HM Government

A Review of the Civil Nuclear R&D Landscape in the UK

Contents

Acronyms

AWE	Atomic Weapons Establishment
BIS	Department for Business, Innovation and Skills
BGS	British Geological Survey
CEA	Atomic Energy and Alternative Energies Commission
CEH	Centre for Ecology and Hydrology
CoI	Co-investigator
CONTEST	Counter-terrorism Strategy
CORDEL	Cooperation in Reactor Design Evaluation and Licensing
CoRWM	Committee on Radioactive Waste Management
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DFid	Department for International Development
EA	Environment Agency
EERA	European Energy Research Alliance
ENEF	European Nuclear Energy Forum
ENSREG	European Nuclear Safety Regulators Group
EPSRC	Engineering and Physical Sciences Research Council
ERP	Energy Research Partnership
EU	European Union
Euratom	European Atomic Energy Community
FCO	Foreign and Commonwealth Office
FROG	Framatome Owners Group
FSA	Food Standards Agency
FTE	Full time equivalent
GIF	Generation IV International Forum
HEFCE	Higher Education Funding Council for England
HMG	Her Majesty's Government
HO	Home Office
HPA	Health Protection Agency
HSL	Health and Safety Laboratory
IAEA	International Atomic Energy Agency
IFNEC	International Framework for Nuclear Energy Cooperation

ITER	International Thermonuclear Experimental Reactor
MDEP	Multinational Design Evaluation Programme
MOD	Ministry of Defence
NAMRC	Nuclear Advanced Manufacturing Research Centre
NDA	Nuclear Decommissioning Authority
NERC	Natural Environment Research Council
NI	Nuclear Institute
NIA	Nuclear Industry Association
NMP	Nuclear Management Partners
NNL	National Nuclear Laboratory
NPL	National Physics Laboratory
NRCG	Nuclear Research Co-ordination Group
NSAN	National Skills Academy for Nuclear
NTEC	Nuclear Technology Education Consortium
NWRF	Nuclear Waste Research Forum
OECD-NEA	Organisation for Economic Cooperation and Development- Nuclear Energy Agency
ONR	Office for Nuclear Regulation
PI	Primary Investigator
Pu	Plutonium
PWROG	Pressurized Water Reactor Owners Group
R&D	Research and Development
RCUK	Research Councils UK
SLC	Site License Company
SNETP	Sustainable Nuclear Energy Technology Platform
STFC	Science and Technology Facilities Council
TINA	Technology and Innovation Needs Assessment
TRL	Technology Readiness Level
TSB	Technology Strategy Board
UK	United Kingdom
UKERC	UK Energy Research Centre
US	United States

Executive Summary

Introduction

In November 2011, the House of Lords Select Committee on Science and Technology published the report of their Inquiry into Nuclear Research and Development (R&D) Capabilities in the UK. The report identified a number of serious shortcomings in the UK nuclear R&D landscape and recommended change in a number of areas, including the level of funding allocated to support nuclear R&D in the UK.

In February 2012, the Government's response to the Select Committee's report set out a programme of work to address the report's recommendations. One part of that programme is a review of the current nuclear R&D landscape in the UK that can inform decisions on the scope, shape and size of the R&D landscape needed for the future.

This review looks at the complete civil nuclear R&D landscape in the UK, from Government policies that give rise to research needs, through existing funding sources that support R&D, to the capability of the UK's research base in the UK to meet the demands of Government and the private sector. This review is part of an integrated package of documents which, taken together, will ensure that a new long-term nuclear energy policy in the UK is optimally underpinned by R&D.

Findings

This review documents a range of Government objectives, across a number of Departments, many of which give rise to R&D needs and therefore R&D funding and/or programmes. The policy landscape is sub-optimal. It is still in the process of evolving to fit the growth in domestic and global ambition for nuclear power. Therefore, some areas are currently subject to development (a long term strategy for fission and a clear path for exploiting UK strengths commercially) and consequently the R&D programme landscape will need to be re-shaped as these areas of policy develop.

The institutional landscape for R&D and associated funding programmes still underpin a pre-2008 White Paper policy framework in which decommissioning, waste-management, existing reactor operations and fusion predominate. R&D funding is low compared to some international competitors and negligible for research into future generations of fission reactors and their associated fuel cycle. Coordination mechanisms across the breadth of this landscape are limited in their scope, including at the level of Government and between different research funders.

This review has compiled a new dataset on research capability in the UK. The review reveals that there is a developing academic capability across both fission and fusion with some internationally recognised centres of excellence. This capability is growing

as a result of increased research council and industrial funding and is in the process of establishing collaborative networks, both domestic and international. The future growth and international standing of this sector could be jeopardised if the funding environment is not sustained or by the scarcity of radioactive material handling facilities.

The capability in the UK's national laboratories and industry is smaller and more fragmented than it has been in the past. However, there remains a core capability covering a range of subject areas in both fission and fusion. As a product of national pressures and market forces, fission R&D is mainly concentrated on current reactor operations, waste management and decommissioning and not on forward-looking areas of interest such as fuel development and advanced reactor systems. Fusion R&D is focussed on the longer term and is funded mostly as a global multilateral initiative. This difference between short-term and long-term funding has an impact on the strategic planning of research and on the management of future capability.

Whilst a younger generation of researchers is entering this area of R&D, the age and experience profile of researchers is a concern across the sector, particularly the potential loss of internationally leading subject matter experts over the next 5-10 years. This issue is especially pertinent as the demand for nuclear talent becomes more competitive worldwide. Although the overall size of the current cohort of post-graduate students in the UK is encouraging, very few are engaged in research related to the future reactor systems which might be required in the long-term. Further evaluation of the skills capability and education provision in the UK will be necessary to understand the potential for this capability to deliver against the long-term UK nuclear energy strategy.

The UK nuclear R&D community is engaged internationally. Collaboration tends to follow funding or individual researchers' and industrial interests. There are strong international links in a small number of areas such as fusion and geological disposal. At present, there is no overarching UK coordinated international strategy for nuclear R&D. Collaboration within the UK is increasing as are the links between academia and industry.

Conclusions

UK civil nuclear policy is evolving to adapt to increased domestic and international expectations for nuclear power. This review concludes that the institutional and funding landscape for R&D in support of UK civil nuclear policy is lagging behind changes in policy and will need to be re-shaped as part of a comprehensive nuclear R&D roadmap in the UK.

UK nuclear R&D capability is smaller than it has been in the past and is focussed on pre-2008 policy drivers. This review concludes that, in addition to exploiting existing strengths in nuclear R&D, attention needs to be focussed on areas where gaps in UK capability exist such as in advanced fuel cycles and future reactor systems.

1. Background and Introduction

In November 2011, the House of Lords Select Committee on Science and Technology published the report of their Inquiry into Nuclear R&D Capabilities in the UK[1]. The report recommended that Government produce a new long-term strategy for nuclear energy in the UK and a nuclear R&D roadmap to underpin such a strategy. The report identified a number of serious shortcomings in the UK nuclear R&D landscape and recommended changes required for the future, including the level of funding allocated to support nuclear R&D in the UK.

In February 2012, the Government's response to the Select Committee's report[2] accepted the need for a long-term strategy for nuclear and for an underpinning nuclear R&D roadmap. As the first step towards a nuclear R&D roadmap, the Government asked their Chief Scientific Adviser, Sir John Beddington, to undertake a review, "drawing up a comprehensive picture of the current nuclear R&D landscape, considering existing nuclear related R&D facilities and programmes, existing and potential resourcing structures for these programmes, and optimal coordination mechanisms for the future".

This review therefore looks at the complete civil nuclear R&D landscape in the UK[3,4], from Government policies that give rise to research needs, through existing funding sources that support R&D programmes, to the capability of the research base in the UK to meet the demands of Government and the private sector. Although this review considers the civil nuclear sector only, it is important to note that the defence sector could offer a number of transferrable skills and expertise to a growing civil R&D sector.

This review has been overseen by the Ad-Hoc Nuclear R&D Advisory Board[5] (NRDAB), established in March 2012 and chaired by Sir John Beddington. The Advisory Board and its Sub-Groups have guided the design of the review, the compilation of its results and the production of this report. The objectives for this review, as agreed by the Advisory Board are to:

[1] House of Lords Select Committee on Science and Technology, 3rd Report of Session 2010-2012, Nuclear Research and Development Capabilities. ISBN 978 0 10 847395 1.
[2] Government Response to the above (see http://www.parliament.uk/business/committees/committees-a-z/lords-select/science-and-technology-committee/news/nuclear-government-response/)
[3] The review is limited to civil nuclear R&D. The definition of nuclear R&D, for the purposes of this review, is R&D that can be related to the production of nuclear power.
[4] Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development. OECD, Paris (2012).
[5] The Board existed between March 2012 and December 2012.

- paint a detailed picture of existing R&D capability[6] which is able to underpin short-term policy aspirations contained in the nuclear energy strategy;

- provide a baseline against which a roadmap can be charted for the future development of nuclear R&D capability in the UK that is required to underpin medium and long-term aspirations contained in the nuclear energy strategy;

- map the institutional landscape of R&D funders, customers and performers in the UK to inform decisions about an optimal landscape for the future;

- assess current mechanisms for the coordination of R&D strategy, funding and delivery in the UK to inform decisions about future ways of working;

- catalogue the extent of funding and follow the flows of funding, both domestic and international, to UK R&D performers;

- assess the extent and quality of national and international collaboration in nuclear R&D.

The review is based on both primary data, collected from research organisations specifically for this purpose and secondary information contained in literature and online resources related to nuclear R&D. The methodology for this review is set out in Annex A.

This review should be seen as part of an integrated package of documents which, taken together, will ensure that Government nuclear energy policy will be optimally underpinned by R&D. The relationship between these documents is described very simply in Figure 1.1.

This review presents conclusions about the present which are used directly as an input to decisions for the future which are either taken or planned in the Nuclear R&D Roadmap.

[6] Capability, for the purposes of this review, includes both research infrastructure and skilled research personnel.

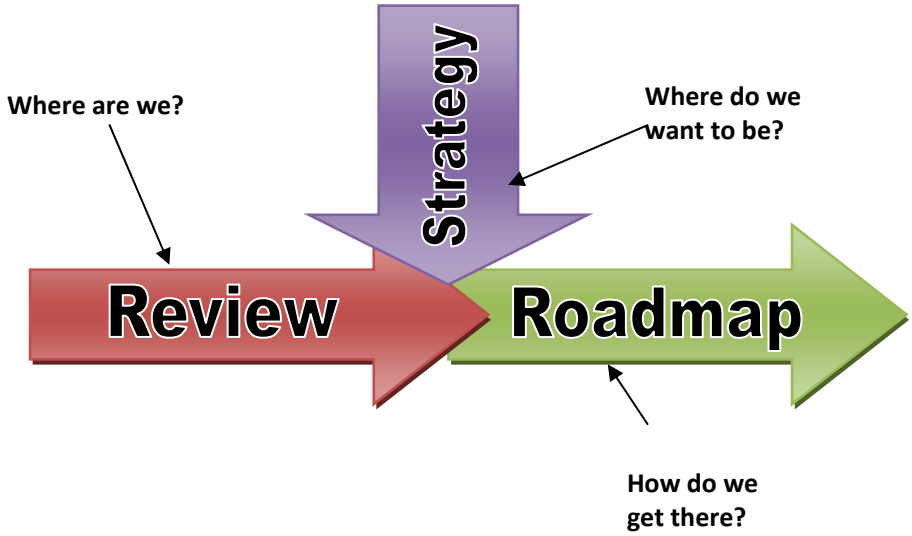

Figure 1.1: The 2012 nuclear R&D package

2. Objectives for Nuclear R&D in the UK

Introduction

The Frascati Manual[7] describes R&D as comprising "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications".

Before looking at the UK R&D capability related to nuclear power, it is important to first consider the questions of why R&D are needed and what the desired output of those processes is. This chapter examines the objectives and strategy currently in place for nuclear R&D in the UK.

The Civil Nuclear Policy Framework

A number of the Coalition Government priorities are directly or indirectly relevant to nuclear energy. In assessing the wide range of objectives set out in Figure 2.1, it is important to recognise that the generation of energy from nuclear fission or fusion gives rise to policy needs beyond the fulfilment of current domestic energy demand. As power generation in the UK is provided by the private sector, policies that relate to the market and those that relate to the growth potential of the sector are needed. As nuclear fission gives rise to elements that are of concern from both safety and proliferation perspectives, policies and legislation that relate to the safe disposal of waste and the protection of fissile material internationally are also required.

In the context of the lifetime of a nuclear power plant (~40-50 years), the UK's decision in 2008[8] to build new reactors to replace the UK's aging fleet is recent. The policy landscape is therefore still evolving in reaction to that decision. In particular, Government will set out a long-term strategy for nuclear energy in 2012 that explains the potential requirement for nuclear energy in the UK additional to that provided by the current new build. Government and industry will also set out their shared vision to realise the potential for growth and jobs in the private sector, building on UK strengths and experience in nuclear power and nuclear waste management and decommissioning.

[7] Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development. OECD, Paris (2012).
[8] Meeting the Energy Challenge: A White Paper on Nuclear Power. BERR (2008) URN 08/525

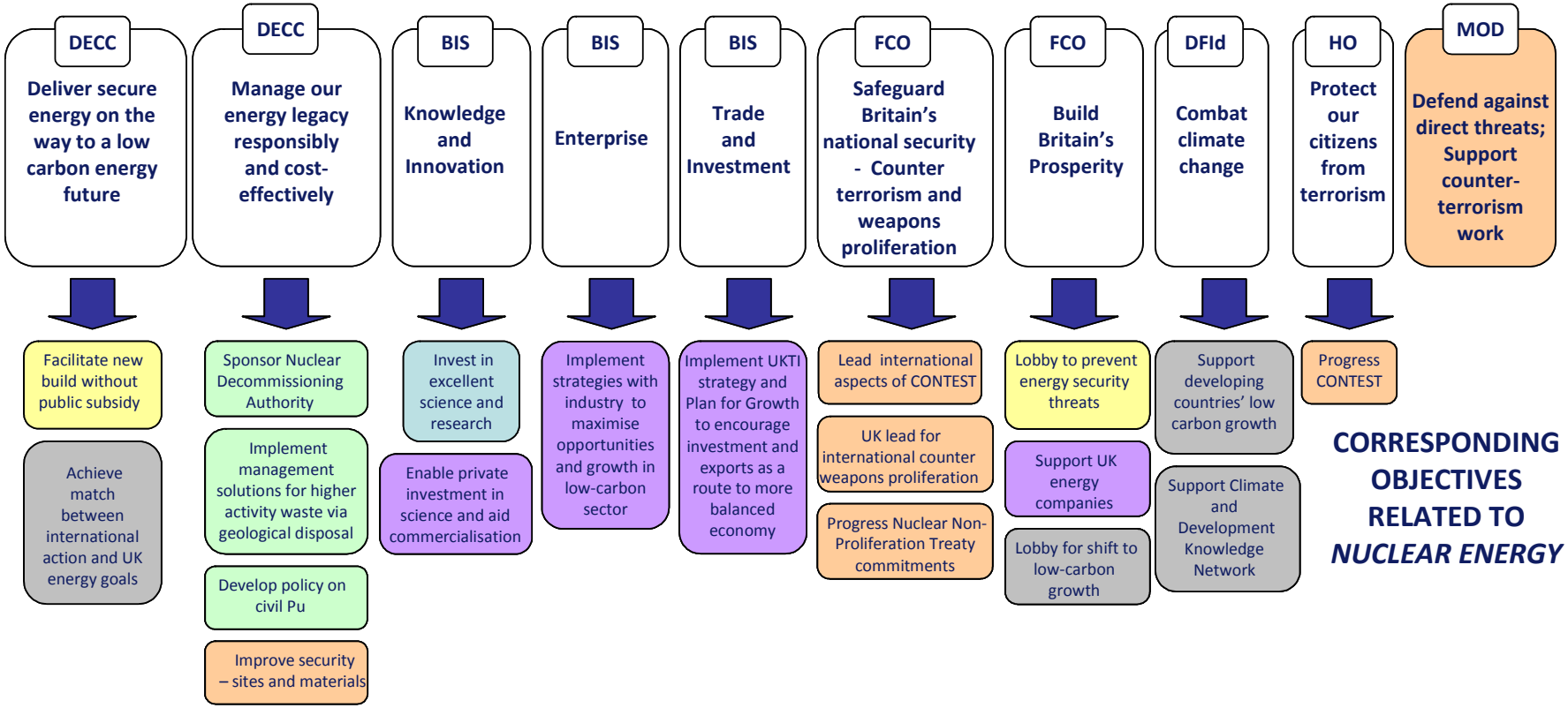

Figure 2.1: Government priorities related to nuclear energy

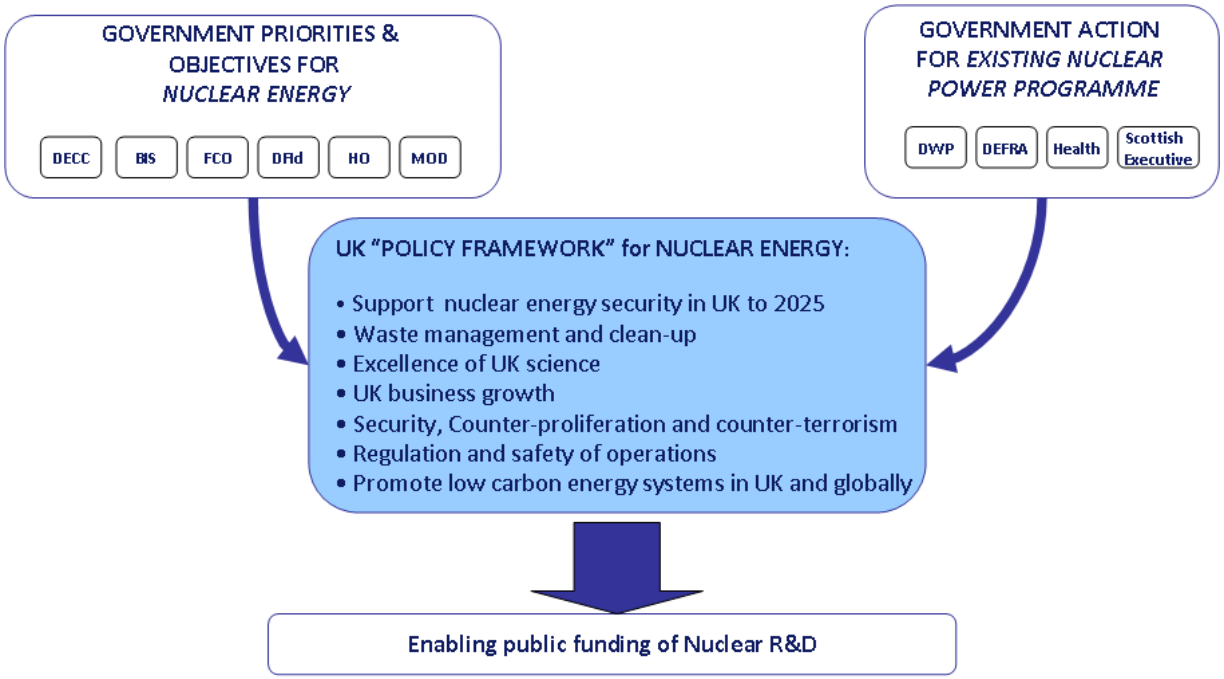

Figure 2.2: Policy framework related to nuclear energy

The existing policy framework is summarised in Figure 2.2. The very long-term ambition for nuclear energy, as represented by nuclear fusion, falls under the "excellence of UK science" priority.

Public Sector Objectives and Strategy for R&D

Many of the Government policy priorities noted above give rise to R&D needs, some of which will be delivered by the private sector and some of which will require direct public intervention. The reasons for public intervention will vary, but include the need to directly support the formulation or implementation of policy or legislation, the need to correct market failures related to private-sector under-investment in R&D and the need to maintain strategic capability in areas of national importance.

This review has compiled the R&D strategies associated with the delivery of a number of Government objectives as detailed in Annex B. The clear focus of the current strategic approach is towards current reactor operations, nuclear decommissioning, waste management and fusion energy. It is not surprising that the apparent gaps in R&D strategy mirror the already identified gaps in policy – those of long-term nuclear fission energy and of optimal commercial exploitation of UK expertise.

The strategy for nuclear fusion R&D is clear, long-term and supports largely supra-national policy goals related to future energy supply. Nuclear fusion power is also at a very different stage of maturity than the current generation of nuclear fission power

– at present fusion R&D programmes are linked to research policy rather than energy policy.

Private Sector Objectives and Strategy for R&D

Private sector objectives for R&D always underpin business objectives but vary with the remit of the company and the in-house capacity for R&D. In the UK nuclear sector, three types of research-active companies predominate:

- Operators; for whom the main R&D objectives relate to the efficiency and safety of current operations;
- NDA site licence companies; for whom the main R&D objectives relate to their agreed programme of decommissioning, waste management and fuel cycle operations work;
- Technology providers; for whom technological innovation can provide market advantage.

