomic Energy Community, OJ C 327/1 (consolidated version of 26 October 2012)

144 In addition, Switzerland has been an "Associated State" since 2014 and Euratom has cooperation agreements with 8 "third countries": USA, Japan, Canada, Australia, Kazakhstan, Ukraine, Uzbekistan and South Africa.

145 Department for Exiting the European Union, *The United Kingdom's exit from and new partnership with the European Union,* Cm 9417, 2 February 2017: https://www.gov.uk/government/publications/the-united-kingdoms-exit-from-and-new-partnership-with-the-european-union-white-paper [accessed 20 March 2017]

146 *Ibid.*

147 HL Deb, 1 March 2017, col 876

148 Q 37 (Jesse Norman MP)

149 Q 59 (Lord Hutton of Furness)

129. Some legal experts however have questioned whether the UK must leave Euratom as a direct result of leaving the EU. According to the Telegraph, a partner at a law firm which advises EDF Energy said that, "The balance of legal opinion is that it's not legally necessary to exit Euratom in order to leave the EU."[150]

130. On 29 March 2017 the Prime Minister, the Rt Hon Theresa May MP, wrote to the President of the European Council, His Excellency Mr Donald Tusk, to notify the European Council of the UK's intention to withdraw from the EU. In the letter she explained that in accordance with Article 50(2) as applied by Article 106a of the Treaty Establishing the European Atomic Energy Community, she was also notifying the Council of the United Kingdom's intention to withdraw from Euratom.[151]

Benefits of Euratom membership

131. Dame Sue Ion told us that the important elements of the Euratom treaty were the arrangements for the monitoring and the looking after of nuclear materials and the arrangements under the Euratom Supply Agency.[152] She also said that Euratom membership had enabled "us to move the best intellectual talent around Europe very freely and easily, which maintains quality as well as capacity."[153]

132. The NNL told us that one of the main benefits of membership of Euratom was the UK's access to and influence on the EU R&D agenda and priorities.[154]

133. Professor Ian Chapman, Chief Executive of UKAEA, summarised the three main benefits that membership of Euratom brought to his organisation:

- Participation in ITER (an international project to design and build an experimental fusion reactor);
- The UKAEA's operation of JET on behalf of the Euratom community;
- Participation in the EUROfusion (European Consortium for the Development of Fusion Energy) programme, which is a conglomeration of all the European fusion laboratories.[155]

Disadvantages of leaving Euratom

134. A number of our witnesses told us that leaving Euratom could have a negative impact on the UK nuclear industry. Professor Burke said it was "disheartening that the Government are going to withdraw from Euratom, … It will be a negative on our research environment."[156] Prospect, a trade union that represents workers in the nuclear industry, told us that the "decision

150 'Hinkley advisers raise questions over Euratom exit plans as 'legal own goal'', *The Telegraph* (7 March 2017): http://www.telegraph.co.uk/business/2017/03/07/hinkley-advisers-slam-euratom-exit-legal-goal/ [accessed 3 April 2017]

151 Letter from Rt Hon Theresa May MP to European Council President Donald Tusk, 29 March 2017: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/604079/Prime_Ministers_letter_to_European_Council_President_Donald_Tusk.pdf [accessed 25 April 2017]

152 The Euratom Supply Agency was established under the Euratom Treaty to ensure a regular and equitable supply of nuclear fuels to EU users. To perform this task, ESA applies a supply policy based on the principle of equal access of all users to ores and nuclear fuel.

153 Q 59 (Dame Sue Ion)

154 Written evidence from the NNL (PNT0046)

155 Q 49 (Prof Ian Chapman)

156 Q 8 (Prof Grace Burke)

[to leave Euratom] is ill-informed, irresponsible and unnecessary. It will have significant implications for the nuclear industry and the research and technology that supports it."[157] The Dalton Nuclear Institute claimed that by leaving Euratom, "the UK will fundamentally change its relationship with what is probably its main vehicle for participation in global nuclear research and risks irreversible damage to the UK research community."[158]

135. Dr Bluck pointed out that leaving Euratom would have an impact "on the transport of [nuclear waste] materials. …. There will be facilities that we do not have, and that may involve the transportation of materials to and from facilities in Europe".[159]

