Nuclear Research and Development Capabilities

Response from the Engineering the Future alliance which includes:

- The Royal Academy of Engineering
- The Institution of Engineering and Technology
- The Institution of Mechanical Engineers
- The Institution of Chemical Engineers
- The Engineering Council
- Engineering UK

House of Lords Select Committee on Science and Technology

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Engineering the Future is pleased to have the opportunity to input into the Committee's inquiry into UK nuclear research and development capability. As the alliance of the UK professional engineering institutions, Engineering the Future can draw upon a wide range of expertise in the nuclear field. It is clear that maintaining a strong nuclear research and development capability within the UK is important not only in its own right, but also in terms of positioning the UK as a credible partner in the international civil nuclear business and in maintaining the skills pipeline required by the industry in the UK for today and the future.

This response has been coordinated by the Royal Academy of Engineering on behalf of Engineering the Future.

Engineering the Future is a broad alliance of engineering institutions and bodies which represent the UK's 450,000 professional engineers.

We provide independent expert advice and promote understanding of the contribution that engineering makes to the economy, society and to the development and delivery of national policy.

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The implications of future scenarios

- *What are the research and capability requirements of nuclear energy policy options, roadmaps and scenarios up to 2050?*
- *What consideration is the Government giving to the UK's R&D requirements to meet the policy objectives for nuclear energy both in the near term and longer term (to 2050)? Does more need to be done?*
- *What research capabilities and commitments are required now to meet these future nuclear energy policies?*

1. It should be remembered that 2050 is just a nominal date, one commonly chosen by a number of organisations when looking at the future energy system for the UK[1]. The energy landscape is, in fact, a continuum that will continue to develop up to, and beyond, 2050. Given the inter-generational implications of decisions made in the next 20 years it is important that the nuclear component of the UK's energy mix is seen as an integral part of that continuum.

2. The EPSRC review of nuclear science and engineering and the Energy Research Partnership (ERP) Nuclear Fission study found that the R&D implications of a 12GW nuclear fleet and a 38GW fleet are very different. They may be summarised as corresponding respectively to countries newly adopting nuclear power (Gen III+) or those well established in the nuclear industry worldwide with industrial development aspirations such as France or Japan. Without, at least, involvement of next generation reactors, and ideally a hand in the leadership of such, the UK will be largely (if not wholly) dependent on other country's design bases and designs. UK leadership is important to shape policies, designs, and processes to suit our national needs and desires, not the needs and desires of others – especially those driven by commercial interests.

3. In the case of a large and ongoing commitment to nuclear energy as part of the future UK energy mix, reprocessing will need to be considered and acknowledgement given to the likelihood of Generation IV[2] deployment in the post 2040 era. In this case the UK will need to refresh and maintain the expertise it has in reprocessing technology and contribute to the development of Generation IV systems on the international stage.

4. Current government attention to these issues is somewhat lacking. In fact, it could be argued that the government has completely absented itself from any responsibility and left it all to the market as far as next generation technologies and their deployment are concerned. Although government has provided some assistance to try and help the supply chain for Generation III+ systems it is not helping to the extent it should on R&D.

5. A number of recent decisions highlight the government's position:

    - It withdrew funding for the National Nuclear Centre of Excellence on coming to power.
    - It has persisted with the commercial model for the National Nuclear Laboratory (NNL), without any commitment to fund tasks a 'National

[1] The date was first used by the RCEP in their 2000 report *Energy: The Changing Climate*
[2] In the context of this response, Generation IV nuclear technologies are taken to mean all next generation technologies beyond Generation III+ as opposed to the limited list of technologies sometimes used.

Laboratory' would normally undertake for the Government of the day, which does little for the UK's long-term R&D on future systems (see later for more details).
- It has not addressed the very limited remit of the Nuclear Decommissioning Authority (NDA) (confined to clean up of past legacy rather than assurance of future).
- It withdrew the UK from subscribing to the Nuclear Energy Agency's nuclear database.

6. Taken individually, these decisions appear defendable but together they show the lack of a coherent strategy for nuclear R&D capabilities within the UK and the reluctance to fund anything associated with nuclear energy even if this was detrimental to the national interest (bullets 1 and 4) or the changing policy landscape (bullet 3).

7. The nuclear accident at Fukushima, Japan and its subsequent management tell us more resources are needed on a day to day basis just to keep our own media, politicians and civil service supplied with accurate information. In fact during the crisis in Japan the NNL set up a 24 hour service with approximately 40 experts to inform the government, for which it received no additional funding.