Some Government owned laboratories are privately run businesses (most notably the National Nuclear Laboratory (NNL) and the National Physical Laboratory (NPL)). The NNL has developed its own in-house R&D objectives that are partly delivered through self-funded programmes, by approximately £1m per annum. These programmes consist of five signature research areas (i-v) and an innovation programme; i) spent fuel and nuclear materials, ii) waste immobilisation, storage and disposal, iii) fuel and reactors, iv) legacy waste and v) decommissioning and nuclear security

Findings

- This review has highlighted the fact that the policy landscape surrounding nuclear energy is diverse, but contains a series of clear existing policy objectives. A number of R&D strategies and programmes underpin this policy landscape, especially in the areas of current reactor operation, decommissioning, waste management and fusion.

- In response to the major change in direction taken in the 2008 White Paper, this review supports the need for development of policy and supporting R&D strategies in two main areas which reflect the potential importance of nuclear power in meeting long-term UK emissions targets, energy security and industrial success:
  - *a long-term strategy* for nuclear energy that explains the potential requirement for nuclear energy in the UK additional to that provided by the current new build;
  - *a shared vision* to realise the potential for growth and jobs in the private sector, building on UK strengths and experience in nuclear power and decommissioning.

3. Institutional Landscape of Nuclear R&D in the UK

Introduction

The UK has a market-based approach to nuclear energy in which many organisations work together to deliver the required outputs in terms of power, decommissioning, waste management etc. To fully understand the nuclear R&D landscape in the UK, it is therefore important to examine the institutional landscape. This chapter looks at the institutional remits of the organisations involved in nuclear R&D and how the organisations are connected through accountability, contractual, financial and other linkages.

The UK Institutional Landscape

The remits of the various organisations involved in nuclear R&D in the UK are summarised in the table at Annex C.

A detailed map of the institutional landscape for nuclear R&D in the UK has been produced as part of this review. As the purpose of this exercise is to inform future decisions about the landscape, a decision was taken that an attempt to simplify the map to facilitate reproduction would be counter-productive. Therefore the full map is available on-line[9].

The information collected shows a diverse and numerous range of organisations involved in nuclear R&D in the UK and a complex series of relationships between these organisations. This institutional landscape has developed over the last two decades following the breakup of a small number of national organisations. The relationships between the organisations are varied, ranging from direct governance to contracts for the management of sites and facilities (for which R&D might be required), to contracts specifically for R&D, to simple lines of communication between interested parties.

It is worth noting that some organisations have multiple roles. For example, AMEC is a parent body for Sellafield Ltd through the National management Partners (NMP) consortium; it is a Nuclear Decommissioning Authority (NDA) Estate Tier 2[10] contractor that funds R&D on a contract-by-contract basis, as well as an R&D performer in its own right with in-house R&D capability.

[9] http://www.nnl.co.uk/science-technology/uk-r-d-map.aspx
[10] http://www.nuclearsupplychain.com/decom-opportunities

Is the Nuclear R&D Landscape Fit for Purpose?

Although complex, the current landscape has evolved to deliver the wide range of objectives described in Chapter 2. As the UK's strategic direction and associated objectives are developed, it is inevitable and desirable that further evolution of the landscape will be required. The case studies below provide examples of areas where changes in either the remits of certain organisations, or the links between those organisations might result in a more optimal institutional landscape.

Case Studies	
NDA estate mission versus capability	NDA Site Licence Companies (SLCs) such as Sellafield Ltd are contracted and incentivised against core hazard reduction, decommissioning and clean up objectives. However, many of the sites have capabilities that stretch beyond this core mission (e.g. spent fuel services) and/or the expertise to deploy capability associated with the core mission on a wider scale (e.g. overseas)
NNL's role in advising Government	At present most of NNL's activities are undertaken under commercial contracts for UK and international customers. A change to the remit of NNL to a three tier model would allow it to: provide advice to Government on civil nuclear technical matters (tier 1), lead and undertake strategically important R&D through national programmes (tier 2) and continue to deliver work for customers (tier 3). Commercial work under tier 3 work will help to offset costs for the tax payer for tiers 1 and 2 activities.

R&D to Inform Policy

One area for which an optimal institutional landscape is essential is the provision of evidence for policy making. In this area, research needs to not only meet the appropriate scientific standard; it needs to be sufficiently independent of the policy decisions being taken.

A good example related to nuclear power is the research required to support future policy decisions on geological disposal of highly active nuclear waste in the UK. In this example, it is crucial that potential host communities trust the research which informs the safety case and that trust is partly based on perceived independence.

Research to inform policy therefore needs to be carefully commissioned in such a way that private sector or public sector conflicts of interest are avoided and that the evidence is perceived externally as wholly independent.

Whilst the application of the Haldane principle[11] (which describes the notion that "decisions about what to spend research funds on should be made by researchers rather than politicians")[10] might make Research Council funding an attractive solution to this issue, the very same principle also precludes such directed research commissioning. Therefore, it is rather the application of the (Rothschild)[12] customer-contractor principle that is required in which an "intelligent customer" in Government commissions and analyses independent research contracted externally.

How Does the Nuclear R&D Institutional Landscape Compare with International Benchmarks?

For the purpose of this review, the institutional landscape in the UK has been compared to that in France and the USA.

The French civil nuclear sector is closer to the state than that in the UK and the institutional landscape is both smaller in terms of the number of organisations involved and simpler in terms of the relationships between those organisations. The atomic energy commission (CEA) in France is state funded and performs the majority of R&D, including for Areva (which is 90% state-owned), EDF Energy (which is 75% state owned) and the French nuclear safety (IRSN) and waste management agencies (ANDRA).

The US civil nuclear sector relies on both public and private sector R&D. The institutional landscape in the US contains some of the same complexity that is seen in the UK. The US Department of Energy plays a much greater role in the funding, policy coordination and management of R&D in the US than its equivalent in the UK, partly through the operation of its numerous national laboratories.

[11] Haldane Enquiry Report on the Machinery of Government on the Ministry of Reconstruction. CMND 9234 London: HMSO; 1918.
[12] Cabinet Office, A framework for Government Research and Development; 1971

Findings

- The institutional landscape for nuclear R&D in the UK is complex, reflecting both a market-based approach to power generation and the involvement of both public and private bodies in R&D

- Government and the public sector more generally, play a number of different roles in the institutional landscape reflecting the wide range of objectives discussed in Chapter 2. DECC, BIS and their respective agencies predominate as might be expected given DECC's policy lead for nuclear energy and the BIS policy lead for industrial policy and R&D.

- The private sector R&D landscape in the UK is dominated by those organisations serving the NDA Estate and EDF Energy.

- The institutional landscape has evolved to meet both policy and business need. Some further refinement, coordination or consolidation of the landscape will be required to **(i)** address a changing policy and/or business environment or **(ii)** exploit opportunities at the overlap of different objectives and eliminate redundancies.

4. Funding of Nuclear R&D in the UK

Introduction

R&D is a resource-intensive activity, especially in areas such as nuclear energy where specialist equipment is often required and where additional expectations for safety, security and waste management need to be taken into account. This chapter looks at the funding of nuclear R&D in the UK in order to provide a baseline against which decisions for future expenditure can be taken.

Public Sector Support for Nuclear R&D in the UK

Table 4.1 sets out UK Government expenditure on nuclear R&D (separated into fission R&D, fusion R&D and "other") in the UK. This totalled £66m in 2010/2011.

Table 4.1: UK Government expenditure on nuclear R&D 2010/11

Total fission (£29m)[14]	Total BIS (£18.1m)[13]	EPSRC (£11.7m)
		STFC (£2.6m)
		NERC (£1.8m)
		TSB (£2.0m)
	Total DECC (£10.9m)	NDA[15] (£10.9m)
Total fusion (£33m)[10]	Total BIS (£33.0m)[11]	EPSRC (£33.0)
Total other (£4m)[10]	Total DH (£3.7m)	HPA (£1m)
		FSA (2.7m)
	Total Defra (£0.3m)	EA (£0.3m)

[13] BIS also provides research funding to universities through their Higher Education Funding Council for England (HEFCE) research allocation. The total amount (for all areas of research and all universities) was £2,303m in 2010/2011. It is not possible to disaggregate this figure to provide data on nuclear R&D. The same situation applies to the funding councils of devolved administrations.

[14] The Government also funds nuclear R&D in the UK indirectly through its contribution to the EU budget and therefore to the Euratom programme and other nuclear-related elements of the EC Seventh Framework Programme. A theoretical contribution of €54.4m or £46.9m can be calculated from the Euratom R&D budget for 2010 (£435m) and the UK's share of the EU budget after abatement (12.5%). In Euratom competitive calls since 2007 (i.e. the Seventh Framework Programme), UK participants have received €1m for fusion and €23m for fission R&D. In addition, the UK receives £45m annually from Euratom for the Joint European Torus at the Culham Centre for Fusion Energy (CCFE).

[15] NDA also funds nuclear R&D in the UK indirectly through the overall budgets provided to site licence companies who may undertake R&D in order to meet their contractual obligations to NDA. The collated estimates for R&D spend by the site licence companies in 2010/2011, as reported to the House of Lords in June 2012 was £121.3m.

Figure 4.1 breaks down this figure into different categories of technology readiness levels (TRLs)[16]. Most of this expenditure is concentrated in TRLs1-3 reflecting the fact that the majority comes from research council budgets. Both TSB and NDA spend some money on development (TRLs 4-6) whereas only a small amount is spent by NDA on deployment (TRLs 7-9). NDA site licence companies spend significantly in this higher TRL bracket[16].

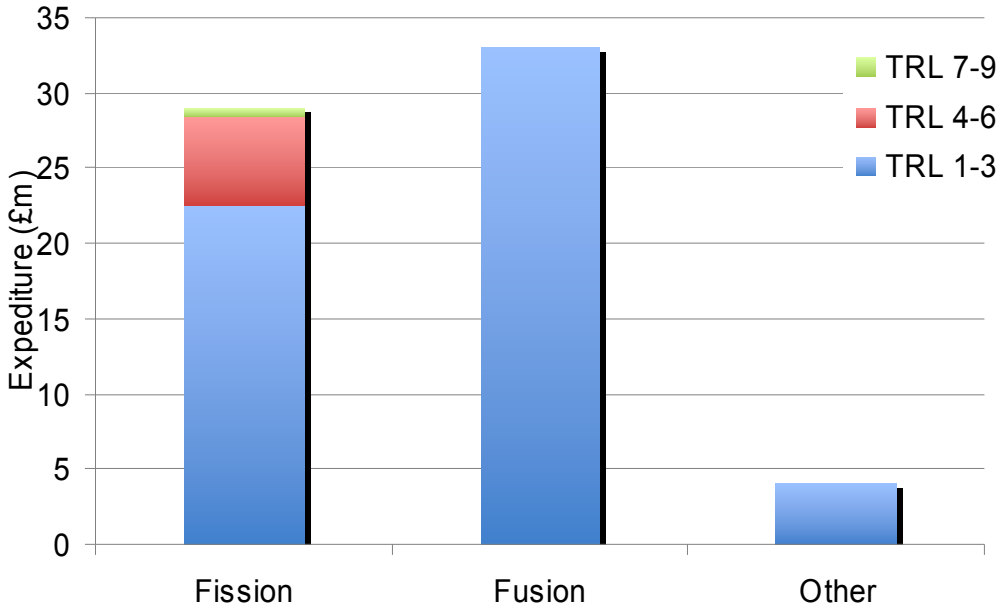

Figure 4.1: UK Government expenditure on nuclear R&D 2010/11

The Role of European Funding

The historical emphasis given to this area in Europe since the Euratom Treaty was signed (at the same time as the European Economic Community Treaty) in 1957 means that the European budget is an important source of funding for nuclear R&D in the UK[15] However, participation in Euratom programmes requires matched funding to be provided for some participants.

European support for nuclear power is not unanimous as it was between the six original signatories in 1957, and as a result, the R&D focus of Euratom tends to be on safety, waste management and fusion rather than future fission energy provision.

[16] *Technology Readiness Assessment Guide* (DOE G 413.3-4). United States Department of Energy, Office of Management; 2009.

University Expenditure on Nuclear R&D in the UK

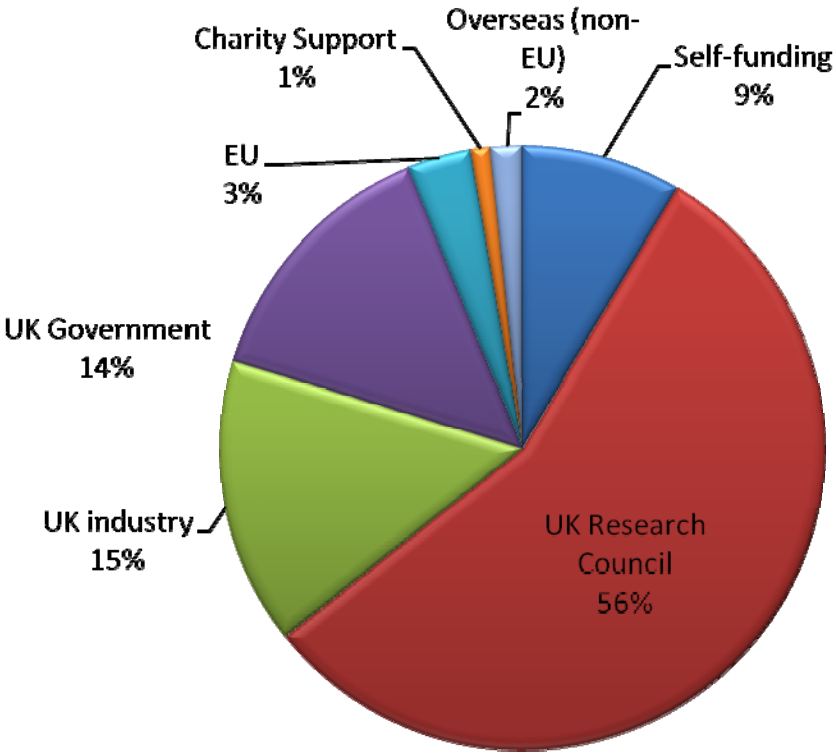

Figure 4.2: Total funding (£269 m) received by provider for academic institutions over the period January 2006-July 2012

Figure 4.2 summarises the data collected for this review from universities on their expenditure on nuclear R&D (2006-2012) by source. The total reported expenditure was £269m over this six-year period.

Figure 4.3 provides a breakdown of university expenditure by subject area, suggesting that the focus of R&D in this sector is on current reactor operations, decommissioning, waste management and fusion.

National Laboratory Expenditure on Nuclear R&D in the UK

Table 4.2 summarises the data collected for this review from national laboratories on their expenditure on nuclear R&D (2011) by source. In this document we will consider seven national laboratories NNL, NPL, Culham Centre for Fusion Energy (CCFE), Centre of Ecology and Hydrology (CEH) , Health and Safety Laboratory (HSL), British Geological Survey (BGS) and the civil R&D sector of the Atomic Weapons Establishment (AWE). The total reported expenditure for all the national laboratories in this period (2011) was £110m.

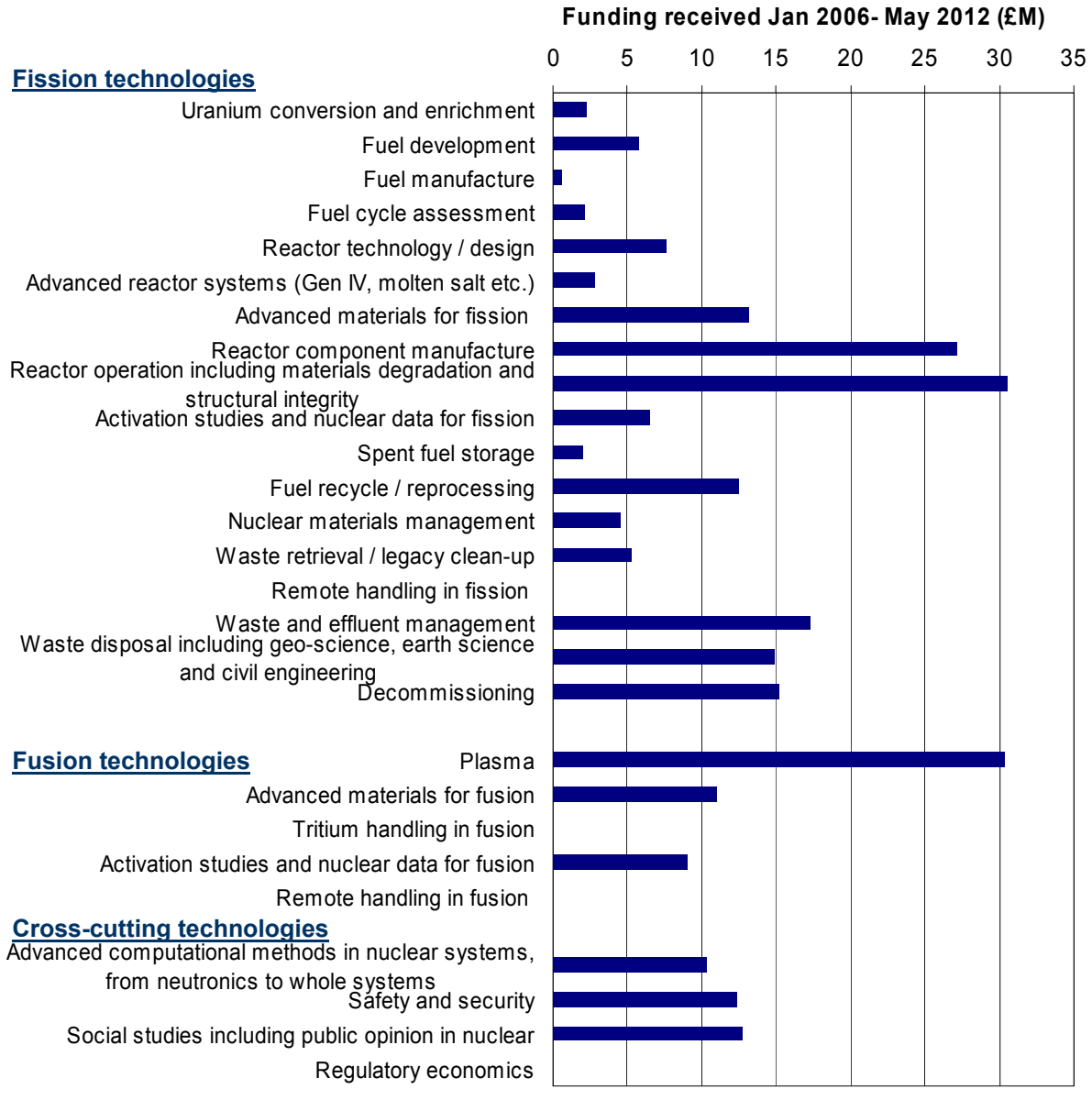

Figure 4.3: Funding received by subject area for academic institutions over the period January 2006-May 20012

Table 4.2 Funding received by provider for National Laboratories (£m) (2011)

	Self-funding	RCUK	UK industry	UK HMG	EU	Charity Support	Overseas (non-EU)
AWE	0.30	0.00	0.00	0.00	0.00	0.00	0.00
BGS	0.17	0.10	0.15	0.05	0.77	0.00	0.05
CEH	0.15	0.06	0.00	0.02	0.50	0.00	0.01
NNL	1.03	0.11	32.02	6.20	0.73	0.00	0.93
NPL	0.00	0.00	1.00	0.50	1.00	0.00	0.00
CCFE	0.00	19.84	0.00	0.00	44.41	0.00	0.00

Trends in Funding for Nuclear R&D in the UK

Following funding data from 1980 onwards there is clear evidence[17] of strong shifts in UK nuclear R&D funding. There was a continuous decline from 1980 to 2000 and then a modest increase from 2000 - 2009. This fits the anecdotal experience of many questioned in the review who highlighted the dramatic decline in R&D in recent decades up to the emergence of the so called 'nuclear renaissance' in the 2000's. It should be noted that although R&D spending rose between 2000 and 2009 it remained in 2009 at only 7% of the level spent in 1980[18] (see Figure 4.4).

[17] IEA database set to adjust for 2010 prices (http://wds.iea.org/WDS/TableViewer/tableView.aspx)

International Comparisons of Funding for Nuclear R&D

Figure 4.4 provides a comparison of funding for civil nuclear R&D between different countries.