136. Dr Rebecca Weston, Technical Director at Sellafield Ltd, said that leaving Euratom would have a significant impact on nuclear materials accountancy (the independent verification of special nuclear materials) and nuclear proliferation safeguards. She explained that the requirement for third-party assurance to overseas customers was currently discharged through Euratom. Any replacement system would take time and money to put in place.[160]

137. Dame Sue Ion told the House of Commons Business, Energy and Industrial Strategy Committee that the Euratom treaty made the supply, exchange and transfer of nuclear materials across borders easy and that:

> "The nuclear co-operation agreements that exist are vital to international trade. From a research angle, the radioactive materials that are used in research in medicine etc. are all covered by the EURATOM agreement. Movement of the best intellectual talent within Europe is made easy by the treaty. Access to the very high-cost facilities that are not within the UK but which UK researchers use on a daily basis is also important, as is leverage for funding of what would otherwise be very expensive projects."[161]

Moving forward

138. Mr Norman told us in regard to membership of Euratom that the Government was actively working on alternative arrangements and that "There are clear routes forward, from our point of view, which would allow us to continue to deal in the same way with the issues of safety, safeguarding and trade, *et cetera*, that Euratom preserves. … we are devoting significant resources to maintaining and, potentially, even enhancing some of the benefits that we currently achieve from it."[162]

139. We asked our witnesses how the UK should seek to replace its membership of Euratom. Lord Hutton stressed the importance of avoiding a "cliff edge"—that is, the UK's membership of Euratom coming to an end without a alternative arrangements having been put in place.[163] He explained that this would mean that the UK could not go on trading in nuclear goods and services because it would be outwith the internationally recognised framework of nuclear safeguards.[164]

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157 Written evidence from Prospect (PNT0019)
158 Written evidence from the Dalton Nuclear Institute, University of Manchester (PNT0018)
159 Q 8 (Dr Michael Bluck)
160 Q 10 (Dr Rebecca Weston)
161 Oral evidence taken before the House of Commons Business, Energy and Industrial Strategy Committee, 28 February 2017 (Session 2016–17), Q114 (Dame Sue Ion)
162 Q 37 (Jesse Norman MP)
163 Q 59 (Lord Hutton of Furness)
164 *Ibid.*

140. With regards to research and development, Lord Hutton favoured consideration of associate membership status but pointed out that this would not replicate the full spectrum of benefits that the UK receives from Euratom membership.[165] Prof Chapman, whilst not specifying what he thought the best deal for the UK would be, stressed the importance of finding a way to sustain the benefits of Euratom membership. He said there was a panoply of options from "associate membership to the UK funding all of this independently, still having open doors and collaborating openly".[166] Both Prof Chapman and Lord Hutton emphasised the importance of an early decision on the UK's future relationship with Euratom.[167]

141. Dame Sue Ion said it was important that arrangements were put in place to ensure "that the UK's world-class expertise in fusion is maintained going forward. Our companies have had access to very lucrative contracts coming from the fusion side and we must make sure that our expertise, as a nation, is still able to be deployed in that."[168]

142. Lord Hutton told us that he had written to The Rt Hon Greg Clark MP, Secretary of State for Business, Energy and Industrial Strategy, asking him to set up a task force with industry and government to plan for the UK's withdrawal from Euratom.[169] Similarly Dr Weston and Prof Chapman said that their organisations were keen to work with the Government to understand and develop the UK position.[170]

143. ***We note the Minister's reassurances that the Government is devoting significant resources to maintaining and, potentially, even enhancing some of the benefits that the UK currently achieves from membership of Euratom. We echo Lord Hutton's suggestion that the Government should convene a working group of industry and government representatives to develop a plan to preserve the essential benefits of Euratom.***

144. ***There is a real urgency for Government action on this. The UK's membership of Euratom must not be allowed to expire without a suitable replacement being in place. Such an eventuality would put the UK at risk of losing its lead in fusion research and in effect throw away decades of research. Furthermore it would put the UK at risk of losing access to the markets and skills it needs to construct new nuclear power plants and may leave existing stations unable to acquire fuel.***