8. The UK currently only has limited expertise in the alternative systems deployed elsewhere in the world. We have few experts with knowledge of BWR systems, and of LWR systems more generally. What we do have is concentrated in a relatively small number of individuals either already retired or at the upper end of their working careers. Lack of a defined long-term plan for nuclear energy and lack of R&D on reactor systems means we are not training the future generation of experts. This is left to the countries which support the current main reactor vendors such as the USA, Japan, France, Korea or Russia.

9. In summary, the UK needs to decide at a strategic level where it wants to be positioned in the international nuclear industry. In the case of other power generation technologies, for example gas turbines, it simply buys equipment from the international market and does not support R&D. In principle, the UK could buy nuclear power technology and expertise from the global market, but in that event would have an ever decreasing influence on the direction and capabilities of nuclear technology, and on the UK's ability to develop its own policy and industry base on nuclear power technologies, systems and nuclear fuel cycle in the future.

10. A plan or roadmap for nuclear energy which enables a research portfolio to be articulated and funded should be developed urgently and owned within a responsible part of government. Recognition must be given to the fact that the government cannot absent itself from the strategic decisions needed to define the future UK energy system; there is too much at stake nationally and internationally.

The research base

- *Does the UK have adequate R&D capabilities, including infrastructure, to meet its current and future needs for a safe and secure supply of nuclear energy?*
- *Are there sufficient opportunities and avenues to conduct translational nuclear research in the UK to develop future technologies? Which bodies should be funding this work?*

11. At the moment the UK's R&D capabilities are inadequate and in danger of declining further without increased investment. We have in the NNL both people and facilities that are world class and a number of universities that offer courses in nuclear engineering. Continued and increased funding to enable the UK to play a role in international programmes is essential. The Research Councils do already fund some work in this field but not enough in future systems.

12. A means needs to be found to properly support the NNL to do what the national laboratory in other countries do. Nuclear research is by its nature expensive, especially once you reach the practical work which is essential to make real progress and an effective contribution. The long-term nature of the work means that it is beyond the remit of the TSB and probably the proposed Technology Innovation Centres – energy is mentioned in the TSB Prospectus but not nuclear power explicitly. The Energy Technologies Institute may be a possibility but nuclear power is not currently part of its portfolio.

13. Joint ventures with the main international nuclear power plant and fuel cycle vendors are needed to sustain the industrial relevance of UK’s nationally funded energy R&D. This includes work relevant to nuclear fusion and the ITER project centred in Cadarache, France.

Competing in the global market

- *What are the research areas in which the UK is recognised internationally as having strengths?*
- *What are the costs and benefits to the UK of a more or less active R&D capability within the country?*

14. The UK is losing ground in the global reactor and nuclear fuel cycle market all the time – it is perhaps currently no better than seventh or eighth in global rankings in terms of R&D capabilities. Whenever there are meetings to share what is happening on next generation systems or recycling technologies the USA, France, Japan, Korea and more latterly India and China all mention each other but no longer the UK. The UK are known not to be putting significant resources in so we are no longer seen as credible other than as commentators based on the historic knowledge of a very small and declining number of experts.

15. Because of our industrial experience in reprocessing and the technical resources which underpin Sellafield operations, we are seen as having internationally competitive resources but it is disappointing that we appear willing to let them die away.

Strategic oversight and co-ordination

- *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?*
- *What role should the Government play in identifying gaps in research, providing oversight of the whole landscape and encouraging co-ordination between funders and deliverers? Are they fulfilling that role? Should more be done?*

16. At present there is insufficient coordination between the relevant bodies and no one with oversight of the whole nuclear R&D landscape. This is a situation that should be rectified.

17. There are a plethora of bodies, most of which have different routes into government and issues associated with them. These include:

    - The NNL: the Shareholder Executive is charged with running this as a commercial operation with no type of grant income for R&D. Over 80% of its funding in fact comes from government via third parties.
    - The Culham Centre for Fusion Energy funded by the research councils but managed by UKAEA for a different part of the Shareholder Executive.
    - The NDA funding nuclear R&D associated with clean-up and the UK's nuclear legacy site operations also representing the UK internationally but with no remit for much of what the international nuclear community is concerned with.
    - Various initiatives in UK universities, for example the University of Manchester's Dalton Nuclear Institute and the Centre for Nuclear Engineering at Imperial College.

18. Government should have a role and identify a lead department but to do so it needs first to have a well defined roadmap otherwise it cannot identify gaps in research or encourage coordination between funders and deliverers. It should also recognise it needs to fund as well as urge others to do so.