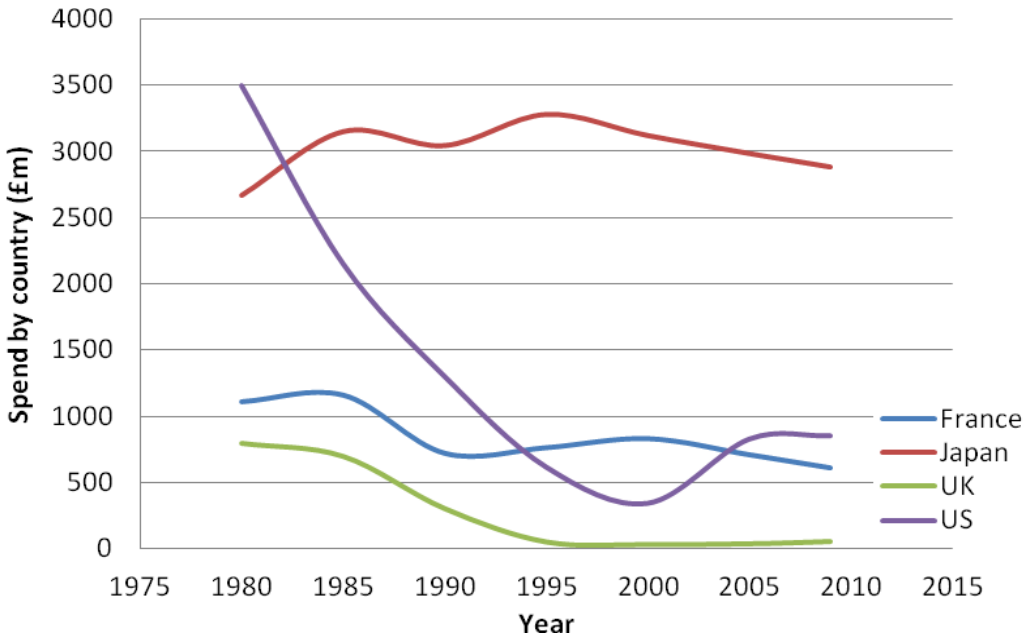

Figure 4.4: Civil nuclear R&D spend by country 1980-2009 (standardised to 2010 prices in $m)[18]

Findings

- There are a variety of funding sources for nuclear R&D in the UK. UK Government expenditure in this area for 2010/2011 was £66m. In comparison with some international benchmarks, this level of expenditure is low.
- The majority of this spend is focussed on the nuclear power of the past (decommissioning), the present (safety and performance) and the long-term future (fusion). Mirroring earlier findings on energy policy and research strategy, there is less funding allocated to research into future generations of fission reactors and their fuel cycle which is contrary to the situation in major nuclear nations (France, US, Japan) where this is a major focus.

5. Coordination of Nuclear R&D in the UK

Introduction

The nuclear R&D landscape in the UK, as described in previous chapters, is complex. Although different organisations support different policies and objectives, questions have been raised in the past about the cohesion of this multifaceted landscape. Therefore, this chapter examines and describes existing coordination mechanisms in the UK.

Coordination within Government

Collective Government decisions on nuclear energy issues are taken by the Economic Affairs Cabinet Committee. This Committee would also take high-level decisions related to nuclear energy R&D.

No specific, official-level coordination mechanism for nuclear energy or nuclear R&D exists within Government, although coordination on these subjects is achieved through other mechanisms with a broader remit. For example, the Low Carbon Innovation Coordination Group includes nuclear within its remit and has been active in this area. It has taken an oversight role in the ongoing Technology and Innovation Needs Assessment (TINA exercise).

Coordination Among Research Funders

Although there are no coordination mechanisms that exist specifically to coordinate the work of nuclear research funders, some groups do play this role to a limited extent.

The Energy Research Partnership is formed of a number of research funding organisations and has been active in the area of nuclear R&D, most recently producing a nuclear fission roadmap[18]. The NDA's Research Board also plays a role in coordinating the research of its members. Coordination between the Research Councils is achieved through Research Councils UK (RCUK) and the cross-council Energy Programme.

Coordination Between Research Performers

There are a variety of coordination mechanisms to bring together the efforts of research performers, some of which are specific to nuclear R&D and some of which include nuclear R&D in a wider portfolio. A few examples of coordinating bodies follow:

[18] http://www.energyresearchpartnership.org.uk/nucleartechnologyroadmap

The Nuclear Research Co-ordination Group (NRCG) aims to coordinate university research programmes to support the creation of the necessary skills base for the UK's future civil and defence nuclear policy. The group includes research councils, industry, regulators, NNL and Government and is an informal platform for sharing ideas and discussing future direction rather than a body with formal capacity to direct. The Nuclear Industry Group of the Institute of Physics is a broad ranging group open to all members of the institute who are involved with, or interested in, the nuclear sector. It is predominantly a networking body, but focuses its coordination activity on professional skills capacity building in the nuclear sector. The Nuclear Power Committee of the Institute of Mechanical Engineers has a dual role. Firstly an element of the coordination of information provision to those making decision on nuclear policy. Secondly, to support the building of capacity across academia for any future nuclear programme needs.

The Nuclear Non-Proliferation Working Group of the Royal Society, considered the potential of new technologies and governance best practices to make the nuclear fuel cycle more secure and proliferation resistant, with a particular focus on the management of spent fuel (including interim storage, geological disposal, and reuse)[19]. A group of experts from academia and industry was established for the project and they conducted a wide-ranging evidence gathering exercise, which included a series of events, meetings with stakeholders, and an open public call for evidence. Stakeholders included individuals from government, industry, academia, and intergovernmental and non-governmental organisations in the UK and other countries.

Nuclear Waste Research Forum (NWRF) is a body that coordinates R&D needs and opportunities in integrated waste management and site restoration across the NDA estate and beyond. In particular the NWRF research board is a key part of the NDA governance and has members from NDA, EDF, AWE, Rolls Royce, MoD, CEA, EU and regulators to coordinate R&D issues in waste management and decommissioning. The NWRF has government support and was set up in response to the Committee on Radioactive Waste Management (CoRWM) recommendations to improve coordination in waste management R&D.

Coordination Between the Public and Private Sectors

Mechanisms that serve to bring public and private sector research-active organisations together are increasing in the UK, but are still at an early stage of development. This is an activity which will have an ever-growing importance to the nuclear sector given the market-based approach to power generation.

There are two recently launched examples in this space, both of which are already having an impact. Firstly, the Nuclear Advanced Manufacturing Research Centre (NAMRC), which officially opened in May 2012 with the purpose of supporting the

[19] http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/projects/nuclear-non-proliferation/FuelCycleStewardshipNuclearRenaissance.pdf

nuclear industry in identifying and over-coming manufacturing barriers. Secondly, the Energy Generation and Supply Knowledge Transfer Network, which aims to facilitate the spread of information across those who are currently involved in the UK nuclear sector and stimulate the involvement of other sectors that may be able to support the UK nuclear industry.

Findings

- Although there are a number of mechanisms for coordinating the work of those undertaking R&D in the UK, formal mechanisms to ensure coordination at the level of Government and between different research funders are limited (both for domestic issues and international issues).

6. Civil Nuclear R&D Capability in the UK

Introduction

The demands placed upon nuclear R&D capability in the UK have changed since the 2008 White Paper that signalled the Government's intention to build new nuclear power reactors in the UK. The need for R&D is likely to change further as a result of the new long-term strategy for nuclear energy in the UK. This chapter therefore looks in detail at the capacity to undertake nuclear R&D in the UK to deliver existing policy and provides a baseline against which changes can be considered to ensure that new policy is optimally underpinned by R&D.

Human Resources for Nuclear R&D in the UK

Using the methodology described in detail in Annex A, this review has identified 1886.9 full time equivalent (FTE) nuclear R&D personnel in the UK, 1260 in the UK's national laboratories, 393.9 in industry and 233.5 in UK universities.

The information that follows describes that research base and provides a snapshot of current focus of those personnel. This review has not looked at the individual backgrounds of researchers to ascertain what they have the potential to do rather than what they are doing. However, given the experience of many of the R&D personnel identified it is obvious that many will have skills related to nuclear R&D above and beyond those currently being deployed.

Similarly, there will be researchers currently using their skills outside the civil nuclear space who have expertise that could be applied to this sector. This is particularly true for a large group of nuclear R&D personnel in the defence sector in the UK who could support future reactor R&D.

66.7% of nuclear R&D personnel in the UK are employed by the UK national laboratories, with the overwhelming majority of them to be found at the NNL or the CCFE. Figure 6.1 shows the location of the major sites for NNL (Sellafield, Warrington and Preston) and for CCFE (Culham near Oxford), NPL and the CEH. Figure 6.1 also provides data on the experience of staff at these institutions, which show that the majority of staff (in excess of 75%) have more than 15 years experience.

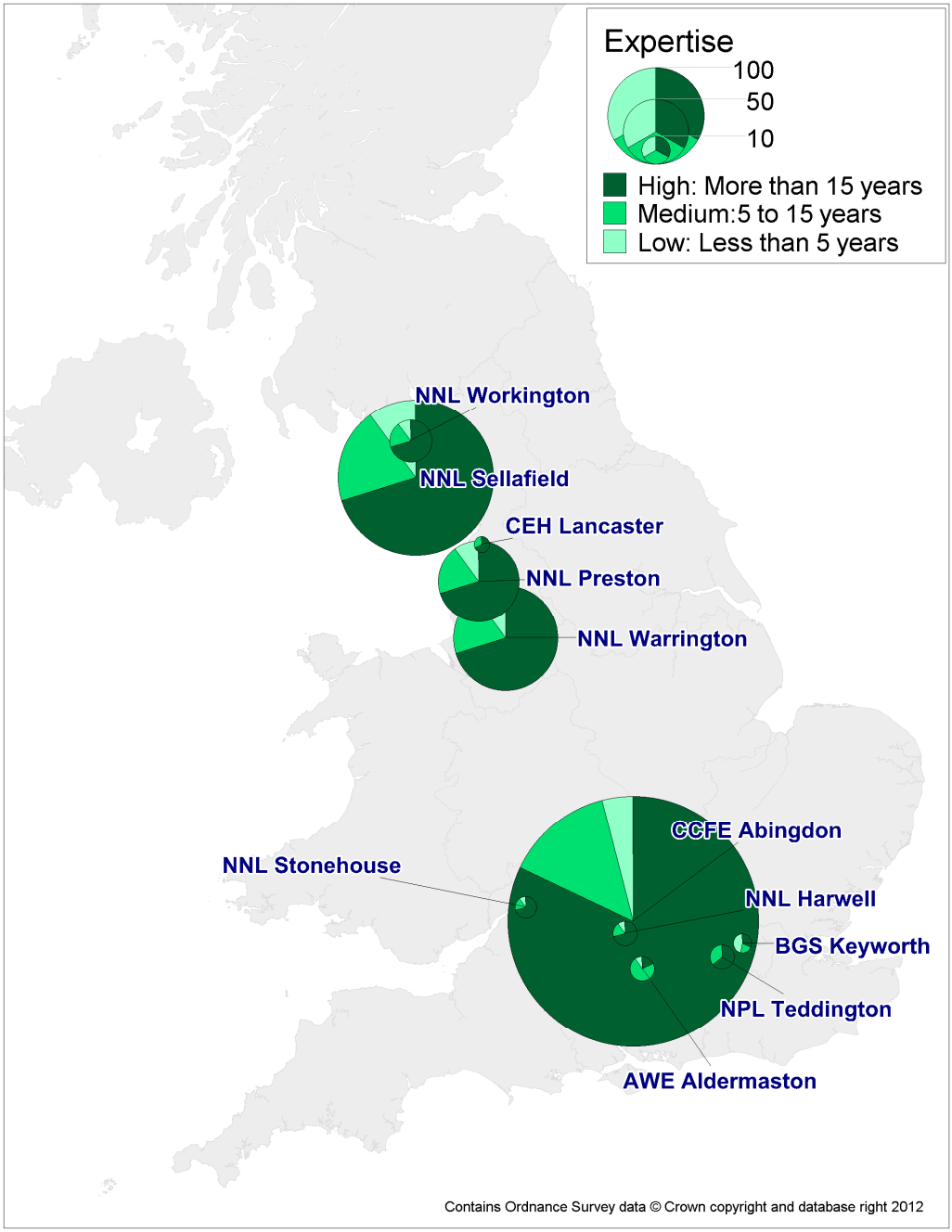

Figure 6.1: The size and experience of the nuclear R&D workforce at the UK's national laboratories, totalling 1259.5 FTE.

As can be seen in Figure 6.2, the majority of the work of the national laboratories is focussed on waste management, current reactor technologies and fusion. Little manpower is devoted in the areas of fuel cycle assessment, fuel development, advanced reactors and advanced fuel cycles. However, through limited programmes in these areas, either supported by industry or through self-funding, the NNL has maintained its capability. This will be lost in the coming years without intervention due to retirements and the closure of the fuel cycle plant removing the likelihood of industry funding. The primary customer for the work of the NNL is the NDA and its

site licensees and EDF Energy and virtually all of the effort of the CCFE is directed towards future fusion power.

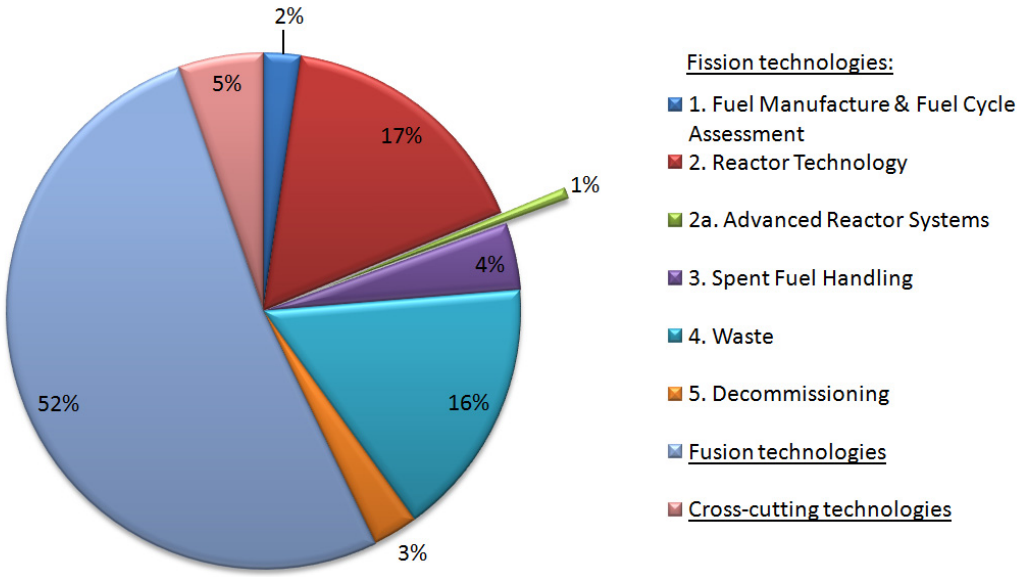

Figure 6.2: The subject focus of the nuclear R&D workforce in the UK's National Laboratories, totalling 1259.5 FTE.

20.9% of nuclear R&D personnel in the UK are employed by industry. These staff are more widely spread than the national laboratory staff as can be seen in Figure 6.4. The two largest employers of nuclear R&D personnel are AMEC and Sellafield. A more mixed range of experience is seen in the private sector than in the national laboratories, with greater numbers of staff with less than 15 years experience.

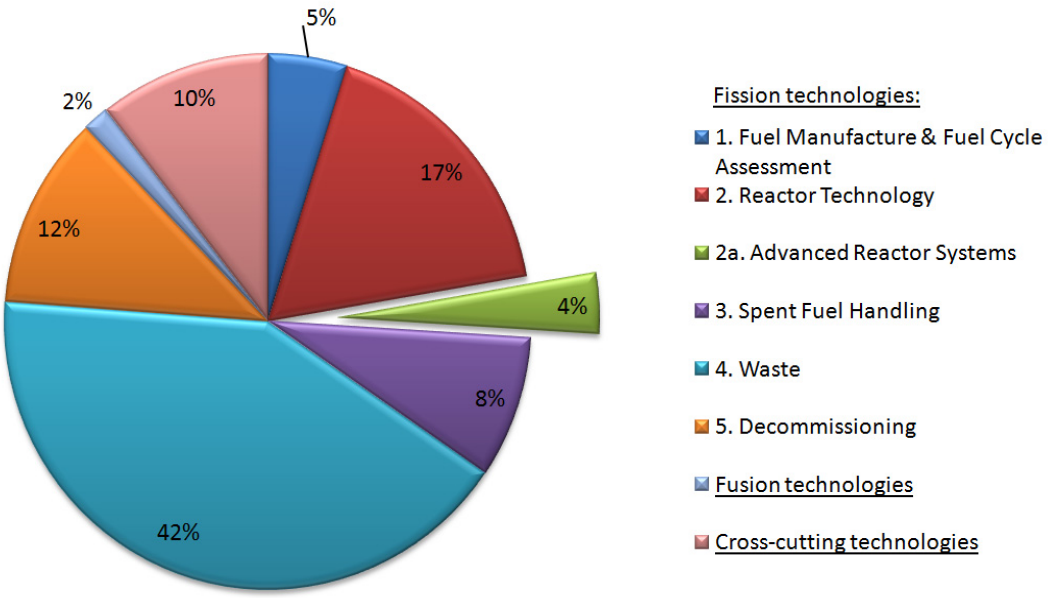

Figure 6.3: The subject focus of the industrial nuclear R&D workforce in the UK, totalling 393.9 FTE.

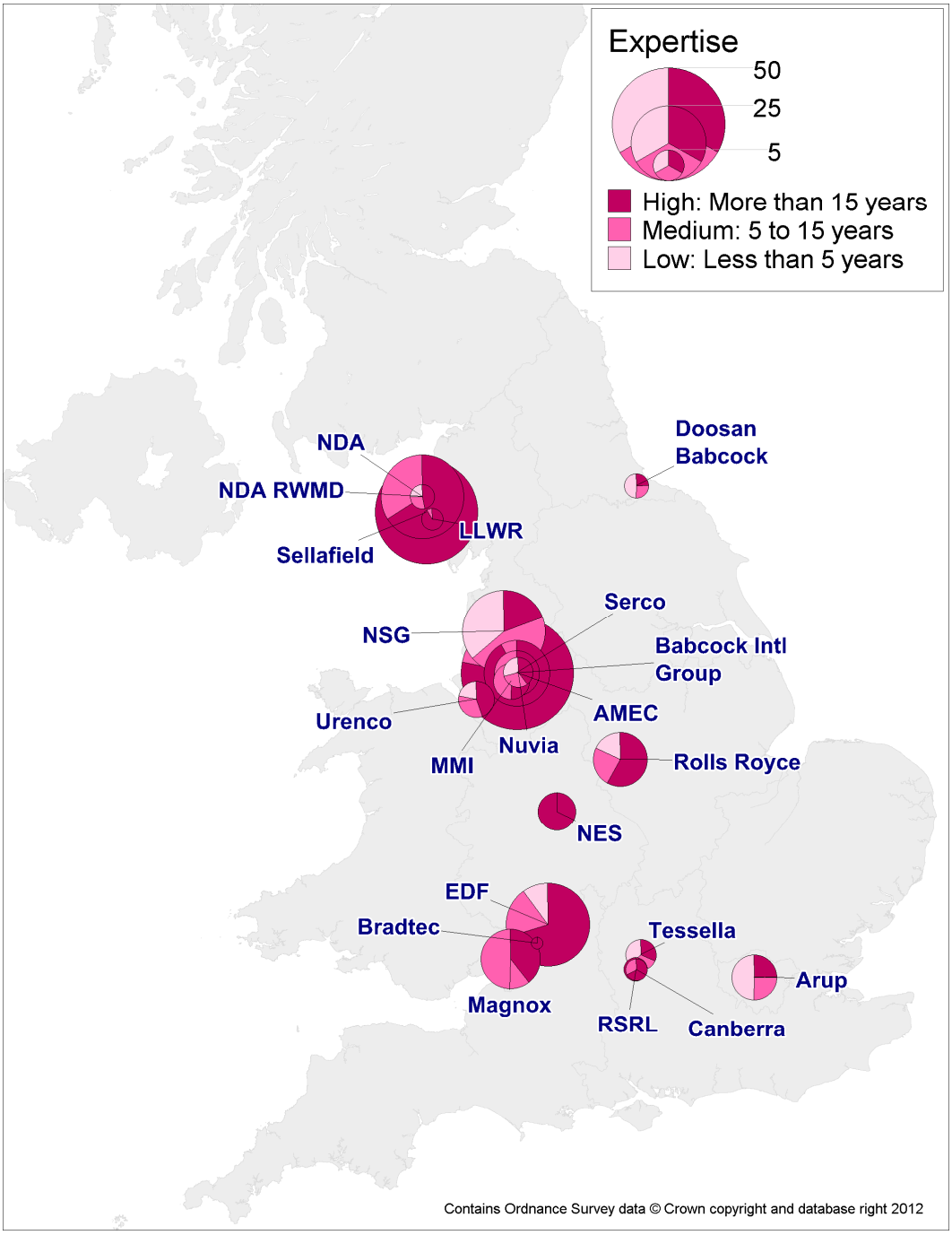

Figure 6.4: The size and experience of the industrial nuclear R&D workforce, totalling 393.9 FTE.