165 Q 59 (Lord Hutton of Furness)
166 Q 49 (Prof Ian Chapman)
167 Q 49 (Prof Ian Chapman) and Q 59 (Lord Hutton of Furness)
168 Q 59 (Dame Sue Ion)
169 Q 59 (Lord Hutton of Furness)
170 Q 19 (Dr Rebecca Weston) and Q 49 (Prof Ian Chapman)

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

UK civil nuclear research and development

1. The Committee restates its recommendation from 2011 that a non-departmental public body (NDPB), distinct from the National Nuclear Laboratory (NNL), be set-up with a co-ordinating and supervising role for nuclear R&D in the UK. Such a body could work in close collaboration with the Nuclear Industry Council (NIC). It is important that any new body takes forward the important recommendations from the Nuclear Innovation and Research Advisory Board (NIRAB) as soon as possible. In an industry as long-term as nuclear a new permanent body of this kind will help ensure continuity and consistency for R&D in the UK. It could also help save money by reducing or eliminating duplication of R&D across the different bodies involved. (Paragraph 30)

2. The Government must make clear whether it is still working to its 2013 roadmap and, if so, what body has oversight of it and is responsible for measuring progress against it. An NDPB, as described above, would be ideally placed to measure progress against a roadmap, as recommended by the Committee in its 2011 report. (Paragraph 31)

3. We reiterate the recommendation from our 2011 report that the new NDPB should be given a modest amount of new funding to carry out its activities. It should also have the power to attract money from industry and elsewhere. (Paragraph 32)

4. Despite the additional £250m over five years promised by the Government in 2015 the amount of UK funding for nuclear research, development and innovation is much lower than public funding levels in other leading nuclear nations, including the US, France and Japan. (Paragraph 37)

5. If the Government's aim is for the UK to be active across the main areas of nuclear R&D and not simply to restrict its interest to being an operator of equipment supplied by others it needs to make significant investments, particularly in those areas (such as Generation IV technologies) that both NIRAB, in its final report, and this Committee, in 2011, have recommended. (Paragraph 37)

UK civil nuclear strategy

6. The development of nuclear energy within the UK cannot be seen in isolation or as an end in itself. It must be seen as part of a wider energy policy which seeks to balance the competing demands of affordability, security of supply, decarbonisation and interoperability with other elements in the electricity generation mix. (Paragraph 44)

7. Civil nuclear is a long term industry where changes in direction in successive Governments' policies and periods of lack of clarity have had a detrimental effect on the development of the industry, particularly in respect of civil nuclear generation over the last 20 years. The Government has highlighted the importance of the nuclear sector in its industrial strategy green paper and must develop a clear, long term vision and set of goals for civil nuclear strategy. (Paragraph 51)

8. In light of the strongly critical evidence we have received the Government needs to review and refresh the 2013 strategy for nuclear energy, in conjunction with the NIC and take swift and concrete steps towards its further implementation. Furthermore this strategy must be widely publicised and provide both a clear vision and consistency for the long term in conjunction with other existing or planned energy technologies. (Paragraph 52)

9. The Government must decide whether it wishes the UK to be a serious player in developing nuclear generation technology as a designer, manufacturer and operator or alternatively to restrict its interest to being an operator of equipment supplied by others from overseas. While this is not necessarily a binary choice, and a mixture of the two may be possible, being a technology manufacturer would require a step change in the level of Government funding and a long term commitment by the Government to providing underpinning strategic support. We urge the Government to take a clear and firm view. Not making a timely decision could have serious consequences: if the Government fails to act in a timely fashion it could end up wasting money by doing too little, too late or worse too much, too late. The Government must break the cycle of indecision. (Paragraph 57)

10. Once the Government has made this overarching decision, other strategic decisions will flow from this to define a clear set of objectives and timescales with which the nuclear industry can align itself. If the Government were to decide that the UK should be a serious player in nuclear fission, the following would be the minimum steps needed to achieve this:

    - Development of a domestic research programme that is of sufficient scope and scale to make the UK an attractive partner for developing new technology to support new nuclear build (including Small Modular Reactors) in the UK and abroad.