International and European research activities and comparisons

- *Should the UK be involved in international and European research activities on nuclear? If so, how and what are the benefits and costs of doing so?*
- *What can the UK learn from how other countries presently organise and deliver R&D provision for nuclear? To what extent are other countries increasing or decreasing their research capacity in order to deliver future nuclear policies?*

19. It should be noted that most other countries with an interest in nuclear energy are not currently scaling down their research activities. Even the US recognises that it needs to increase its activities in this field in spite of tight budgeting conditions. The US Department of Energy (DOE) expects to provide cost share funding for small modular reactors (<300MWe) to fill, among other applications, the power gap created by the decommissioning of aging coal plants in the 150MWe to 250MWe range, while also substituting clean energy for dirty energy. Most relevant nations have well defined roles for their national laboratories to carry out nationally and internationally important R&D as opposed to the how the UK is currently running the NNL.

20. It is also worth noting that previously, in the mid to late 1980s, US utilities and the DOE got together to revitalise the industry in the US. The DOE provided impetus through cost sharing programs while US utilities (and international utilities including British Energy) provided leadership in establishing new design requirements. It took more than a decade but the results were positive. New designs were created and now are being commercially deployed – in particular the Westinghouse AP600, the precursor of the AP1000, four of which are being built in China and six of which are under contract with three US utilities. The AP1000 would not have been possible if the US government had not supported the development of the AP600.

21. With this in mind, the UK should certainly be involved in international research activities. It will gain significant leverage on its investment if it is a proactive player within the European Commission's Strategic Energy Technology Plan (which includes sustainable nuclear fission in its remit) as well as the Sustainable Nuclear Energy Technology Platform (SNE-TP) and the European Sustainable Nuclear Industrial Initiative (ESNII). It should seek to have the UK NNL facilities designated as European User facilities in order to get leverage there too.

22. The lack of a state-of-the-art research reactor to provide hands on experience is a particular weakness for the UK as is the availability of operational active facilities to conduct essential work on real experimental systems. Access to UK facilities for handling active materials has become so restrictive and commercially driven that it remains a major disincentive for academic engagement. Where there are major UK R&D capabilities and infrastructure, the bulk now resides within commercial organisations that in turn provide the main impetus for directing and maintaining nuclear R&D in the university sector. The reality is that current UK civil nuclear R&D is biased by strong commercial drivers to deliver short and medium term solutions and there is no long term vision or roadmap for strategic developments that aims to provide a safe and secure supply of nuclear energy.

23. If the UK wishes to retain a significant nuclear technology capability in the medium to long term and to develop new 21st Century reactors and fuel recycling processes, it would seem that major collaborative research projects with other nuclear nations such as France are the only practicable options.

Roles and responsibilities

- *Are the bodies involved in funding research and setting research agendas adequately fulfilling their roles and responsibilities? Should anything change?*
- *In particular:*
  1. *what is the role of the Research Council's cross-council Energy Programme? Is it giving sufficient attention to the UK's current and future nuclear energy research requirements?*
  2. *is the National Nuclear Laboratory fulfilling its R&D remit appropriately? Can it deliver the required research to support the UK's future nuclear energy policies? How does it compare to NNL's in other countries?*
  3. *is the Nuclear Decommissioning Authority's R&D remit still appropriate, given the UK's current and potential future nuclear policies?*

23. Engineering the Future does not believe the relevant bodies are adequately fulfilling their roles and responsibilities in the context of civil nuclear research and development. Addressing these shortcomings must include a re-evaluation of those roles and responsibilities as well as the practices of the organisations themselves.

24. The Research Council's cross-council Energy Programme is not giving sufficient attention to the UK's current and future nuclear energy research requirements but this is symptomatic of a wider, general problem with the Energy Programme, where absence of any strategic planning in the energy sector makes it almost impossible to build a coherent research programme.

25. The NNL doesn't have an R&D remit unless another body is paying for a specific piece of work (other than some far-sighted action by the current management to fund signature research out of its own funds because they do have a concern for what the future holds). The two top level UK policy aims on the low carbon economy and energy security both require the UK to have a long term commitment to active fuel cycle research otherwise the UK will not be credible internationally. Furthermore the UK's current issues in plutonium disposition and geological disposal require expertise born out of research in advanced fuel cycles on active materials in active facilities - a role the NNL should have.

26. The NDA remit is not now appropriate given it was set up only to close down nuclear licensed sites at the minimum cost to the taxpayer. They should now be looking at how to maintain recycling expertise and accommodate a potentially much increased inventory of spent fuel in a 38GW nuclear fleet, especially in the context of continued uncertainty in the provision of geological disposal facilities.