As can be seen in Figure 6.3, the focus of work for many of the UK's private sector R&D personnel is either waste management or reactor technology. Very little manpower is devoted in the areas of fuel cycle assessment, fuel development, advanced reactors and advanced fuel cycles. A large difference can be seen between the work of the national laboratories and that of the private sector in the area of fusion. This is understandable, given the time to market associated with fusion R&D.

12.4% of nuclear R&D personnel in the UK are employed in the academic sector, across a number of different universities. As can be seen in Figure 6.5 and Figure F.1 (in Annex F), the University of Manchester and Imperial College represent large centres of nuclear R&D. There is a greater degree of "junior" staff in universities with more (academic) researchers in the 5-15 years experience range than is seen at the national laboratories or in the private sector.

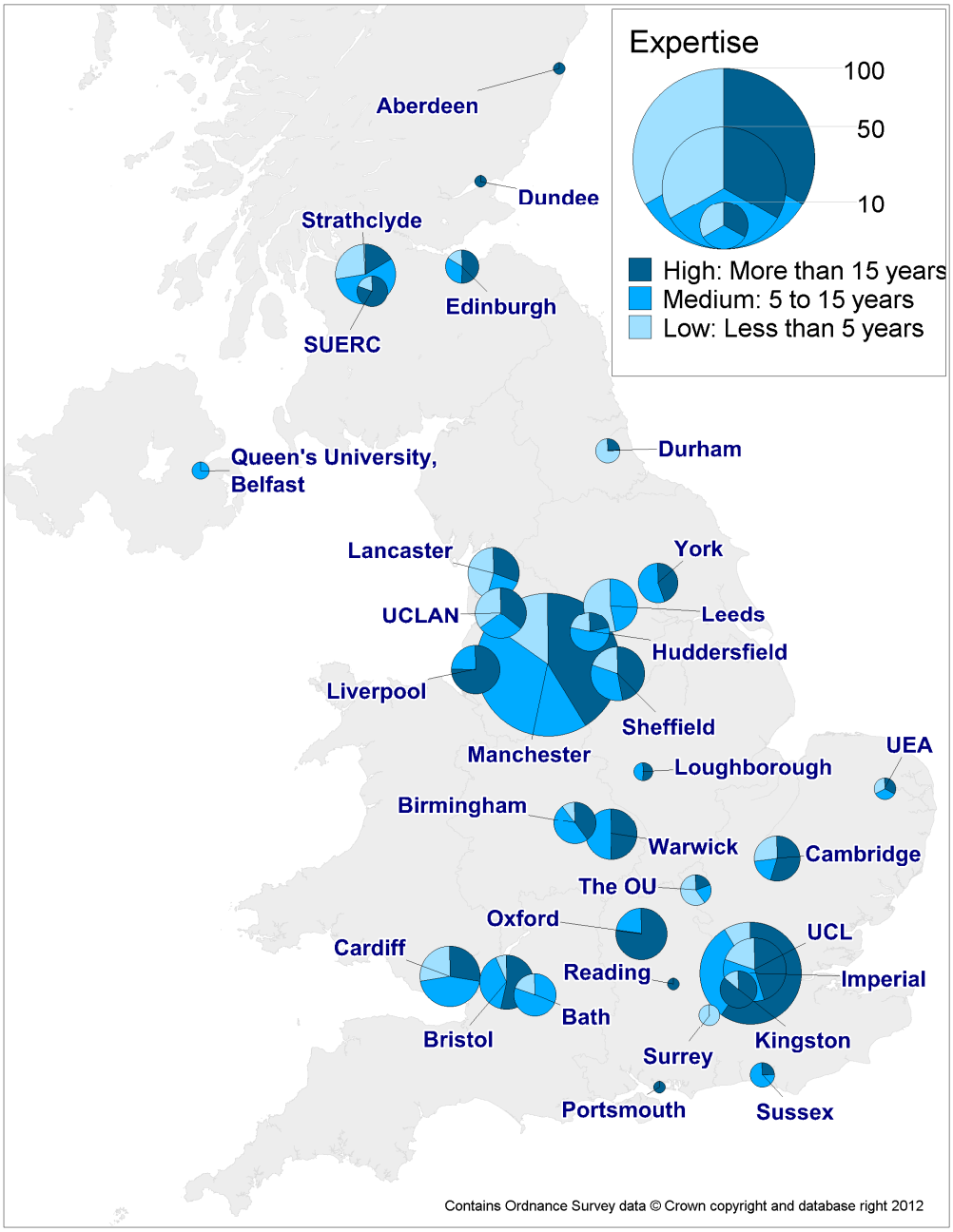

Figure 6.5: The size and experience of the academic (excluding post-doctoral researchers) nuclear R&D workforce in the UK, totalling 237.5 FTE.

As can be seen in Figure 6.6 and Figure F.2 (in Annex F) the subject focus of academic researchers and post-doctoral staff is consistent with the overall emphasis

of nuclear R&D in the UK and with the foci of their private sector and national laboratory colleagues. Decommissioning, waste management, current reactor operations and fusion account for the majority of the academic research effort. Very little manpower is devoted to advanced reactor systems, for example, in Figure F.2 (in Annex F), only 0.2 FTE post-doctoral staff were noted working in this area.

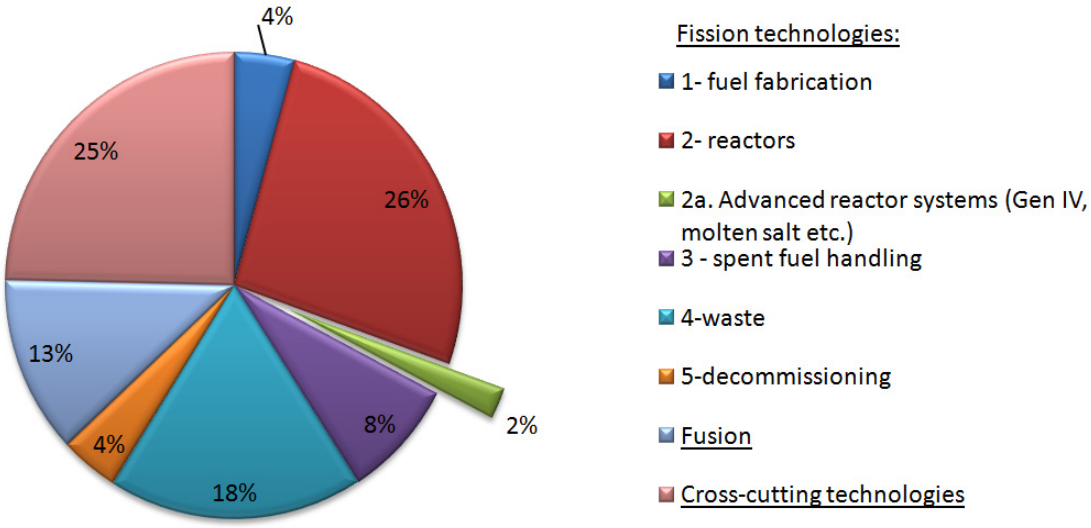

Figure 6.6: The subject focus of the academic (excluding post-doctoral researchers) nuclear R&D workforce in the UK, totalling 237.53 FTE

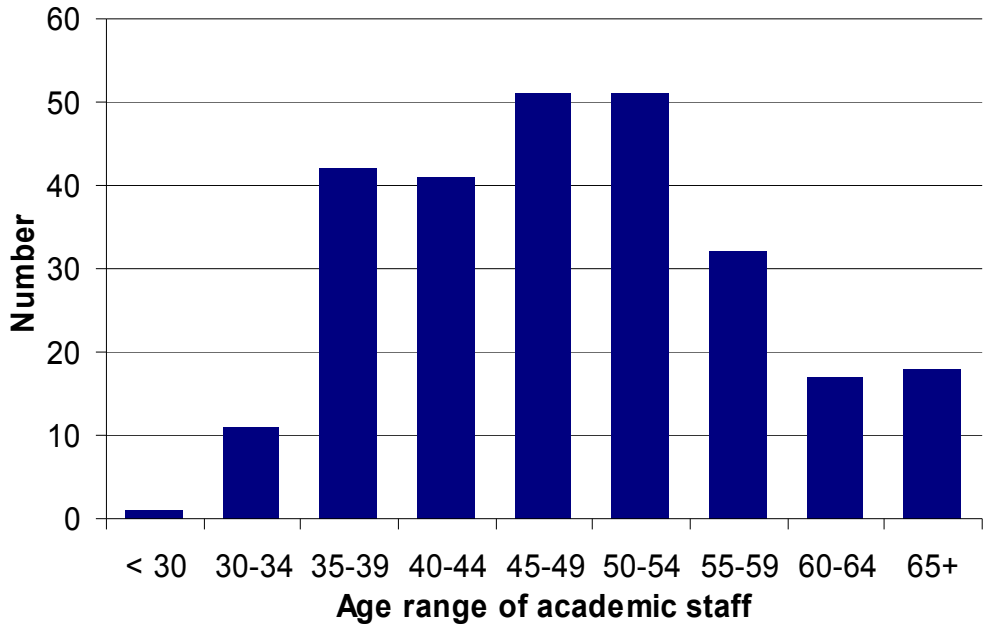

Figure 6.7: Age profile of primary investigators (PIs) and Co-investigators (CoIs) holding EPSRC grants in nuclear fission (2010-2011). NB. Some individuals are on multiple grants and they are counted once for each grant they are on.

In terms of the sustainability of nuclear R&D base in the UK, this review does provide some evidence to support concerns with regard to the age profile of researchers (as inferred from the experience of staff, particularly in the national laboratories). Direct evidence related to the age of researchers is sparse, but EPSRC have provided a breakdown of their grant applicants in the area of nuclear fission (Figure 6.7).

The number of students currently studying for a PhD in this area is encouraging for the future of all three R&D sectors described above. The universities consulted by this review reported a total of 627 at various stages of their post-graduate studies (Figures F.3 and F.4).

Financial Resources for Nuclear R&D in the UK

The headline funding for nuclear R&D in the UK was covered in chapter 4. In this chapter, the review looks in more detail at the resources available to individual public sector research performers in the UK. A detailed and comprehensive overview of complete R&D funding by the private sector is not available due to commercial sensitivities

Figure 6.8 and Figure 6.9 show the amount of reported funding for nuclear R&D in UK national laboratories and universities, alongside the human resources available.

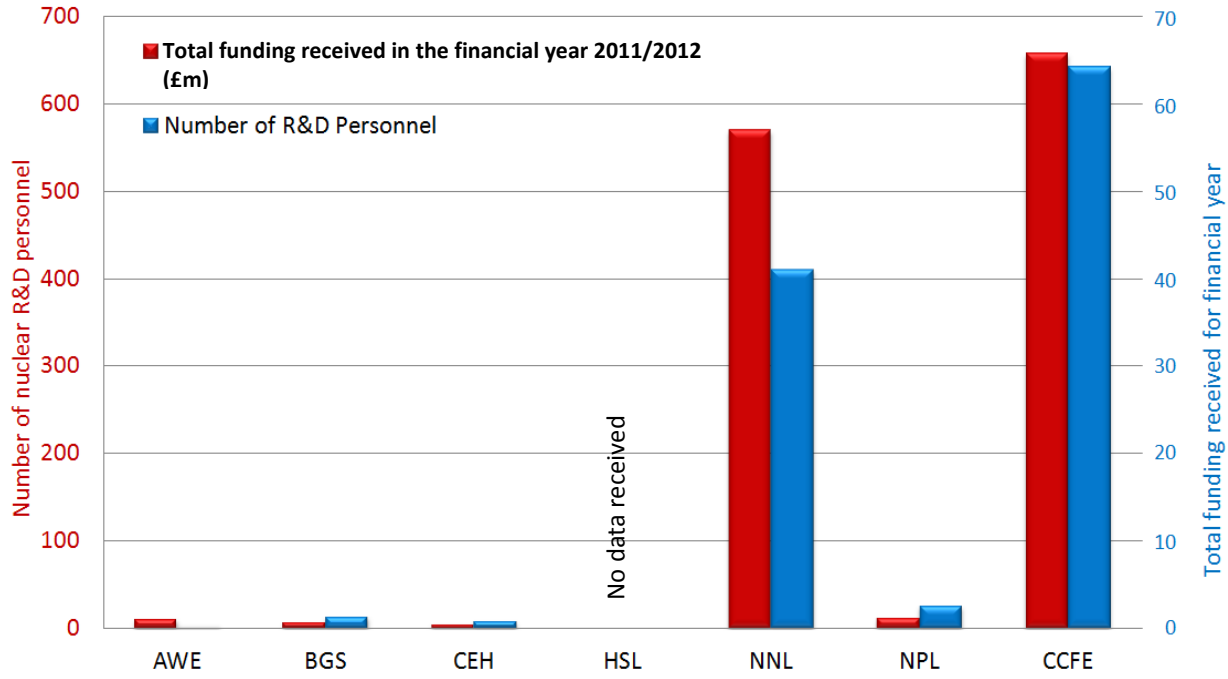

Figure 6.8: Financial and human resources for nuclear R&D available to the national laboratories in the UK

Again, the four major players in terms of FTE and funding are NNL plus CCFE among the national laboratories and the University of Manchester plus Imperial College among the universities

Figure 4.2 and Table 4.2, in chapter 4, show the sources of funding for public sector research performers in the UK. As expected, the research councils provide the majority of funding for universities, but there is also a significant level of industry funding.

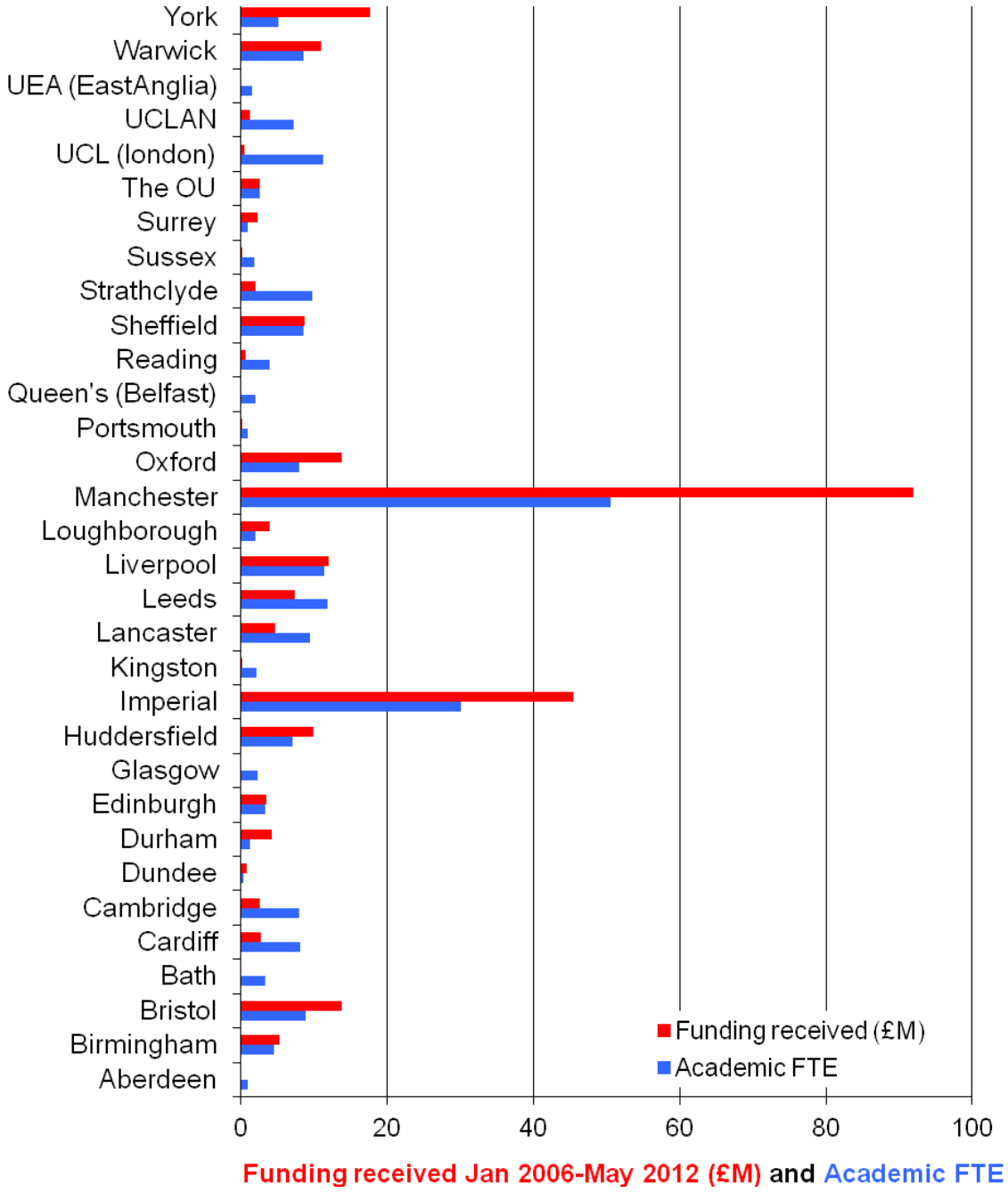

Figure 6.9: Financial and human resources for nuclear R&D available to universities in the UK, from a variety of sources outlined in Figure 4.4. *NB* The Sheffield component of the NAMRC has not been included here, whereas the Manchester component has.

Facilities for Nuclear R&D in the UK

This review focuses on those facilities that are either uniquely required for nuclear R&D or significant facilities that are important for cutting edge R&D in this area.

The most obvious facilities that are relatively unique to nuclear R&D are those required to irradiate materials, undertake work with radioactive materials and those essential to handling pre-irradiated materials.

This review has found that there are a limited number and range of facilities for handling highly active materials in the UK. The main difference between national laboratories, private sector and the academic sector is the level of radioactivity that can be handled and stored at each institution. In general, a limited number of national laboratories and the private sector report having facilities able to handle highly radioactive samples (e.g. hot cells). The most significant facilities for undertaking work with high active material are within the laboratories owned by NDA and operated by NNL at Sellafield. Part of the facility within NNL's Central Laboratory is not operational although a large plutonium laboratory complex is currently being commissioned. The academic sector, however, reports very few facilities, with those that do exist only able to handle low radiation doses; either from low level activity materials, very small quantities of highly radioactive materials or surrogate non-active materials.

Facilities for irradiating materials are also limited. The UK's only research reactor, operated by Imperial College, is about to be decommissioned, highlighting the importance of access to international facilities in this area (see Chapter 7). A university-based accelerator at Cranfield University is likewise due to be closed. New facilities are being commissioned in the UK, including the Dalton Cumbria Facility (part of the University of Manchester) which will provide an ion beam accelerator and a cobalt-60 irradiator. Furthermore, Surrey universities ion bean centre, can undertake a wide variety of research using ion implantation, ion beam analysis (IBA) and microbeam analysis, and has strong links with industry.

Findings

- Whilst the number of nuclear R&D personnel is lower than at the height of the UK nuclear industry in the 1970s and 1980s, this review has identified in excess of 1800 FTE across the national laboratories, the universities and the private sector.
- The R&D undertaken by these personnel is broadly aligned with current UK civil nuclear policy as outlined in Chapter 2:
    - 3.1% fuel fabrication
    - 17.9% current reactor operations
    - 1.5% advanced reactors systems

Findings

  - 5.6% spent fuel handling
  - 21.8% waste management
  - 4.8% decommissioning
  - 7.3% safety, security and social sciences
  - 38.0% fusion

- Again, in keeping, with current UK civil nuclear policy, there is a limited focus on advanced reactor systems (1.6%) and associated fuel cycles undertaken mostly through EU programmes. In UK universities, only 0.2FTE of a post-doctoral research assistant was reported as working in this area. However, the focus of current research may, to some extent, mask dormant capability in these areas, especially if one considers the relatively recent UK withdrawal from the Gen IV fast reactor and fuel cycle programmes and the number of workers with more than 15 years experience (especially in the national laboratories). The age profile of these experts, coupled with the lack of funding at present is a concern.

- To complement the expenditure figures for spend on nuclear R&D by Government Departments in Chapter 4, this review has identified funding received by the national laboratories (for one recent financial year) and by UK universities (between 2006 and 2011).

- The funding received by national laboratories and academia is broadly aligned with existing policy in nuclear energy, as outlined in Chapter 2:

  - 3.7% fuel fabrication
  - 14.5% current reactor operations
  - 9.7% spent fuel handling
  - 15.2% waste management
  - 3.9% decommissioning
  - 5.6% safety, security and social sciences
  - 46.7% fusion

- Again, in keeping, with current UK civil nuclear policy, there is a limited reported funding of public sector research performers on advanced reactor systems (0.6%) and associated fuel cycles.
- An audit of facilities for nuclear R&D in the UK points to a paucity of facilities for handling highly radioactive materials, which will limit the expansion of R&D in a number of areas. However, full commissioning of the NNL's facilities could address this issue.