    - Participation in and contribution to international programmes (for example the Generation IV International Forum). (Paragraph 58)

11. We re-state our 2011 recommendation that the UK should re-join the Generation IV International Forum (GIF). In 2011 the Government told us that the UK's membership of Euratom was sufficient to be involved in the development of advanced reactor designs. But, as we discuss in Chapter 6, the UK is leaving Euratom and this adds to the importance of the UK re-joining GIF. The UK cannot maintain a world leading position for fission or fusion technologies by acting in isolation. (Paragraph 63)

12. Both the Government and the nuclear industry have high hopes for the newly re-constituted NIC. However, the Committee is disappointed by the baffling hiatus between meetings of the NIC from 2014 to 2017. It must not be allowed to stall as it did in its previous incarnation. The Government now needs to square up to the outstanding decisions relating to nuclear, taking advice from the NIC. (Paragraph 67)

13. We recommend that the membership of the NIC should be representative of the UK nuclear industry and its aspirations for domestic and international development. The NIC should comprise both national and international experts, heads of the major UK organisations and also representation from the supply chain, especially where experience in innovation and international reach is evident. (Paragraph 68)

14. Sector deals in sectors such as aerospace and automotive have proved effective but these industries are significantly larger than the civil nuclear industry. Nevertheless, whilst acknowledging the limitations of the nuclear sector due to its size, we believe it is desirable and sensible to proceed with a sector deal as a national priority. The proposed sector deal on skills and competitiveness for civil nuclear needs to be based on a clear, long term and sustained Government vision for the direction of the sector so that it is known what skills will be needed. (Paragraph 69)

Small Modular Reactors

15. The Government should seek technical advice from NNL as a matter of routine, as well as other industry experts, when considering technical decisions such as the development of SMRs. (Paragraph 96)

16. It is important to recognise that there are several distinct questions that arise from the consideration of SMRs. Perhaps the most important, given that deployment before the late 2020s is unlikely, is what role they could be expected to play alongside the other elements in the UK energy mix at that time. In principle a number of SMRs on a single site could replace a single large reactor. Alternatively SMRs could be more widely distributed with attendant advantages and disadvantages. Both public acceptability and availability of finance, public and private, will be very important. Although a UK role for SMRs would be important, alone it would be unlikely to justify major investment. A joint venture between manufacturers with different and substantial home markets would be welcome. (Paragraph 97)

17. We are disappointed that the Government launched a competition for SMRs and has not kept to its stated timetable. This has had a negative effect on the nuclear sector in the UK and if the Government does not act soon the necessary high level of industrial interest will not be maintained. It is particularly alarming that the results of Phase One of the competition, which does not involve the selection of an SMR design, have yet to be announced by the Government. (Paragraph 98)

18. We did not detect any urgency from the Government to make a decision on the SMR competition. Whilst acknowledging the need for due care, the Government must publish its strategy for SMRs without delay if industrial interest is to be maintained and if commercial opportunities are not to be missed. We have reached a critical moment for the future of the United Kingdom as a serious nuclear power strategically positioned to capture coming opportunities. (Paragraph 99)

19. The Government should also publish its techno-economic assessment of SMRs immediately and make clear whether it believes there is a sound economic case for the UK to make a substantial strategic investment. (Paragraph 100)

National Nuclear Laboratory

20. We do not see any great advantage at present in the merging of the UKAEA and the NNL which are two organisations of a very different character. (Paragraph 117)

21. The NNL is well-placed to be a source of independent advice to the Government and to support and deliver research and development in the UK nuclear sector. To do this properly, it will require dedicated core funding. Whilst acknowledging the current climate of financial stringency, we urge the Government to give early consideration to providing modest funding to the NNL commensurate with that provided to other UK national laboratories and similar bodies. (Paragraph 124)

Euratom

22. We note the Minister's reassurances that the Government is devoting significant resources to maintaining and, potentially, even enhancing some of the benefits that the UK currently achieves from membership of Euratom. We echo Lord Hutton's suggestion that the Government should convene a working group of industry and government representatives to develop a plan to preserve the essential benefits of Euratom. (Paragraph 143)

23. There is a real urgency for Government action on this. The UK's membership of Euratom must not be allowed to expire without a suitable replacement being in place. Such an eventuality would put the UK at risk of losing its lead in fusion research and in effect throw away decades of research. Furthermore it would put the UK at risk of losing access to the markets and skills it needs to construct new nuclear power plants and may leave existing stations unable to acquire fuel. (Paragraph 144)

APPENDIX 1: LIST OF MEMBERS AND DECLARATIONS OF INTEREST

Members

Lord Borwick
Lord Broers (co-opted)
Lord Cameron of Dillington
Lord Fox
Lord Hennessy of Nympsfield
Lord Hunt of Chesterton
Lord Mair
Lord Maxton
Baroness Morgan of Huyton
Baroness Neville-Jones
Lord Oxburgh
Viscount Ridley
Earl of Selborne (Chairman)
Lord Vallance of Tummel
Baroness Young of Old Scone

Declarations of interest

Lord Borwick

No relevant interests declared

Lord Broers

Fellow and Past President, Royal Academy of Engineering
Fellow, Royal Society
Foreign Associate, US National Academy Engineering
Foreign Member, Chinese Academy of Engineering

Lord Cameron of Dillington

No relevant interests declared

Lord Fox

No relevant interests declared

Lord Hennessy of Nympsfield

Fellow, British Academy
Attlee Professor of Contemporary British History, Queen Mary, University of London

Lord Hunt of Chesterton

Fellow, Royal Society
Consultant, Tokamak Energy
Emeritus Professor, University College London

Lord Mair

Fellow, Royal Academy of Engineering
Fellow, Royal Society
President-elect, Institution of Civil Engineering
Professor of Civil Engineering, Cambridge University
Engineering Advisor to Laing O'Rourke Group, Civil Engineering contractor for Hinkley Point C

Lord Maxton

No relevant interests declared

Baroness Morgan of Huyton

Vice Chair of Council, King's College, University of London

Baroness Neville-Jones

Member of the Engineering and Physical Sciences Research Council (EPSRC) which funds research nuclear power research

Lord Oxburgh

Chairman of small energy-related companies: Carbon-12, 2oc, Green Energy Option (GEO)

Viscount Ridley

Land leased for coal mining in Northumberland

Member of the Scientific Advisory Council of the Global Warming Policy Foundation

Earl of Selborne

Fellow, Royal Society

Lord Vallance of Tummel

No relevant interests declared

Baroness Young of Old Scone

Chancellor of Cranfield University

Fellow, Royal Society of Edinburgh

A full list of Members' interests can be found in the Register of Lords Interests: http://www.parliament.uk/mps-lords-and-offices/standards-and-interests/register-of-lords-interests/

Specialist Adviser

Professor Tom Scott, Director of the Southwest Nuclear Hub, the Bristol-Oxford Nuclear Research Centre (NRC) and the Interface Analysis Centre (IAC), University of Bristol

Professor of Materials at the University of Bristol and co-director of the South West Nuclear Hub

Academic lead for the Sellafield Centre of Expertise in Uranium and Reactive Metals

Funded on a 5 year Royal Academy of Engineering professorial research programme that is co-funded by the Atomic Weapons Establishment (AWE)

Technical director of a University of Bristol spin-out company, Imitec Ltd., which specialises in developing novel radiation mapping technologies

Sits on the Programme Advisory Committee for the Culham Centre for Fusion Energy

APPENDIX 2: LIST OF WITNESSES

Evidence is published online at www.parliament.uk/nuclear-research-technology and available for inspection at the Parliamentary Archives (020 7219 3074).

Evidence received by the Committee is listed below in chronological order of oral evidence session and in alphabetical order. Those witnesses marked with ** gave both oral evidence and written evidence. Those marked with * gave oral evidence and did not submit any written evidence. All other witnesses submitted written evidence only.