7. National and International Collaboration in Nuclear R&D

Introduction

In general terms, R&D is a collaborative process. Sometimes a “critical mass” in terms of researchers, ideas and facilities is required to achieve a desired result. To achieve this critical mass, either large R&D groups are formed to tackle a particular problem (for example the Manhattan Project or the US Apollo Programme) or researchers, ideas and facilities are linked together through different forms of collaboration.

This chapter assesses the extent of national and international collaboration in nuclear R&D and reviews the domestic, bilateral and multilateral mechanisms to encourage that collaboration.

Collaboration within the UK

This review has identified that collaboration takes place at varying levels within the UK, suggest a relatively well-networked nuclear R&D community. In particular, there are a number of industry or academic links with research centres in Universities established by the private sector, for example EDF Energy. The national laboratories have close links to academia. The NNL has strategic agreements with six universities and works with another fifteen across a range of research areas.

Figure 7.1 and Figure 7.2 provide information on collaborations between academia, national laboratories and the NDA.

Table 7.1 provides a list of organisations which, in some way, play a role in promoting collaboration within the UK. Most of the organisations in Table 7.1 do not exist specifically to promote R&D collaboration. Their role in this respect is normally a by-product of other activity (e.g. R&D funding).

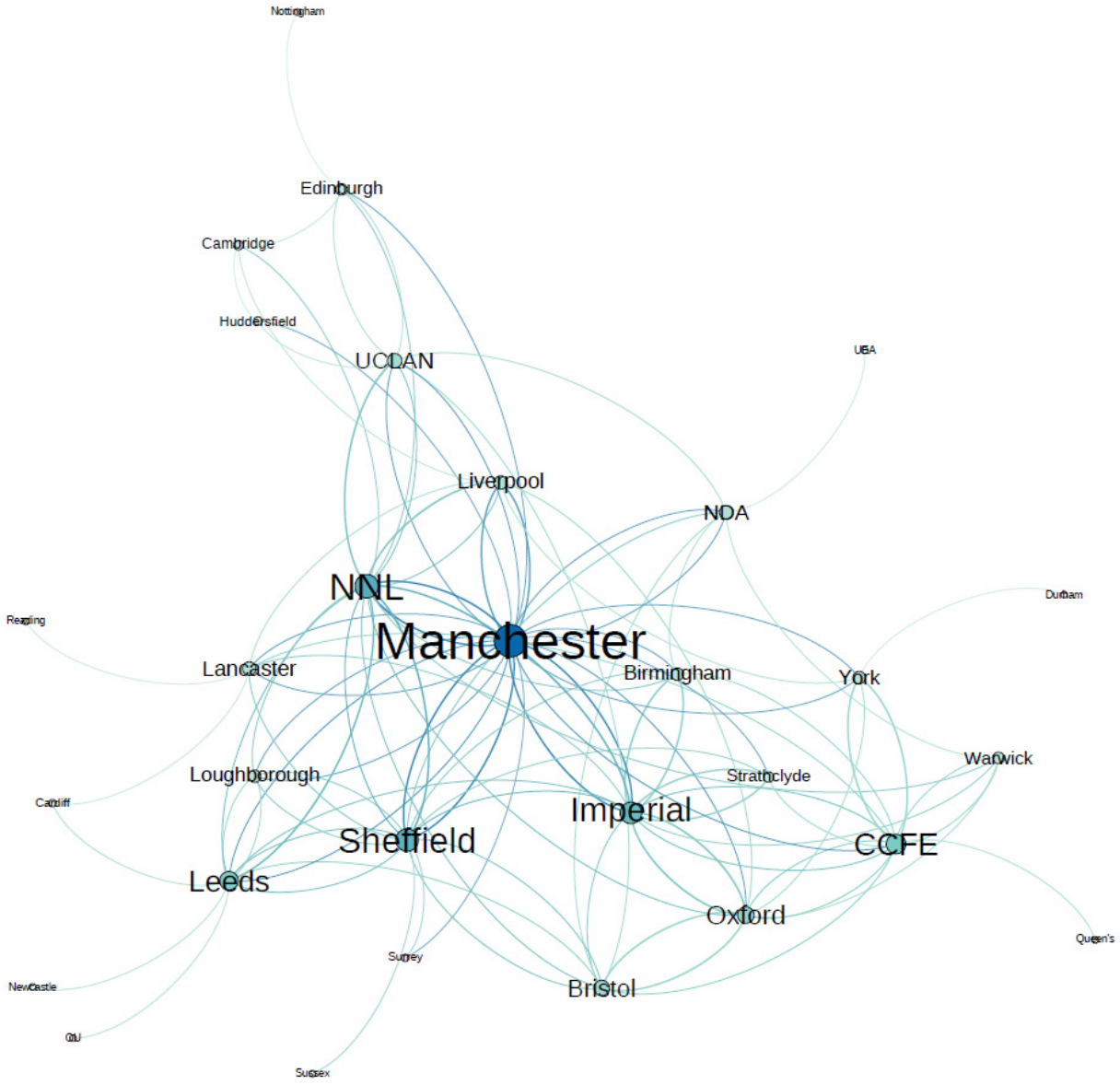

Figure 7.1: UK collaboration in nuclear R&D between academic and selected other institutions, based on the information received during data collection. The thickness of the linking lines denotes the strength of the collaboration.

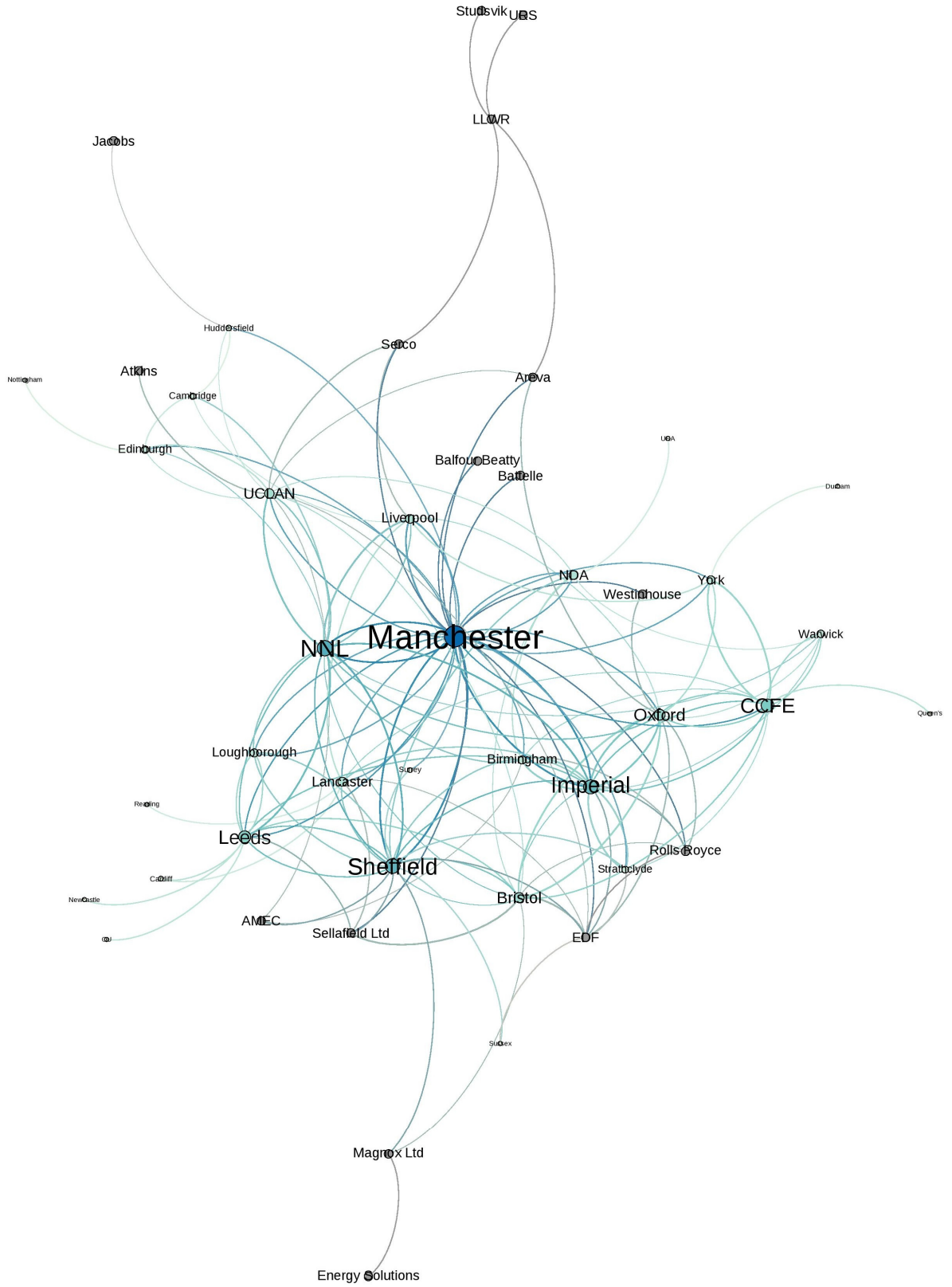

Figure 7.2: UK collaboration in nuclear R&D between academic institutions and industry, based on the information received during data collection. The thickness of the linking lines denotes the strength of the collaboration.

Table 7.1: Organisations that promote domestic collaboration

Organisation	Role
Research Councils UK (RCUK)	The research councils, including the EPSRC-led Energy Programme play a key role in funding consortia of R&D organisations across a wide range of subjects related to both nuclear fission and fusion. Key investments have included “Keeping the Nuclear Option Open”, Decommissioning, Immobilisation and Management of Nuclear Wastes and Disposal and the Nuclear Technology Education Consortium (NTEC).
RCUK Nuclear Champion	Funded by ESPRC and led by Imperial College, the Nuclear Champion project has, among others, a specific aim of establishing networks of collaboration.
Nuclear Research Coordination Group (NRCG)	The NRCG is an informal strategy group convened by EPSRC with the aim of supporting the ongoing development of the UK University sector nuclear R&D programme.
Technology Strategy Board (TSB)	TSB is a funder of technology-based innovation in the UK that has, in recent years, launched four R&D programmes in the nuclear area.
Nuclear Advanced Manufacturing Research Centre (NAMRC)	NAMRC works to combine the experience of industry with the capability of universities. Its three work programmes, manufacturing process R&D, quality requirements, and training and skills development aim to help UK business collaborate and compete internationally.
Nuclear Decommissioning Authority (NDA)	The NDA have established a Research Board, and other support bodies to aid collaboration and coordination of research to support the activities of site license companies.
Nuclear Waste Research Forum (NWRF)	NWRF is an advisory body to the NDA Research board. It has a broad membership of NDA staff, Site license company representatives, regulators and wider industry. The main focuses of its work is R&D to support integrated waste management and site restoration with working groups in characterisation, waste packaging, decommissioning, land quality.

Organisation	Role
Office for Nuclear Regulation (ONR)	ONR is the national regulator and maintains a Nuclear Research Index (NRI). The NRI provides guidance of research priorities and the current direction of research, with industry encouraged to align its research to the current trends.
Nuclear Industry Association (NIA)	NIA is the UK nuclear industries trade association, with around 260 members. It does not have a formal R&D role, and R&D has not been a priority in the past, but it does provide a platform for networking and collaboration across all areas relevant to the industry.
Nuclear Institute (NI)	The NI is a professional institute and learned society for nuclear. It has no formal R&D role but provides a platform for networking and collaboration through events and journals.
Nuclear Technology Education Consortium (NTEC)	NTEC is a consortium of 15 universities and learned institutes that provide postgraduate education relevant to nuclear. It's pooled training programme provides an opportunity for collaboration
Energy Research Partnership (ERP)	The ERP is a broad forum covering all energy fields. However, it has promoted nuclear collaboration keenly in addition to its activity as an open forum for collaboration; notably in the Nuclear fission report of 2010[19].
UK Energy Research Centre (UKERC)	UKERC is the hub of UK energy research and provides a gateway for national and international collaboration. Nuclear is not one of its prime focuses, but it has produced a suite of tools for policy makers and researchers in the UK that is of use to the nuclear field.

International Collaboration

The scale of some aspects of nuclear R&D, combined with the global nature of some of the policy questions surrounding nuclear power have meant that international collaboration has, for decades, been typical in some areas of nuclear R&D

This review has identified a number of international collaborations between UK nuclear R&D organisations and those overseas. Figure 7.3 provides a very high-level summary of those collaborations.

Figure 7.3: Major UK international collaborations in nuclear R&D

Table 7.2 provides a list of organisations which, in some way play a role in promoting international collaboration in nuclear R&D

Table 7.2: Organisations that promote international collaboration

Organisation	Role	Assessment
Research Councils UK (RCUK)	The RCUK Energy Programme has strong links with India's civil nuclear R&D community and the US's Nuclear Energy Universities Programme. In regards to fusion specifically they support collaboration with ITER in France and the National Ignition Facility in the US.	Only involves UK academia, with the Indian national laboratory BARC.

Organisation	Role	Assessment
Foreign and Commonwealth Office (FCO)	UK Trade and Investment (UKTI) is a joint branch of the FCO and BIS focused on promoting the success of UK businesses in international markets. It uses the FCO embassy network and BIS Science and Innovation Network (SIN) to identify opportunities for UK businesses in international nuclear power related work.	Good links in Japan and developing links in France, Middle East Countries, South East Asia and Baltic countries.
European Atomic Energy Community (Euratom)	Euratom supports collaboration between member states across fission, fusion, and non-proliferation issues. This is done through direct control of a pooled budget extracted through the central EU budget. It operates on a cycle of Research Framework Programmes, with the current stage being Framework Programme 7	Some involvement by academia, national laboratories and industry.
International Atomic Energy Agency (IAEA)	The IAEA has the broad mandate to facilitate cooperation between all of its members. This is considered to include R&D and this is typically operated through Coordinated Research Projects (CRPs) that bring together member states in collaborative research work.	No UK involvement in the technical working groups.

Organisation	Role	Assessment
Organisation for Economic Cooperation Nuclear Energy Agency (OECD-NEA)	The NEA provides a forum for OECD members to discuss and collaborate on elements of nuclear R&D. It is more than forum and provides administrative support to aid members in bringing together collaborative efforts. Currently the NEA has 12 ongoing experimental joint projects underway.	Funded via NDA for waste management and decommissioning groups. RWMD sit on (Radioactive Waste Management Committee) RWMC and NDA sit on Working Party on Decommissioning and Dismantling (WPDD). NDA funded attendance at working groups e.g. Sellafield Ltd at NEA WPDD characterisation meetings. NDA hosting WPDD annual meeting in Cumbria this week funded by NDA on behalf of DECC.
Generation IV International Forum (GIF)	GIF focuses on pooling the efforts of 10 active and 3 non-active members in the R&D necessary to support the development of generation iv nuclear reactors. The UK is a non-active member who participates indirectly through the subscription of Euratom (i.e. a low level of involvement).	
International Framework for Nuclear Energy Cooperation (IFNEC)	IFNEC provides a broad forum for participating states to discuss matters in regards to the civil use of nuclear power.	Funded and NDA attend of behalf of DECC.
European Nuclear Safety Regulators Group (ENSREG)	ENSREG is an independent expert body of senior officials from EU member states and the commission itself. It focuses on consideration of security, safety, and radiation protection.	

Organisation	Role	Assessment
European Nuclear Energy Forum (ENEF)	ENEF brings together a broad range of stakeholders from officials, industry, and consumer groups to discuss wider nuclear issues.	Only an irregular meeting group, no research activity
Sustainable Nuclear Energy Technology Platform (SNETP)	SNETP is a body, originally established through Euratom funding, focused on supporting the research, development and demonstration of technologies that will allow Europe to achieve its Strategic Energy Technology Plan. SNETP provides a forum for members to meet to discuss shared work and increasingly looks to more firmly coordinate members R&D efforts through additional instruments such as the European Sustainable Nuclear Industrial Initiative (ESNII). Both NNL and AMEC have representatives on the Board although neither have a remit to provide coordination on behalf of the UK. A sub-group of SNETP considering Gen II/Gen III reactors has now been incorporated into Nugenia along with other activities that came from EU Framework programmes RWMD are involved in and will be chairing Technology platform implementing geological disposal (TPIGD). This will provide an opportunity to coordinate from UK perspective. Under EU frameworks there have been several joint R&D programmes such as Carbowaste.	No research activity, only a coordinating group. There are a number of UK members in academia, NNL and industry.

Organisation	Role	Assessment
European Energy Research Alliance (EERA)	EERA looks at all energy fields but has established a programme on nuclear R&D. It has a largely academic membership, with approximately 20 UK university departments involved. The current focus is on the materials necessary to support generation IV.	
International Thermonuclear Experimental Reactor (ITER)	ITER is the international project for the development of fusion research. It includes 7 world partners, including the UK and EU, and currently has a major facility under construction in France. The UK contribution to ITER is coordinated by CCFE who have a requirement to support the broader involvement of industry.	
Pressurized Water Reactor Owners Group (PWROG)	The mission of the PWROG (run through Westinghouse) is to improve the competitiveness of member plants through cost-effective resolution of issues common to more than one member, and to provide a superior regulatory interface in support of member activities.	
Framatome Owners Group (FROG)	The FROG was set up by five utilities who were either operating or building nuclear power plant units incorporating an AREVA NP nuclear steam supply system or nuclear island. The aim of the FROG is to pool the expertise of its Members and of Areva NP itself in an effort to increase unit availability and improve NPP safety and efficiency. This enables common problems to be identified and resolved through a cost-effective exchange of information.	

Organisation	Role	Assessment
Multinational Design Evaluation Programme (MDEP)	MDEP is a multinational initiative taken by national safety authorities to develop innovative approaches to assess the resources and knowledge of the national regulatory authorities who are currently or will be tasked with the review of new reactor power plant designs.	
Cooperation in Reactor Design Evaluation and Licensing (CORDEL)	CORDEL aims to promote mutual acceptance of design reviews and in the long term international certification of designs. They participate in IAEA safety standard revision processes and cooperate with other international programmes like MDEP. CORDEL also monitors developments within various international industries, intergovernmental and regulatory initiatives.	

Whilst this review has found a number of international collaborations and has confirmed UK engagement with a number of international bodies, no overarching strategy for international collaboration was identified.

Of particular importance due to its significance as a funder is Euratom. No strategy for UK engagement with Euratom or dedicated support to enable organisations to leverage EU funding was identified. There have been attempts to coordinate the UK's approach to Euratom in the past with limited success in the absence of a UK strategy.

The International Sub-Group of the NRDAB has undertaken a Strengths-Weaknesses-Opportunities-Threats analysis of potential R&D partners for the UK. This analysis should inform the development of a UK international strategy in the future.

Findings

- The evidence collected by this review suggests a moderate level of domestic and international collaboration by those organisations undertaking nuclear R&D in the UK. This is particularly the case for fusion research, where the effort is primarily international.
- Collaboration is driven either by funding (where consortia approaches can be encouraged), by the interests of individual researchers or by industrial objectives. There is no overarching UK strategy for international engagement in this area.
- Due to the nature of fusion research (with a clear UK strategy based on international objectives) collaboration is more widespread. Fission research on the other hand does not have a clear UK strategy to build collaborations on, and therefore tends to be more fragmented.
- There are few bodies or mechanisms in the UK with the specific mandate to encourage collaboration although some funding bodies do play this role.
- There are many bodies at an international level which aim to promote international collaboration. It is sometimes confusing as to the respective prominence and responsibility of each these bodies and their relative importance to UK policy goals.
- The level of the UK's participation in the Generation IV International Forum (GIF) is one particular issue of interest to many in the UK nuclear R&D community and this review found considerable support for re-engagement.

8. Conclusions

In 2008, the Government published a White Paper which signalled support for a renewed programme of nuclear power in the UK. The White Paper represented a significant policy shift in the UK from a strategy based on dealing with a dwindling nuclear power industry and with the historic legacy of that industry, to a strategy which also includes a long-term future for nuclear power (from fission) in the UK.

In providing a snapshot of the civil nuclear R&D landscape in the UK, this review portrays an R&D system that is in the process of evolving to adapt to this new, broader range of civil nuclear policy priorities. This review provides an evidence base to inform future Government intervention in that evolutionary process.

This review concludes that further clarification of policy in two areas would be highly beneficial if an optimal civil nuclear R&D landscape is to be developed in the UK. First, the Government's assumptions for the role of nuclear power beyond the current phase of new build will heavily influence the amount and type of R&D carried out in the UK. Secondly, the economic growth potential and international commercial opportunities that this sector may provide.

This review concludes that the institutional landscape and funding that surround civil nuclear R&D is complex and is based on a market approach to nuclear energy. However, the landscape is broadly consistent with current policy goals. Some changes in the landscape and the funding available may be required to underpin new policy direction and as the range of policy widens, coordination mechanisms within this landscape will need to be strengthened.