Oral evidence in chronological order

*	Professor Grace Burke, Director of Materials Performance Centre, University of Manchester	QQ 1–8
**	Professor Mike Tynan, Chief Executive, Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC)	
**	Dr Michael Bluck, Director of Centre for Nuclear Engineering, Imperial College London	
**	Dr Rebecca Weston, Technical Director, Sellafield Ltd	QQ 9–19
**	David Orr, Senior Vice President, Future programmes and Technology, Rolls-Royce Nuclear	
**	Tom Mundy, Executive Vice-President Program Development and Managing Director–UK & Europe, NuScale Power	
**	Dr Adrian Simper OBE, Technology and Strategy Director, Nuclear Decommissioning Authority (NDA)	QQ 20–30
**	Dr Richard Savage, Chief Nuclear Inspector, Office for Nuclear Regulation (ONR)	
**	John Donald, Superintending Inspector, Office for Nuclear Regulation (ONR)	
**	Xavier Mamo, Director Research and Development UK Centre, EDF Energy	
**	Jesse Norman MP, Minister for Energy and Industry, Department for Business, Energy and Industrial Strategy (BEIS)	QQ 31–37
**	Professor John Loughhead OBE FREng FTSE, Chief Scientific Adviser, Department for Business, Energy and Industrial Strategy (BEIS)	
**	Craig Lucas, Director of Science and Innovation for Climate and Energy, Department for Business, Energy and Industrial Strategy (BEIS)	
**	Professor Paul Howarth, Chief Executive Officer, National Nuclear Laboratory (NNL)	QQ 38–49
**	Professor Ian Chapman, Chief Executive Officer, UK Atomic Energy Authority (UKAEA)	

**	Dame Sue Ion, Chair, Nuclear Innovation and Research Advisory Board (NIRAB)	QQ 50–59
**	Lord Hutton of Furness, Chair, Nuclear Industry Association (NIA)	

Alphabetical list of all witnesses

	AMEC Foster Wheeler (AMEC FW)	PNT0044
	Atkins	PNT0015
	Atomic Acquisitions (AA)	PNT0040
	Professor Colin Boxall, Lancaster University	PNT0051
	Bristol University/SW Nuclear Hub	PNT0043
*	Professor Grace Burke, Director of Materials Performance Centre, University of Manchester (QQ 1–8)	
	Cambridge Nuclear Energy Centre, University of Cambridge	PNT0056
**	Centre for Nuclear Engineering, Imperial College London (QQ 1–8)	PNT0054
	Dalton Nuclear Institute, University of Manchester	PNT0018
	Simon Dawson	PNT0002
**	Department for Business, Energy and Industrial Strategy (BEIS) (QQ31–37)	PNT0029 PNT0060
**	EDF Energy (QQ 20–30)	PNT0039
	Energy Technologies Institute (ETI)	PNT0012
	GE Hitachi Nuclear Energy	PNT0030
	Gwynedd Council	PNT0011
	Professor Neil Hyatt, University of Sheffield	PNT0028
**	Dame Sue Ion, Chair, Nuclear Innovation and Research Advisory Board (NIRAB) (QQ 50–59)	PNT0031
	Robin Jones, Wylfa Nuclear Power Station	PNT0003
	Professor William Lee, Imperial College London	PNT0004
	Piers Manson, BSc, MBA, MIoP, MSaRS	PNT0023
	Dr Leslie Mitchell FREng	PNT0007
	Moltex Energy	PNT0037
	R Nash, BSc	PNT0023
**	National Nuclear Laboratory (NNL) (QQ 38–49)	PNT0046
	National Skills Academy for Nuclear (NSAN)	PNT0048
	North Wales Economic Ambition Board	PNT0059
	NSG Environmental Ltd	PNT0050

**	Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC) (QQ 1–8)	PNT0026
**	Nuclear Decommissioning Authority (NDA) (QQ 20–30)	PNT0036
**	Nuclear Industry Association (NIA) (QQ 50–59)	PNT0041
	Nuclear Institute (NI)	PNT0033
	Nuclear Skills Strategy Group	PNT0014
**	NuScale Power (QQ 9–19)	PNT0049
**	Office for Nuclear Regulation (ONR) (QQ 20–30)	PNT0024
	Penultimate Power UK	PNT0013
	Plaid Cyrmu	PNT0042
	Prospect	PNT0019
	Chris Rogers	PNT0009
**	Rolls-Royce plc (QQ 9–19)	PNT0006
**	Sellafield Ltd (QQ 9–19)	PNT0052
	Snowdonia Enterprise Zone (SEZ)	PNT0055
	Gary Swift	PNT0001
	Terrestrial Energy Inc.	PNT0057
	Rory Trappe, Trawsfynydd site	PNT0008
	TUV SUD Nuclear Technologies	PNT0021
	U-Battery	PNT0047
**	UK Atomic Energy Authority (UKAEA) (QQ 38–49)	PNT0035
	UK Boiling Water Reactor (BWR) Research Hub and Network	PNT0020
	UK Nuclear Data Network (UKNDN)	PNT0016
	University College London (UCL)	PNT0025
	University of Leicester	PNT0022
	University of Oxford	PNT0034
	Weinberg Next Nuclear	PNT0045
	Westinghouse UK	PNT0027

APPENDIX 3: CALL FOR EVIDENCE

The House of Lords Science and Technology Select Committee, under the Chairmanship of Lord Selborne, is conducting an inquiry into *Priorities for Nuclear Research and Technologies*. The Committee invites interested individuals and organisations to submit evidence to this inquiry. The deadline for written evidence submissions is Friday 24 February 2017.

Background

The Committee published a report Nuclear Research and Development Capabilities on 22 November 2011.[171] Since the publication of that report the Government has accepted and acted on a number of the recommendations of the Committee. The Committee will now revisit some of the conclusions and recommendations of that report to investigate the developments that have taken place and what more needs to be done to ensure the UK can meet its future nuclear energy requirements. The Committee will look specifically at the upcoming decision on a small modular reactor (SMR) design for the UK; and the roles of the National Nuclear Laboratory (NNL) and the Nuclear Innovation and Research Advisory Board (NIRAB).

Scope

Small Modular Reactors

The inquiry will consider the upcoming Department for Business, Energy and Industrial Strategy decision on opportunities for Small Modular Reactor (SMR) development and selection for the UK, the economic case for SMRs and the potential economic benefits to the UK by being an early adopter of this technology.

Small Modular Reactors (SMRs) are a relatively new technology for civil nuclear power generation. They are smaller than conventional nuclear reactors, with power outputs of around 300MWe or less. The modularity of SMRs means that much of the design and plant can be fabricated in a factory environment and transported to site. Globally there are some 45 designs at various stages of development, though none as yet are ready for deployment. They provide an opportunity to implement newer, passively safe designs and they offer financial and deployment-time advantages compared to largescale nuclear—owing to their modular design. There could be considerable export opportunities for SMRs. There are potential barriers to deployment of SMRs in the UK, however, including uncertainties in the economic case—which will be influenced by novelty of the adopted design or designs, regulatory hurdles, public acceptance and the cost of running potentially several nuclear licensed sites.

In March 2016 the Government launched an SMR Competition to identify the best value SMR design for the UK, and a decision on the winner is expected imminently. In parallel with this competition the Government intends to develop an SMR roadmap setting out the policy framework for SMRs to help the UK achieve its energy objectives.[172]

171 Science and Technology Committee, *Nuclear Research and Development Capabilities* (3rd Report, Session 2010–12, HL Paper 221)

172 BEIS, *Small Modular Reactors Competition Phase One* (March 2016): https://www.gov.uk/government/publications/small-modular-reactors-competition-phase-one [accessed 21 April 2017]

Governance and Nuclear Strategy

This inquiry will examine whether the current remit of the National Nuclear Laboratory (NNL) allows it to function with clarity and purpose benefitting the wider civil nuclear sector in the UK. This will include the ability of NNL to operate as a national laboratory through providing advice to Government on nuclear topics, driving innovation to address nuclear industry challenges, maintaining and growing the talent within nuclear research and development R&D, and providing the appropriate facility structure to support nuclear R&D programmes. The inquiry will examine what actions, if any, the Government needs to take in this area.