Promoting stronger links, than those currently in existence, between nuclear R&D at different TRL levels is also of importance. This will help to address national programmes in legacy wastes, new build, geological disposal and plutonium management. It will also ensure that industrial processes are properly underpinned and that a suitable work force can be developed, who can translate between TRL levels 1-9 in all areas of nuclear R&D. Furthermore, strengthening links between all TRL levels in nuclear R&D will ensure that the right infrastructure is in place to support the nuclear R&D industry.

Currently the nuclear R&D community receives funding from a variety of sources, both national and international. However, this review finds that in comparison to international benchmarks, the level of funding for civil nuclear R&D in the UK is low. Furthermore, this review finds that the majority of funding is directed towards decommissioning, safety and performance of current reactors and fusion energy. There appears to be a noticeable dearth of funding provided to R&D of future fission energy. This is in stark contrast to major nuclear nations, such as USA, France and Japan.

There are a number of mechanisms for coordinating the work of research performers in the UK, however, formal mechanisms to ensure coordination at the level of Government and research funders were found to be limited.

This review concludes that the civil nuclear R&D capability in the UK is broadly consistent with current policy goals (there is a substantial amount of R&D occurring in fusion and existing fission energy area, but very little in topics relating to Generation IV reactors or future fission energy supply). The structure of this capability presents opportunities for expansion with both very experienced expertise and a large post-graduate cohort.

Due to the age profile of staff in the national laboratories and the lack of funding in certain areas, some important capabilities and knowledge bases are vulnerable without future intervention, as many staff are due to retire within the next 5-10 years (in particular, fuel development and fuel cycle R&D, reprocessing and associated waste management).

The evidence collected by this review suggests that there is a moderate level of domestic and international collaboration by organisations undertaking nuclear R&D in the UK, particularly in fusion where the effort is primarily international. However, international collaboration is driven by funding or though personal interest of individual researchers. Currently, there is no overarching UK strategy for international engagement in this area and only a few bodies (e.g. some funding bodies) or mechanisms in the UK have a specific mandate to encourage collaboration. Finally, encouraging greater participation in the Generation IV International Forum is one particular issue of interest to many in the UK nuclear R&D community and this review found considerable support for re-engagement.

Annex A: Methodology for the Review

The national laboratory, private sector and academic R&D data presented in this document is a result of a detailed data collection process, where a tailor made questionnaire was developed and peer reviewed by specific members of the NRDAB, specifically for this review. The data collection concentrates on the complete nuclear fission fuel cycle, fusion research, and cross-cutting research areas such as social sciences and safety.

All data received has been included in this review, however, it must be noted that the quality of submissions varied across the board and that all responses may not have been answered to the same level of detail. However, every effort has been made to ensure the trends shown here are as accurate as possible. Additionally an audit of student numbers has been carried out on the two largest academic institutions (Imperial College and Manchester University).

A questionnaire (Figure A.1) was sent to each of the 265 members of the NIA was received and collated from 23 research-active businesses in the UK with a nuclear R&D capability. Furthermore, data was requested from 14 other research performers in the UK (including 7 national laboratories) on their R&D capabilities.

The questions outlined in Figure A.2 were sent to selected academic institutions and data was received and collected from 31 universities. It is important to note the input from NAMRC has been split across Sheffield and Manchester universities in their respective parts.

This data collection process has produced a comprehensive data pack of information and presented within this report is an analysis of the collated data. Annex F gives a breakdown of those organisations and institutions with a nuclear R&D capability who responded to the review survey.

Although the list of organisations and institutions is comprehensive, it is by no means definitive and there may be other organisations that have a nuclear R&D capability that has not been captured. In particular, small and medium enterprises (SMEs) have not been able to be included in this review exercise.

For the purposes of display throughout the document, responses to programme areas outlined in Figures A.1 and A.2, were grouped into high level categories. The breakdown of these categories is displayed in Table A.1.

Table A.1: List of Programme R&D Areas

	Programme Area	Fuel Manufacture & Fuel Cycle	Reactor Technology	Advanced Reactor Systems	Spent Fuel Handling	Decommissioning	Waste	Fusion research	Cross-cutting research
Fission Fuel Cycle Components	Uranium conversion and enrichment	✓							
	Fuel development	✓							
	Fuel manufacture	✓							
	Fuel cycle assessment	✓							
	Reactor technology / design		✓						
	Advanced reactor systems (Gen IV, molten salt etc.)			✓					
	Reactor component manufacture		✓						
	Reactor operation including materials degradation and structural integrity		✓						
	Activation studies and nuclear data for fission		✓						
	Spent fuel storage				✓				
	Fuel recycle / reprocessing (current operations)				✓				
	Fuel recycle / reprocessing (advanced fuel cycle)			✓					
	Nuclear materials management				✓				
	Waste retrieval / legacy clean-up						✓		
	Waste and effluent management						✓		
	Decommissioning					✓			
	Waste disposal including geo-science, earth science and civil engineering						✓		
Fusion Research	Plasma							✓	
	Advanced materials for fusion							✓	
	Tritium handling in fusion							✓	
	Activation studies and nuclear data for fusion							✓	
	Remote handling in fusion							✓	
Cross-cutting Research	Advanced computational methods in nuclear systems, from neutronics to whole systems								✓
	Safety and security								✓
	Social studies including public opinion on nuclear								✓
	Regulatory economics								✓

Figure A.1: Questions sent to Private Sector and National Laboratories

Capturing the UK Civil Nuclear Energy R&D Capability: Private Sector & National Laboratories

This review is designed to establish to what extent various UK private sector organisations and national laboratories are involved with civil nuclear R&D programmes. The aim is to capture the UK nuclear fission and fusion R&D capability, in particular with reference to the following:

Fission Fuel Cycle Components

- Uranium conversion and enrichment
- Fuel development
- Fuel manufacture
- Fuel cycle assessment
- Reactor technology / design
- Advanced reactor systems (Gen IV, molten salt etc.)
- Reactor component manufacture
- Reactor operation including materials degradation and structural integrity
- Activation studies and nuclear data for fission
- Spent fuel storage
- Fuel recycle / reprocessing (current operations)
- Fuel recycle / reprocessing (advanced fuel cycle)
- Nuclear materials management
- Waste retrieval / legacy clean-up
- Waste and effluent management
- Decommissioning
- Waste disposal including geo-science, earth science and civil engineering

Fusion Research

- Plasma

- Advanced materials for fusion
- Tritium handling in fusion
- Activation studies and nuclear data for fusion
- Remote handling in fusion

Cross-cutting Research

- Advanced computational methods in nuclear systems, from neutronics to whole systems
- Safety and security
- Social studies including public opinion on nuclear
- Regulatory economics

Areas to Address

In order to help with this review, please summarise the current nuclear capability in your organisation using the following questions and discuss how you see them developing over the next 12 months. The key areas that will be focused on here are summarised as follows:

A. Focus and Leadership
B. Expertise
C. Facilities
D. Programmes Performed Internally
E. Programmes Funded Externally
F. Outputs
G. Links with Academia and Industry
H. Training and Outreach
I. Recruitment & Retention of Skills

A. Focus and Leadership

i) What areas of nuclear R&D do you have capability in?

ii) How is nuclear R&D structured in your organisation?

iii) Who are the principal leads for the nuclear R&D programmes?

B. R&D Capability Expertise (tab "B" of attached spreadsheet)

Please summarise the expertise (and location) at your organisation, by answering the following questions using the excel spreadsheet associated with this document to compile the data.

i) Summarise number of staff members (full-time equivalents) engaged in nuclear R&D activities in the last financial year (2011-2012).

ii) For principal leads and other staff, please indicate their level of experience in nuclear R&D (H≥15 years, M=5 to 15 years, L≤5 years).

iii) Provide (and if possible name) the number of national and international experts within your organisation and their nuclear R&D areas.

C. Facilities

What nuclear R&D facilities are available at your organisation? Please summarise your amenities under three levels and give the location:

Level 1. High activity radioactive facilities (e.g. hot cells / shielded facilities, glove boxes (for actinide science), fume hoods) and the equipment associated with these facilities.

Level 2. Low activity radioactive facilities and the equipment associated with these facilities. Include equipment that is used for nuclear R&D and also concurrently for research in other areas, e.g. electron microscopes.

Level 3. Non radioactive engineering facilities (e.g. non active laboratories and engineering rig halls for nuclear R&D) and the equipment associated with these facilities.

Please include the scope and status of the facilities and also if you have any other important nuclear R&D equipment / modelling capabilities. Are any of your capabilities at risk? If so, why?

D. Programmes Performed Internally (tab "D" of spreadsheet)

Summarise the nuclear R&D programme areas that you are (a) currently involved in and (b) have been involved in during the past 5 years.

For each programme area please indicate:

- Funding and funder (see list below).

- Size of the programme (if appropriate including any grants, timescale for the grant, the start year and the grant number).

- Timescale to fruition of the nuclear R&D work [short term (<1 year), medium term

(between 1-3 years) and long term (>3 years)].

- Breakdown of the programmes into basic research (TRL 1-3), applied R&D (TRL4-6), technical support / industrial application (TRL 7-9).

Please include any observed trends in R&D funding over the last 10 years and the stability of R&D funding.

Funding Sources:

- Self-funding
- UK Research Council
- UK industry
- UK Government (local and regional)
- Charity support
- EU
- Overseas (non-EU)

NB: to avoid double accounting, please only include that component of the research spend that is undertaken in your organisation with respect to collaborative programmes, and work with your collaborating partner(s) to ensure that the full R&D programme is properly accounted for in your combined submission.

E. Programmes Funded Externally (tab “E” of spreadsheet)

If your organisation funds nuclear R&D programmes externally, please indicate:

- Nuclear R&D programmes areas that you fund.

- Annual budgets.

- Timescale to fruition of the nuclear R&D work [short term (<1 year), medium term (between 1-3 years) and long term (>3 years)].

- Breakdown of the programmes into basic research (TRL 1-3), applied R&D (TRL4-6), technical support / industrial application (TRL 7-9).

- Who you use as the main Research / R&D deliverers.

- Support to international programmes (where / what / how much)

- If you carry out R&D in house, and if so, the capability, area and size of programme.

- Whether your future R&D funding is likely to increase or decrease.

F. Outputs

Please comment on the following:

- Number of patents associated with nuclear technology over previous 5 years.
- Example case studies for impact over previous 10 years.

G. Links with Industry, National Labs, Academia and External Organisations

Please discuss, with details, any international agreements, strategic partnerships or committee memberships that individuals or your organisation may have with:

- UK, EU and International Industry.
- UK, EU and International National Laboratories.
- UK, EU and International Academic institutions.
- UK, EU and International boards and expert groups.
- UK, EU and International nuclear organisations, e.g. IAEA/OECD

Please provide evidence for your partnerships to demonstrate the strength of the relationship. For example, include details on any programme grants, Memoranda of Understanding, Strategic Agreements, etc. that you may hold with these bodies. For overseas partnerships, please also include any information regarding funding. For example, if the collaboration is monetary or based on knowledge sharing.

H. Training and Outreach

Please give an overview of any external training programmes that you provide. Furthermore, if you offer any schools outreach programmes or similar specifically addressing nuclear energy issues, please also discuss these here.

I. Recruitment & Retention of Skills

Please provide an overview regarding the current (and near term future) levels of recruitment into your nuclear R&D capability areas and the ability to retain the skills in these areas within your organisation.

Please also describe the mechanisms in place at your organisation to retain information on past programmes (through individuals or archives).

Figure A.2: Questions sent to Academic Institutions

Capturing the UK Civil Nuclear Energy R&D Capability: Academia

This review is designed to establish to what extent the academic research programmes of various UK institutions are involved with civil nuclear R&D[1]. The aim is to capture the UK academic nuclear fission and fusion R&D capability with respect to the nuclear fuel cycle, in particular with reference to the following:

- Uranium conversion and enrichment
- Fuel development
- Fuel manufacture
- Reactor technology / design
- Reactor component manufacture
- Reactor operation
- Fuel cycle assessment
- Spent fuel storage
- Fuel recycle / reprocessing
- Nuclear materials management
- Waste retrieval / legacy clean-up
- Waste and effluent management
- Decommissioning
- Waste disposal
- Safety and security
- Remote handling of material
- Fusion technologies- plasma/ materials issues

Areas to address

In order to help with this review, please summarise the current nuclear capability in your institution using the following questions and discuss how you see them developing over the next 12 months. The key areas of address that will be focused on here are summarised as follows:

A. Focus and leadership;
B. Expertise;
C. Facilities;
D. Programmes;
E. Outputs; and
F. Links with academia and industry.

A. Focus and Leadership

i) How is the nuclear R&D structured in your institution and,

ii) Who are the academic leads for the nuclear programmes?

B. Expertise

Please summarise the expertise at your institution, by answering the following questions and using the *excel spreadsheet* attached to this letter to compile the data.

i) Name key Principal Investigators, other academics or other staff engaged in nuclear R&D and describe what areas they cover in their research using the table provided.

ii) Summarise numbers of staff members and PhD researchers partaking in nuclear R&D activities this academic year (2011-2012).

iii) For Principal Investigators and other academics, please demonstrate their level of experience (**H**≥15 years, **M**=5 to 15 years, **L**≤5 years) and indicate the percentage of full time equivalent (FTE).

C. Facilities

What nuclear research facilities are available at your institution? Please summarise your amenities under three levels:

Level 1. Equipment whose primary recognised purpose is to undertake nuclear research, e.g. radiochemistry lab, autoclaves, Nuclear Advanced Manufacturing.

Level 2. Equipment which is used for nuclear research and also concurrently for other areas, e.g. electron microscopes.

Level 3. Items that could be used for nuclear research but are not, e.g. microscopes.

D. Programmes

Summarise nuclear R&D programmes across full nuclear fuel cycle over previous 5 years. Quantify level of research income against specific funding sources under the following headings in the *spreadsheet attached (*click tab “D”).

- Self-funding
- UK Research Council
- UK industry
- UK Government (local and regional)
- Charity support
- EU
- Overseas

NB: *to avoid double accounting, please only include that component of the R&D that is undertaken in your institution with respect to collaborative programmes, and work with your collaborating partner(s) to ensure that the full R&D programme is properly accounted for in your combined submission.*

E. Outputs

Please comment on the following:

- Number of nuclear papers in Journals over previous 5-years.
- Citations for nuclear publications over previous 5-years.
- Number of patents associated with nuclear technology over previous 5-years.
- Example case studies for impact over previous 10 years.

F. Links with Academia and Industry

Please discuss, with details, any strategic partnerships that your institution may have with

- Other UK, EU and International Academic institutions
- UK, EU and International industry
- UK, EU and International boards and expert groups, e.g. CoRWM
- Key UK, EU and International nuclear organisations, e.g. NIA, NI, IAEA, WNA

Please provide evidence for your partnerships to demonstrate the strength of the relationship. For example, include details on any programme grants, Memorandum of Understanding, Strategic Agreement, etc. that you may hold with the above bodies. For overseas partnerships, please also include any information regarding funding. For example, if the collaboration is monetary or based on knowledge sharing.

G. Training and Outreach

Please give an overview of any undergraduate or postgraduate training programmes you provide. Furthermore, if you offer any schools outreach programme or similar specifically addressing nuclear energy issues, please also discuss these.

If your institution engages with public bodies for nuclear R&D (for example IAEA, CoRWM etc.) then please list these and the nature of your collaboration.

Thank you for your assistance with this review.

Annex B: Nuclear Policies and Objectives Contained in the Departmental Business Plans

Figure B.1: Nuclear Policies and Objectives Contained in the Departmental Business Plans

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored								
		Y/N	Strategy/ objectives in place? Y/N	programme in place? Y/N	Comment	Y/N	Internal/ External	WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
DECC		Y	N	N												
	DECC-Science & Innovation	assumed	N	N		Y	external									

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored								
			Strategy/ objectives in place?	programme in place?	Comment			WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
		Y/N	Y/N	Y/N		Y/N	Internal/ External									
	DECC-Nuclear Decommissioning & Security	Y	N	Y	UK safeguards support programme	Y	external		x							
	DECC-Office for Nuclear Development	Y	N	N		N										
	NDA	Y	Y	N	Direct Research Portfolio	Y	external	x				x				
	NDA-RWMD	Y	Y	Y	HA waste disposal strategy	Y	external	x								

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored								
			Strategy/ objectives in place?	programme in place?	Comment			WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
		Y/N	Y/N	Y/N		Y/N	Internal/ External									
	NNL	Y	Y	Y	signature research programmes	Y	both	x	x		x	x		x	x	
FCO		Y	N													
	FCO-Defence & Intelligence	Y	N	Y	Strategic Programme Fund-Counter Proliferation Programme	Y	external		x							

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored								
			Strategy/ objectives in place?	programme in place?	Comment			WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
		Y/N	Y/N	Y/N		Y/N	Internal/ External									
	FCO-EcoNmic & Consular	Y	N	Y	UK-US Collaboration Development Award Programme											
	FCO-Political	Y	N	N												
UKTI	UKTI	Y	N	N		N										
BIS		Y	N													

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored								
			Strategy/ objectives in place?	programme in place?	Comment			WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
		Y/N	Y/N	Y/N		Y/N	Internal/ External									
	UK Space Agency	N	N	N		Y	external									
	CCFE	Y	Y	Y	EFDA	Y	internal							x		
	RCUK via EPSRC	Y	N	Y	RCUK Energy Programme	Y	external	x				x		x	x	
	TSB	Y	Y	Y	Energy Action Plan	Y	external	x								

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored								
			Strategy/ objectives in place?	programme in place?	Comment			WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
		Y/N	Y/N	Y/N		Y/N	Internal/ External									
	RC India via EPSRC	Y	N			Y	external				x				x	
Home Office		Y	N													
	Borders Agency	Y	N	N		Y	external		x							
	Office of Security & Counter Terrorism	Y	N	N	*check CONTEST*	Y	external		x							

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored							
			Strategy/ objectives in place?	programme in place?	Comment			WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
		Y/N	Y/N	Y/N		Y/N	Internal/ External									
	Centre for Applied Science & Technology	Y	N	N	*check CONTEST*	Y	internal		x							
DEFRA		Y	N	N		N										
	Environment Agency incl SEPA	Y	N	N		Y	external						x			
	FERA	Y	N	N		Y	internal		x	x			x			

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored								
			Strategy/ objectives in place?	programme in place?	Comment			WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
		Y/N	Y/N	Y/N		Y/N	Internal/ External									
	FERA-GDS	Y	N	Y	Emergency Response and Recovery Programme	Y	external			x						
DWP		N	N	N		N										
	HSE	N	N	N												
	ONR	Y	N*	N	*strategy in development	Y	external						x			

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored								
			Strategy/ objectives in place?	programme in place?	Comment			WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
		Y/N	Y/N	Y/N		Y/N	Internal/ External									
Health		N	N													
	FSA	Y	N	Y	radiological safety of food programme	Y	external			x						
	HPA	Y	N	Y	EURATOM MELODIE	N	internal			x						
MOD		Y	N													

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored								
			Strategy/ objectives in place?	programme in place?	Comment			WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
		Y/N	Y/N	Y/N		Y/N	Internal/ External									
	AWE	Y	N	N		Y	external	x								
	CBRN Delivery Team	Y	N	N		Y	external		x							
	DSTL	Y	N	N		Y	external		x							
International Development		Y	N	N		N										

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored								
			Strategy/ objectives in place?	programme in place?	Comment			WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
		Y/N	Y/N	Y/N		Y/N	Internal/ External									
Communities & Local Government		assumed	N	N		N										
Education		assumed	N	N		N										
Transport		assumed	N	N		N										
HMRC		N	N	N		N										

Government Dept	Relevant directorate, agency, NPRB,etc	Interest in civil nuclear energy?	Evidence of formalised approach to Civil nuclear R&D			Funder of civil nuclear R&D		R&D Field sponsored								
			Strategy/ objectives in place?	programme in place?	Comment			WM&D	Security, Safeguards & CBRN	Rad protection	new build	Back end & Adv. fuel cycle	Safety, env & regulatory	fusion	sustainability, acceptability	plant support
		Y/N	Y/N	Y/N		Y/N	Internal/ External									
Justice		N	N	N		N										
Culture, Media & Sport		N	N	N		N										

Annex C: Existing Public Sector and Nuclear Energy R&D Strategies, Objectives and Programmes

Table C.1: Existing Public Sector and Nuclear Energy R&D Strategies, Objectives and Programmes