One of the recommendations of the Committee's 2011 report led to the establishment of the Nuclear Innovation and Research Advisory Board (NIRAB) in 2014 as a temporary advisory board in accordance with Cabinet Office guidance. The role of NIRAB was to advise Ministers, Government Departments and Agencies on issues related to nuclear research and innovation in the UK and to ensure that public R&D programmes were aligned to support industrial and energy policy.[173] Following the completion of its work it has now been disbanded, with its last meeting in December 2016, and no new body has taken its place.

The inquiry will collect evidence on the effectiveness of NIRAB and whether a permanent successor body needs to be established and if so what the role of this body should be and how it should be constituted.

Questions

The Committee invites submissions on the following points, with practical examples and other evidence where possible. Please only answer those questions of relevance to you. Please also do draw the Committee's attention to any relevant issues not captured in the specific questions below:

1. Where if anywhere do you believe that responsibility should lie for ensuring that the UK has a coherent and consistent long term policy for civil nuclear activities including international collaboration and, within the UK, for cost-effective and efficient articulation of the different elements of nuclear work?

2. The Government's industrial strategy green paper discusses a possible 'sector deal' for the nuclear sector.[174] How might the nuclear sector benefit from such a sector deal? What might a deal involve and who would be the leadership organisations within the sector for such a deal?

SMRs

3. What are the potential benefits, disadvantages and risks from the deployment of SMRs in the UK and more widely?

4. What is the scale of the global market opportunity for SMRs? What would the cost be if the UK does not take full advantage of the opportunities of SMRs?

173 NIRAB, 'About NIRAB': http://www.nirab.org.uk/about-us/about-nirab/ [accessed 25 April 2017]

174 Department for Business, Energy and Industrial Strategy, *Building our Industrial Strategy* (January 2017): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/585273/building-our-industrial-strategy-green-paper.pdf [accessed 21 April 2017]

5. Is the Government doing enough to fund research and development on SMRs, and to stimulate others to do so? Should it be doing more to coordinate UK actions including international engagement on SMR development and future deployment?

6. Are the criteria set out by the Government for the SMR competition appropriate? If not, what should the criteria be? What timescale should the Government be working to in choosing an appropriate SMR design for the UK?

7. Should the UK be involved in the development of Gen IV technology? If so, what funding and support should be put in place to place to help the UK establish a world leading position? Should our activity include development of one or more test reactors?

Governance

8. Is the NNL fulfilling its remit appropriately? Can it deliver the required research to support the UK's future nuclear energy policies? How does it compare to equivalent organisations in other countries?

9. Is the remit of the National Nuclear Laboratory (NNL) suitable to provide research and development support to the UK nuclear sector? Is the current funding and governance model for the NNL appropriate to its role and remit?

10. Is there sufficient co-ordination between the bodies involved in nuclear research and, if not, how should it be improved? Who has oversight of the whole nuclear R&D landscape, including international activities?

11. Was the Nuclear Innovation and Research Advisory Board successful in carrying out its role? Is a permanent successor body to NIRAB required? If yes, what form should this body take and what should its role and remit be?

26 January 2017

APPENDIX 4: ABBREVIATIONS AND ACRONYMS

BEIS	Department for Business, Energy and Industrial Strategy
CCFE	Culham Centre for Fusion Energy
DECC	Department of Energy and Climate Change
EPSRC	Engineering and Physical Science Research Council
ETI	Energy Technology Institute
Euratom	European Atomic Energy Community
EUROfusion	European Consortium for the Development of Fusion Energy
GDA	Generic Design Assessment
GIF	Generation IV International Forum
ITER	An international project to design and build an experimental fusion reactor
JET	Joint European Torus
NDA	Nuclear Decommissioning Authority
NDPB	non-departmental public body
NIA	Nuclear Industry Association
NIC	Nuclear Industry Council
NIRAB	Nuclear Innovation and Research Advisory Board
NIRO	Nuclear Innovation and Research Office
NNL	National Nuclear Laboratory
NPL	National Physical Laboratory
Nuclear AMRC	Nuclear Advanced Manufacturing Research Centre
ONR	Office for Nuclear Regulation
R&D	research and development
SMR	Small Modular Reactor
UKAEA	UK Atomic Energy Authority