Public Sector organisation	Outline of Existing R&D Strategy/Objectives	Type	Linked nuclear R&D programme(s) in place
DECC- Nuclear Security & Decommissioning ***(administered on its behalf by the National Nuclear Laboratory (NNL))***	**UK Support Programme to IAEA Safeguards (UKSP)** Part of the UK contribution to the maintenance of the international safeguards regime, with the aim to assist the IAEA in ensuring the continued and improved effectiveness of its safeguards system. Contributes to IAEA Department of Safeguards and its R&D Programme. The UKSP currently contributes to the Department of Safeguards: • expertise and advice for the further development of safeguards strategies in new and existing activities and plant in the nuclear fuel cycle; • support to IAEA in analysing nuclear material arising from samples taken; • access to facilities and experts for the training of Agency personnel; • development of methods and procedures for safeguarding facilities; • development and assessment of equipment, instruments and methods for application in safeguarding the nuclear fuel cycle; and • Assistance through the provision of expert staff. During the period 1 April 2011 to 31 March 2012, the UKSP contributed to 26 active tasks within the Department of Safeguards R&D Programme, completing work on 2 of these.	Programmatic provision of R&D and solutions to needs identified by IAEA, plus consultancy and training	Yes Multi-year UK contribution to IAEA Department of Safeguards R&D Programme Supported by multiple R&D contractors

Public Sector organisation	Outline of Existing R&D Strategy/Objectives	Type	Linked nuclear R&D programme(s) in place
NDA	**R&D Topic Strategy** (SMS/TS/F2-RD/001/C, March 2011); R&D identified and undertaken by SLCs and their supply chain; Where required NDA will directly sponsor strategic R&D	Approach to responsibilities for R&D and its procurement within NDA estate	N/A
NDA	**Direct Research Portfolio**; Sponsor R&D and technical assessments that resolve generic estate-wide issues or support advice to government relating to legacy waste management and clean-up. Areas of R&D/Assessment: • Lot 1- University interactions; • Lot 2- Waste Processing; • Lot 3 – Material Characterisation; • Lot 4- Actinide and Strategic Materials Purpose of R&D: Inform NDA Strategy, Encourage Innovation or Support Skills	Identifies topics in which direct funding of R&D to framework contractors is possible, and the purpose of the R&D	Possibility via competitive contracts within framework
NDA-RWMD	**Underpinning of Geological Disposal of the UK Higher-activity Radioactive Wastes** (NDA/RWMD/011 – Issue 1): Develop generic designs for disposal of HLW and SF and assess their safety; Support the development of management strategies for materials such as uranium and plutonium; Continue R&D into ILW disposal ; Address implementation issues, e.g. retrievability, disposal in a single geological disposal facility; Prepare for site characterisation; Investigate the social aspects	Sets out required technical needs and associated R&D activities	Yes

Public Sector organisation	Outline of Existing R&D Strategy/Objectives	Type	Linked nuclear R&D programme(s) in place
EPSRC & STFC	**Fusion for Energy Strategy (2010)** • Joint EPSRC and STFC support to fusion research as a long term endeavour in which the UK is making an internationally leading research contribution and demonstrating leadership to realise the goal of fusion energy. • Develop a long term base funding mechanism for magnetic confinement fusion as part of the RCUK energy programme, include support for the reduced MAST upgrade. • Provide targeted "challenge" funding for specific fusion research. • Seek an agreement with Euratom on long term JET funding. • Realise the benefits of more immediate applications as they arise from fusion research programmes. • Industry will be funded as specialist developer and supplier of equipment • Broaden research input and develop the next generation of fusion scientists and engineers via links with universities • Widen the remit of the current Fusion Advisory Board to cover both magnetic and inertial confinement fusion.	Strategic aims and objectives, setting out case for continued long term funding of fusion research, major equipment upgrades and university links	Yes (UK Magnetic Fusion Programme, plus research grants in Plasma and Lasers)
EPSRC	**A 20-year Vision for the UK Contribution to Fusion as an Energy Source** Recognises major challenges to realise fusion as commercial energy source (post 2050); UK support due to major global role that fusion could play. Reviewed in 2009.	Strategic case for continued long term funding of research	Yes (UK Magnetic Fusion Programme)

Public Sector organisation	Outline of Existing R&D Strategy/Objectives	Type	Linked nuclear R&D programme(s) in place
CCFE	Strategy as defined by **European Fusion Development Agreement (EFDA)** with main aims: 1) Developing concepts for fusion power plants and (2) preparing for the ITER experiments. R&D Objectives for UK: • To operate JET, the world's current leading fusion research facility, enabling experimentation by Task Forces of scientists from all EURATOM Fusion Associations, including the UK. • To contribute to the key areas of study in magnetic confinement fusion research	Coordinates the direction of research set by European community of Task Force experts	Yes
CCFE	**UK Magnetic Fusion Programme: Magnetic Confinement Fusion (MCF);** Long-term aim to position UK industry to be a major player when fusion power stations are built; Includes UK funding for the Joint European Torus (JET) at CCFE and upgrade of MAST. Programmed activities: (1) Experiments on MAST; (2) Participation in the JET programme; (3) Improving structural and plasma-facing materials for fusion power stations; (4) Designing specialist heating and measurement technologies for ITER, and facilitating involvement of UK industry; (5) Forward looking efforts on technologies for a demonstration fusion power station to follow ITER.	EPSRC funded R&D Programme including UK contribution to JET and MAST upgrade	Yes (35.5% of energy programme directed to UK Magnetic Fusion Programme)

Public Sector organisation	Outline of Existing R&D Strategy/Objectives	Type	Linked nuclear R&D programme(s) in place
RCUK (led by EPSRC on behalf of all research councils)	**RCUK Energy Programme** Overaching goal is to sponsor research and PhD training to secure a low-carbon future, through the creation of reliable, economically viable energy systems while protecting the natural environment, resources and quality of life. Shaped with advice from internal and external advisory bodies, stakeholders and the academic community. Focus on speculative research through core disciplines; prioritisation of transformative, creative and potentially disruptive research. Continued support of UK research to develop fusion for energy. Aim to produce a comprehensive roadmap of UK research and PhD training needs to meet UK CO_2 reduction targets, and to support energy technology.	Strategic aims of programme set to sponsor speculative and transformative research and PhD training to secure low carbon future; Continued support to fusion.	Yes (35.5% and 5.8% of energy programme directed to fusion and fission respectively)
Technology Strategy Board	**Delivery Plan 2012-2013: Energy Action Plan 2012-2013** • Develop sustainable supply chain and accelerate commercialisation of innovative technologies at SMEs and academia via collaborative R&D competition (partnership with EPSRC, NDA and DECC) • Encourage new SME entrants by supporting development of new underpinning technologies for new build via feasibility studies in nuclear power • Knowledge transfer from university research and develop skills for new build, decommissioning, waste storage and disposal via Knowledge Transfer Partnership (KTP) co funded by NDA	Assist acceleration of innovative technologies, especially by SMEs, and build a UK supply chain for nuclear facility construction, commissioning and operation	Possibility via competitive contracts

Note: R&D programme defined as a coordinated group of linked R&D activities typically active for more than one year

Annex D: Funding Flow Diagram- the UK Nuclear Funding Landscape

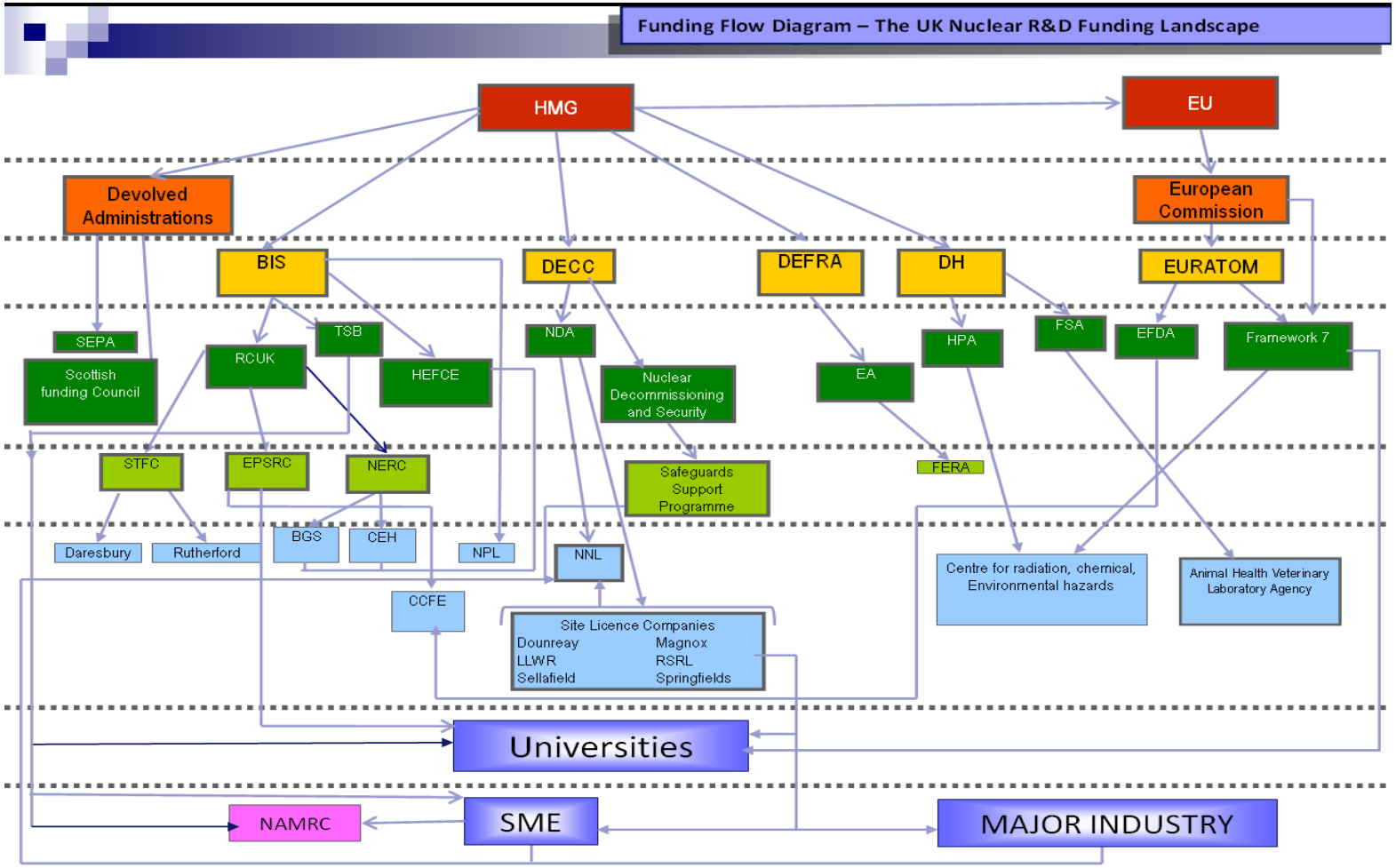

Figure D.1: Funding flow diagram – The UK nuclear R&D funding landscape

Annex E: List of Organisations Involved in the Nuclear R&D Landscape in the UK and Summary of their Remits

Table E.1: List of Organisations Involved in the Nuclear R&D Landscape in the UK and Summary of their Remits

Landscape Sector	Landscape Organisation	Remit- respective of nuclear energy	Accountable to	Funder of UK R&D?
Public	Department for Energy and Climate Change (DECC)	Lead government department responsible for the development and implementation of nuclear policy, covering current and future nuclear installations in the UK as well as dealing with the legacy of nuclear generation. The lead government department responsible for nuclear issues, including the policy on safety and security of the UK's civil nuclear site and civil nuclear emergency planning in England and Wales.	HMG	no
Public	DECC – Nuclear Decommissioning & Security	Nuclear security & Non-proliferation and emergency planning; leads UK support to IAEA Department of Safeguards via UKSP R&D programme	DECC	yes
Public	DECC _OND	Focuses on removing potential barriers to investment, and signals clearly to the industry the serious intent of the Government to push forward nuclear new build.	DECC	no
Public	DECC- Science & Innovation	Group comprising scientists, engineers and statisticians who: provide advice and analysis to policy teams within DECC; maintain the UK greenhouse-gas inventory and produce national greenhouse gas statistics; lead on international science policy issues (Intergovernmental Panel on Climate Change and under the United Nations Framework Convention on Climate Change); and, manage major innovation investment programmes focused on low carbon technologies.	DECC	potential

Public	Nuclear Decommissioning Authority (NDA)	The Nuclear Decommissioning Authority (NDA) is a DECC sponsored Non-Departmental Public Body created under the Energy Act (2004). Its core objective is to ensure the historic civil public sector nuclear legacy sites are decommissioned safely, securely, cost effectively and in ways that protect the environment. It is a strategic authority that owns 19 sites and the associated civil nuclear liabilities and assets of the public sector, previously under the control of UKAEA and BNFL. The NDA is also required to: Operate existing commercial activities and meet current contracts, using revenues to offset spend on decommissioning; and Scrutinise the site decommissioning plans of British Energy.	DECC	yes
Public	NDA-Radioactive waste management directorate (NDA-RWMD)	Directorate within NDA; responsible for implementing geological disposal of higher activity radioactive waste and delivering the UK Government's integrated nuclear waste policy.	NDA, DECC	yes
Public	International Nuclear Services	International Nuclear Services is a wholly owned subsidiary of the Nuclear Decommissioning Authority; is the customer interface to over 20 nuclear utility customers worldwide for irradiated fuel reprocessing, MOX fuel supply and related services. INS also perform the transport of nuclear materials globally, on behalf of UK customers.	NDA	no
Public	Pacific Nuclear Transport Ltd	Pacific Nuclear Transport Limited, a subsidiary of International Nuclear Services, is the world's most experienced shipper of nuclear cargoes.	INS	no
Public	Nuclear Liabilities Fund	public corporation; The Nuclear Liabilities Fund ('NLF') is a Scottish registered company holding investments with a market value of £8.6bn at 31 March 2011, for the purpose of providing funding to meet certain waste management costs of and, in due course, the decommissioning liabilities of, the eight nuclear power stations of British Energy Group plc ('British Energy') - now EDF Energy.	DECC	no

Public	Nuclear Liabilities Financing Assurance Board	Advisory NDPB for DECC; DECC has created the independent Nuclear Liabilities Financing Assurance Board (NLFAB), to provide impartial scrutiny and advice on the suitability of the Funded Decommissioning Programme (FDP), submitted by operators of new nuclear power stations. The Board will advise the Secretary of State on the financial arrangements that operators submit for approval, and on the regular review and ongoing scrutiny of funding	DECC	no
Public	Committee on Climate change	Executive NDPB; Established in November 2008 under the Climate Change Act, the CCC advises the Government on emissions targets and reports to Parliament on progress made in reducing greenhouse gases	DECC	no
Public	Committee on Radioactive Waste Management	Advisory NDPB for DECC; The role of the Committee on Radioactive Waste Management is to provide independent scrutiny and advice to the Government on the long term management, including storage and disposal, of radioactive waste. Within this role its main task is to provide independent scrutiny on proposals, plans and programmes to deliver geological disposal, together with robust interim storage, as the long term management option for the UK's higher activity wastes	DECC	no
Public	Shareholder Executive	Overarching objective is to be an effective shareholder of businesses owned or part-owned by the Government and to manage Government's interventions in the private sector in order to secure best value for taxpayer; to lead the NDA Public Value programme to identify scope for significant affordability improvements without unacceptable impacts on vfm, safety, deliverability and policy; to pursue the commercialisation, efficiency and examination of alternative ownership structures for core assets within the ShEx portfolio; oversight of performance of National Nuclear Laboratory and URENCO UK.	BIS/DECC	no

Public	Department for Business, Innovation and Skills (BIS)	The Department for Business, Innovation and Skills (BIS) is making a difference by supporting sustained growth and higher skills across the economy.	HMG	no
Public	Technology Strategy Board (TSB)	Assist acceleration of innovative technologies, especially by SMEs, and build a UK supply chain for nuclear facility construction, commissioning and operation via Energy Action Plan	BIS	yes
Public	Research Councils UK (RCUK)	A strategic partnership of the UK Research Councils. established to enable the Research Councils to work together more effectively to enhance the overall impact and effectiveness of their research, training and innovation activities, contributing to the delivery of the Government's objectives for science and innovation; RCUK are responsible for investing public money in research in the UK to advance knowledge and generate new ideas which lead to a productive economy, healthy society and contribute to a sustainable world; sponsorship of collaborative cross-council Energy themed research	BIS	yes
Public	Engineering and Physical Sciences Research Council (EPSRC)	Dedicated national funder of long-term, fundamental engineering and physical sciences research and training in the UK, and committed to excellence and impact; Leads the Cross Council Energy Programme.	BIS	yes
Public	Science and Technology Facilities Council (STFC)	Contribution to RCUK Energy Programme; Operates/hosts Daresbury Laboratory and Rutherford Appleton Laboratory	BIS	yes
Public	Economic and Social Research Council (ESRC)	Contribution to RCUK Energy Programme; the UK's largest funder of research on economic and social issues	BIS	yes
Public	Natural Environment Research Council (NERC)	Contribution to RCUK Energy Programme; NERC is the UK's main agency for funding and managing research, training and knowledge exchange in the environmental sciences; NERC is a non-departmental public body funded by BIS	BIS	yes
Public	Biotechnology and Biological Sciences Research Council (BBSRC)	Contribution to RCUK Energy Programme	BIS	yes

Public	Centre of Ecology & Hydrology	The Centre for Ecology & Hydrology (CEH) is the UK's centre of excellence for research in land and freshwater environmental sciences. Their work encompasses a wide range of environmental disciplines ranging from the smallest genes to whole Earth systems; CEH's annual budget is around £33m. NERC provides over £23m; the rest is from external funding	NERC	performer
Public	British Geological Survey	World's longest-established national geological survey and the United Kingdom's premier centre for earth science information and expertise. BGS's annual budget is around £47m. Approximately half of BGS's income (£52·5m) comes from NERC. The remainder comes from commissioned research from the public and private sectors	NERC	performer
Public	Daresbury Laboratory	Hosts STFC nuclear physics group	STFC	facility
Public	Rutherford Appleton Laboratory	Hosts nuclear R&D facilities such as DLS, ISIS, Central Laser Facility	STFC	facility
Public	RCUK India	launched in October 2008 with an aim to bring about a step change in research partnerships between the two countries and make it easier for the best researchers in UK and India to develop high-quality, high impact research partnerships; supporting UK-India Nuclear collaboration with India's Department of Atomic Energy (DAE)	RCUK	yes
Public	Technology Strategy Board (TSB)	Stimulates technology innovation in industry in areas offering the greatest scope for boosting UK growth and productivity.	BIS	yes

Public	UK Space agency	executive agency of the Department for Business, Innovation and Skills (BIS) and at the heart of UK efforts to explore and benefit from space; responsibility for all space activities that have transferred from a number of bodies, including government departments, Research Councils and non-departmental public bodies. The Agency is responsible for the whole of the UK space activities; Collaboration with external organisations including European and global partners such as the European Space Agency (ESA), the European Union, national space agencies and the United Nations	BIS	yes
Public	United Kingdom Atomic Energy Authority (UKAEA)	non departmental public body (NDPB) within the Department for Business, Innovation and Skills (BIS); manages the UK fusion research programme and operates the Joint European Torus (JET) on behalf of the European Fusion Development Agreement (EFDA) at Culham, Oxfordshire	BIS	no
Public	Culham Centre for Fusion Energy (CCFE)	UK's national fusion research laboratory; owned and operated by the United Kingdom Atomic Energy Authority; hosts the world's largest magnetic fusion experiment, JET (Joint European Torus), on behalf of its European partners.; funded by EPSRC, EU FP7	UKAEA; EFDA	yes, performer
Public	National Measurement Office (NMO)	Executive Agency of the Department for Business, Innovation and Skills and is based in Teddington; ensuring that fair and accurate measurement is available and used for transactions regulated by law	BIS	no
Public	Dept of Health	The Department of Health provides strategic leadership for public health, the NHS and social care in England	HMG	no

Public	Health Protection Agency (HPA)	A non-departmental public body dedicated to protecting people's health and reducing the impact of infectious diseases, chemical hazards, poisons and radiation hazards. The Radiation Protection Division (RPD), within the Centre for Radiation, Chemical and Environmental Hazards (CRCE), provides all the specialist research and advice on radiological issues to HPA. . RPD carries out a substantial portfolio of low dose risk research. Members of staff hold key roles in international advisory bodies such as ICRP, contribute to the UK delegation to UNSCEAR and are regularly asked to provide input into US bodies such as NCRP. HPA-RPD has a strong track record of contributions to EC low dose risk research.	Dept of Health	performer
Public	Food Standards Agency (FSA)	The Food Standards Agency is responsible for food safety and food hygiene across the UK; The research and survey work funded by the FSA is focused on helping the Agency understand food issues and meet its policy aims and objectives. Relevant R&D programmes are the Radiological Safety of Food, Radiological surveillance, Radiological emergencies, Radioactivity in food.	Dept of Health	yes
Public	Department for Environment, Food and Rural Affairs (DEFRA)	the government department responsible for environmental protection, food production and standards, agriculture, fisheries and rural communities in the UK; objectives are to enhance the environment and biodiversity, and support a strong and sustainable green economy	HMG	no
Public	Environment Agency (EA)	Executive NDPB; Nuclear Regulator; Oversee how the 32 licensed nuclear sites in England and Wales dispose of their radioactive waste by granting site permits to the operators who run them. Responsible for check-ups on sites to ensure they're not exceeding their limits and releasing as little radioactive waste as possible into the environment	DEFRA	yes
Public	Food and Environment Research Agency (FERA)	Executive agency of DEFRA; purpose is to support and develop a sustainable food chain, a healthy natural environment, and to protect the global community from biological and chemical risks	DEFRA	no

Public	Government Decontamination Service (GDS)	Part of the Emergency Response and Recovery Programme at FERA; the UK GDS helps the UK prepare for the recovery following a deliberate act involving chemical, biological, radiological and nuclear (CBRN) materials, or an accidental release of hazardous materials (HAZMAT) and minimise its impact on society, the economy and the environment.	FERA	performer
Public	Animal Health and Veterinary Laboratories Agency (AHVLA)	Exec Agency of DEFRA; role is to help safeguard animal health and welfare and public health, protect the economy and enhance food security through research, surveillance and inspection.	DEFRA	performer
Public	Government Office for Science	The Government Office for Science is the home of science and engineering across government and exists to support the Government Chief Scientific Adviser, Sir John Beddington. The key role of the GCSA and GO-Science is to ensure that all levels of government, including the Prime Minister and Cabinet, receive the best scientific advice possible, and to enable the many science-using departments across government to create policies that are supported by strong evidence and robust arguments	Cabinet Office	no
Public	Foreign and Commonwealth Office (FCO)	Supports the inalienable right of all States parties to the peaceful use of nuclear energy under the Nuclear Non-Proliferation Treaty (NPT); Supporting countries wishing to develop civil nuclear power programmes with technical assistance, training, and sharing of expertise, and agreements in place to facilitate effective collaboration.	HMG	no
Public	FCO Prosperity: Climate Change and Energy Group	Implementing the FCO Strategic Objective: A low carbon, high growth global economy; manages the Low Carbon High Growth Strategic Programme Fund which enables 22 priority embassies and high commissions to achieve their policy objectives; manages the FCO's relations with business and the trades unions at a strategic level. It also supports SISBO (Security Information Service for Business Overseas)	FCO	no

Public	FCO Defence & Intelligence	The Defence and Intelligence Directorate have a direct role in civil nuclear matters and the relevant departments are: Arms Export Policy; Counter proliferation; Counter terrorism; National Security. Directorate sponsors the Counter proliferation programme within the FCO's Strategic Programme Fund that promotes action on global issues in areas of strategic importance to the UK. Supports/leads UK involvement in Nuclear Security Summit	FCO	yes
Public	FCO Defence & Intelligence : Counter Proliferation Group	Focusing on the FCO policy goal of countering weapons proliferation and its causes. Promoting and implementing the UK Government's policies on nuclear, chemical and biological weapons. This group reports into EC and leads links to Instrument for Stability , CBRN Centre of Excellence , Instrument for Nuclear Safety Cooperation	FCO	no
Public	Home office	the lead UK government department for immigration and passports, drugs policy, crime, counter-terrorism, police and equality	HMG	no
Public	Home Office- Office of security & counter terrorism (OSCT)	Responsible for counter-terrorism; (OSCT); provides strategic direction to the UK's work to counter the threat from terrorism; work to develop and deliver the UK's counter-terrorism strategy, CONTEST.	Home Office	potential
Public	Border Agency	The agency protects the UK border; an agency of the Home Office;	Home office	potential
Public	Centre for Applied Science and Technology (CAST)	(formerly known as The Home Office Scientific Development Branch); develop technological solutions to fight crime; notable capability area is contraband detection (illicit material includes people/stowaways, money, drugs, explosives, weapons and chemical, biological, radiological and nuclear material); R&D performed largely in-house	Home office	performer, potential

Public	Higher Education Funding Council for England (HEFCE)	Distributes public money to universities and colleges in England that provide higher education; non departmental public body sponsored by the Department for Business, Innovation and Skills.	BIS	yes
Public	Higher Education Funding Council for Wales (HEFCW)	The Higher Education Funding Council for Wales (HEFCW) is responsible for funding higher education in Wales. It receives its funds from, and is accountable to, the Welsh Assembly Government	Welsh Assembly Government	yes
Public	Scottish Further and Higher Education Funding Council (SFC)	The Scottish Further and Higher Education Funding Council (SFC) distributes funding for teaching and learning, research and other activities to 43 colleges and 20 higher education institutions in Scotland; a non departmental public body of the Scottish Government	Scottish Government	yes
Public	Ministry of Defence – Counter Terrorism Centre	Exists to respond to the increasing terrorist threat facing the UK and our Armed Forces; By funding research, facilitating innovation and actively seeking collaboration, aim to ensure that the best science underpins the Ministry of Defence and more broadly, the Government's response to the threats posed by terrorism. The Centre serves as the unifying hub to optimise counter terrorism resources.	MOD	potential
Public	centre for defence enterprise	CDE is the entry point for new science and technology providers to defence, bringing together innovation and investment for the defence and security markets. CDE funds research into novel high-risk, high-potential-benefit innovations sourced from the broadest possible range of science and technology providers, including academia and small companies, to enable development of cost-effective capability advantage for UK Armed Forces.	MOD	potential
Public	Cabinet office – Civil contingencies secretariat	Part of the National Security group within Cabinet Office, which ensures that the Prime Minister and other senior Ministers are well served on cross-government intelligence, security and resilience issues; Civil Contingencies Secretariat leads on emergency planning and training to ensure the resilience of the UK at every level. Central, regional, and local, against disruptive challenge.	Prime Minister & Cabinet	potential

Public	Centre for protection of national infrastructure	The Centre for the Protection of National Infrastructure (CPNI) protects national security by providing protective security advice. Protective security is "putting in place, or building into design, security measures or protocols such that threats may be deterred, detected, or the consequences of an attack minimised".	Civil Contingencies Secretariat	potential
Public	UK Trade & Industry	Jointly sponsored by FCO and BIS; works with UK-based businesses to ensure their success in international markets, and encourage the best overseas companies to look to the UK as their global partner of choice. Has an emphasis on innovative and R&D active firms.	FCO, BIS	potential
Public	Department for Work and Pensions (DWP)	The Department for Work and Pensions is responsible for welfare and pension policy and is a key player in tackling child poverty. It is the biggest public service delivery department in the UK and serves over 20 million customers	HMG	no
Public	Health & Safety Executive (HSE)	HSE is the national independent watchdog for work-related health, safety and illness; Crown Non-Departmental Public Body, sponsored by DWP.	DWP	no
Public	Office for Nuclear Regulation (ONR)	Agency of HSE; ONR's mission is to secure the protection of people and society from the hazards of the nuclear industry. ONR regulates 35 nuclear sites across England, Scotland & Wales. ONR plays a role in influencing global safety and security standards. ONR does not undertake its own R&D. In the following areas: Existing nuclear power reactors, including aging and degradation; Nuclear chemical plants; Nuclear plant decommissioning, and Geological disposal of radioactive wastes. ONR is developing its R&D strategy in order to meet future challenges.	Health & Safety Executive (HSE)	yes
Public	Scottish Environment Protection Agency (SEPA)	Scotland's environmental regulator; non-departmental public body, accountable through Scottish Ministers to the Scottish Parliament	Scottish Parliament	no
Public	UK Universities	Provision of Higher Education; Foster academic research	HEFCE,HEFCW, SFC	yes

Public	University of Manchester	Shares M&O contract for NNL with Battelle and Serco; Funded the Dalton Cumbria Facility with NDA; Hosts the Dalton Institute	HEFCE	yes
NDA Estate (PBO)	Nuclear Management Partnership	PBO Consortium of AREVA, AMEC & URS; International consortium French , British and American; Owner of Sellafield Ltd for duration of contract held with NDA (up to 17 years); provides leadership and management expertise;	NDA (and AREVA, URS, AMEC)	no
NDA Estate (Tier 1)	Sellafield Ltd	SLC; Operates Sellafield and Capenhurst sites; holds and is responsible for site licenses at Sellafield (including Windscale) and Capenhurst sites; managed and operated by NMP; Holds contract with NDA that sets out the specific work to be undertaken; mission to decommission an clean up Sellafield and Capenhurst nuclear site; revenue from commercial fuel recycling and manufacturing operations is managed by International Nuclear Services.	NMP, NDA	yes
NDA Estate (PBO)	UK Nuclear Waste Management Ltd	PBO Consortium of AREVA, Studsvik UK, URS (lead) & Serco; Owns Low Level Waste Repository; The current contract with the NDA runs until 31st March 2013;a consortium that holds the Management and Operations contract for LLW Repository Ltd.	NDA	no
NDA Estate (Tier 1)	Low Level Waste Repository Ltd	LLW Repository Ltd offers a range of services to safely and efficiently manage low level waste for Customers throughout the UK. As part of providing services, we also operate the national Low Level Waste Repository on behalf of the Nuclear Decommissioning Authority. UK's repository for LLW; managed and operated by UK nuclear Waste Management Ltd; LLW Repository Ltd is a waste management company that provides services to Customers to treat and dispose of low level radioactive waste. On behalf of NDA, we manage the national Low Level Waste Repository in West Cumbria and oversee a national Low Level Waste programme to ensure that lower activity waste is managed effectively.	UK nuclear Waste Management Ltd	yes

NDA Estate (PBO)	Babcock Dounreay Partnership Ltd	PBO Consortium of Babcock International Group, CH2MHILL & Studsvik UK; Owns Dounreay Site Restoration Ltd ; a consortium of Babcock International Group PLC (50%), CH2M Hill (30%) and URS (20%)	NDA; Babcock International Group, CH2MHILL, URS	no
NDA Estate (Tier 1)	Dounreay Site Restoration Ltd	SLC; managed and operated by Babcock Dounreay Partnership Ltd; mission to decommission an clean up Dounreay nuclear site; DSRL is a wholly-owned subsidiary of the Babcock Dounreay Partnership Ltd, a consortium of Babcock International Group, CH2MHILL and URS. It is funded by the NDA to deliver the site closure programme agreed with the Babcock Dounreay Partnership.; responsible for the clean-up and demolition of Britain's former centre of fast reactor R&D	NDA, Babcock Dounreay Partnership Ltd	yes
NDA Estate (PBO, Tier 2 Contractor)	Babcock International Group	Parent Body Organisation for DSRL and RSRL; the UK's leading engineering support services organisation working in defence, energy, telecommunications, transport and education sectors.	-	potential - as per contract
NDA Estate (Tier 1)	Reactor Sites Restoration Ltd	SLC; managed and operated by Babcock International Group; mission to decommission an clean up reactor nuclear site (Harwell, Winfrith); Research Sites Restoration Limited (RSRL) is the site licence company responsible for the closure programme at Harwell and Winfrith.; RSRL has held the site licence, waste disposal authorisation and other necessary legal permits for managing the site since February 2, 2009; RSRL operates under contract to the NDA	Babcock International Group, NDA	yes
NDA Estate (PBO)/ Private Company	Westinghouse Electric Company LLC	PBO for Springfields Fuel Ltd; Owned and operated by Toshiba Group [Toshiba (77%) (majority owner) The Shaw Group (20%) IHI (3%)] ; holds a long-term lease of the Springfields site, which transferred responsibility for the commercial fuel manufacturing business and Springfields Fuels Limited to Westinghouse	Toshiba Group, NDA	no

NDA Estate (Tier 1)	Springfields Fuel Ltd	SLC; managed and operated by Westinghouse Electric; mission to fabricate UOX fuel, manufacture of Uranium Hexafluoride, process residues and decommission and demolish redundant plants and buildings	Westinghouse Electric	yes
NDA Estate (PBO)/ Private Company	Energy Solutions EU Ltd	PBO of Magnox Ltd; subsidiary of Energy Solutions Inc; Providing nuclear reactor, radioactive waste management, radiological engineering, and decommissioning services to UK and European nuclear facilities; Manages the UK's 10 Magnox reactor sites on behalf of the UK's NDA and services encompass nuclear reactor operations and transition of sites towards decommissioning.	EnergySolutions Inc, NDA	no
NDA Estate (Tier 1)	Magnox Ltd	SLC; Managed and operated by Energy Solutions EU; mission to operate Magnox power stations and decommission those shut down; Magnox, owned by EnergySolutions, is the management and operations contractor responsible for 10 nuclear sites and one hydroelectric plant in the UK. Under contract to the site owner, the Nuclear Decommissioning Authority, the company is responsible for electricity generation at Wylfa, Oldbury and Maentwrog, defuelling at Chapelcross, Dungeness A and Sizewell A, and the decommissioning of Hunterston A, Berkeley, Hinkley Point A, Bradwell and Trawsfynydd.	Energy Solutions EU	yes
NDA Estate (PBO)/Private Company	URS	A leading provider of engineering, construction and technical services for public agencies and private sector companies around the world. URS offers a full range of programme management; planning, design and engineering; systems engineering and technical assistance; construction and construction management; operations and maintenance; and decommissioning and closure services; PBO for UK LLWR, DSRL and SL	NDA	no

NDA Estate (PBO)/Private Company	AREVA	French public multinational industrial conglomerate covers every stage of the fuel cycle, reactor design and construction, and related services. Its main shareholder is the French public-sector company, the CEA.. PBO for SL and LLWR	French state	no
NDA Estate (PBO)/Private Company	CH2MHILL	an American-based global full-service provider of consulting, design, construction, and operations services for corporations, and federal, state, and local governments. PBO for DSRL	-	no
NDA Estate(Tier 2 Contractor)/ Performer	AMEC	British Company; focused supplier of high value consultancy, engineering and project management services to the world's energy, power and process industries. One of the leading providers of technical consultancy, engineering services and programme and asset management to the nuclear industry. PBO for SL	NDA	yes- as per contract, performer
NDA Estate (Tier 2 Contractor)	Studsvik UK Ltd	Part of the Parent Body Organisation that runs the country's Low Level Waste Repository; a Radiation Protection Advice body; Undertake engineering implementation projects in a wide range of industries including nuclear and pharmaceutical; has a nuclear licensed site in Cumbria to process low level radioactive metal by a range of innovative techniques.	Studsvik AB, NDA	performer
NDA Estate (Tier 2 Contractor)	Jacobs Engineering UK Ltd	subsidiary of Jacobs Engineering Group Inc	Jacobs Engineering Group Inc	yes- as per contract
NDA Estate (Tier 2 Contractor)	ACTiv Nuclear	ACKtiv Nuclear comprises three major engineering and construction companies – Atkins, Carillion and Jacobs – that have worked in close co-operation since the mid 1980's. We offer a full lifecycle capability from business case through design to construction, commissioning, operational support and decommissioning	Atkins, Carillion and Jacobs	yes- as per contract

NDA Estate (Tier 2 Contractor)	Nuvia Ltd	Nuvia is a nuclear specialist, covering both civilian and defence sectors, across the complete lifecycle from new build, through operations and maintenance, to final decommissioning and waste management. Nuvia is one of five businesses that form Soletanche Freyssinet, a world leader in specialised civil and geotechnical engineering. Soletanche Freyssinet is a wholly owned subsidiary of VINCI, the world's largest integrated concessions and construction group	Soletanche Freyssinet	yes- as per contract
NDA Estate (Tier 2 Contractor)	Costain	International engineering and construction group ; delivers solutions across infrastructure (highways, rail and airports); environment (water and waste); energy & process (nuclear, power, and hydrocarbons and chemicals); and also provides consultancy and maintenance	-	yes- as per contract
NDA Estate (Tier 2 Contractor)	Redhall Nuclear Ltd	Redhall Nuclear offer multi-disciplined engineering services across three main operations: Power Generation and nuclear new build, Defence (including marine) and Decommissioning & Waste Management	-	yes- as per contract
NDA Estate (Tier 2 Contractor)	Atkins Ltd	Leading engineering and design consultancy; specialising in civil and structural engineering design	-	yes- as per contract
NDA Estate (Tier 2 Contractor)	Doosan Babcock	Doosan Babcock Energy Ltd is a world leader in the provision of engineering services and solutions to the energy industry. It has a long pedigree in the nuclear and thermal energy sectors in addition to a vast amount of experience in the oil, gas, petrochemical and pharmaceutical sectors; Part of Doosan Power Systems Ltd a UK subsidiary of Doosan Heavy Industries	Doosan Power Systems Ltd	yes- as per contract

NDA Estate (Tier 2 Contractor)	Nuclear Engineering Services Ltd	Nuclear Engineering Services (NES) specialise in the design, manufacture, assembly, test, installation and commissioning of bespoke solutions for the nuclear decommissioning, defence, and nuclear new build markets. supplied an extensive range of equipment and solutions to most UK nuclear power stations, including fuel route, remote handling and inspection equipment, encapsulation and waste handling solutions, gloveboxes and shielded containments, and reprocessing equipment.; NES is a Tier One Board Member of the Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC), based in Sheffield	-	yes- as per contract
NDA Estate (Performer)	Bradtec Decon Technologies Ltd	promoting and patenting technologies to enable the early decommissioning of nuclear power and associated research facilities throughout the world.; has a cooperation agreement with Hyder Consulting for providing consultancy for accelerated decommissioning of UK facilities; conducts R&D with University of West of England	-	performer
NDA Estate (Performer)/Private Company	CANBERRA UK Ltd	CANBERRA UK is one of the UK's leading suppliers of instrumentation for a diverse range of applications in the nuclear industry. The company was formed following the divestment of AEA Technology's Instrumentation business to CANBERRA; Areas are gamma and alpha spectroscopy, radiation protection instrumentation an d non-destructive assay systems	CANBERRA, AREVA	yes, performer
NDA Estate (Performer)	Babcock Nuclear Services	Babcock is the UK's largest specialist nuclear support services organisation.	Babcock international group	performer
NDA Estate (Performer)	DBD Ltd	DBD is a UK-Based, independent enterprise providing innovative solutions to complex management, technical and engineering issues focused on highly regulated industries.	-	performer

NDA Estate (Performer)	Frazer-Nash Consultancy Ltd	a world class systems and engineering technology organisation; one of the UK's biggest providers of systems and engineering technology in the defence, nuclear, power & energy, civil aerospace, rail, marine, petrochemical and industrial sectors	-	performer
NDA Estate (Performer)	Galson Sciences	provides a range of nuclear decommissioning and radioactive waste management services to an international clientele; Specialises in risk and impact assessment, risk management, nuclear safety and radioactive waste management and geoscience studies	-	performer
NDA Estate (Performer)	Hyder Consulting (UK) Ltd	UK subsidiary of Hyder Consulting, a multi-national advisory and design consultancy	Hyder Consulting	performer
NDA Estate (Performer)	MMI Engineering	a technical consulting firm providing services to a wide range of industries including Oil & Gas, Nuclear, Renewable Energy, Petrochemical, Defence & Security and Aerospace; specializing in the management of man-made and natural hazards by the application of a blend of expertise drawn from a range of scientific and engineering backgrounds.	-	performer
NDA Estate (Performer)	NIS Ltd	a specialist integrated engineering company providing bespoke design and manufacture of plant and equipment by the transfer of technology; owned by parent company NIS Holdings Ltd.	NIS Holdings Ltd.	performer
NDA Estate (Performer)	NSG Environment Ltd	providing decommissioning and waste management services to the UK civil and defence nuclear installations for more than 20 years.; owned by parent company NIS Holdings Ltd.	NIS Holdings Ltd.	performer
NDA Estate (Performer)	Nu-Tech Associates	Nu-Tech Associates Ltd specialises in Industrial Exhibitions, Event Management and Public Relations with a particular emphasis, although not exclusively, on nuclear, defence and science related sectors.	-	no
NDA Estate (Performer)	(Ove) Arup	an independent firm of designers, planners, engineers, consultants and technical specialists offering a broad range of professional services	-	performer

NDA Estate (Performer)	Poyry UK Energy Ltd	UK subsidiary of Poyry Group, a global consulting and engineering company dedicated to balanced sustainability and responsible business; part of the Energy and Management Consulting Business Groups with expertise across: Nuclear, Renewable Energy, Investment Banking for Forest and Energy sectors, Energy Consulting and Forest Industry Consulting.	Poyry Group	performer
NDA Estate (Performer)	Quintessa	providing consultancy services for environmental appraisal and risk assessment to support decision making.	-	performer
NDA Estate (Performer)	REACT Engineering Ltd	provide engineering consultancy services specialising in nuclear decommissioning	-	performer
NDA Estate (Performer)	RSK Group	one of Europe's leading multidisciplinary environmental consultancies; RSK offers its nuclear industry services through RSK Radiological, a joint venture between RSK and the US-based decommissioning expert Radiation Safety and Control Services Inc. (RSCS).	-	performer
NDA Estate (Performer)	Tessella	international provider of science powered technology and consulting services in life sciences, energy, consumer products and digital preservation	-	performer
NDA Estate (Performer)	THALES Transport and Security Ltd	a world leader in mission-critical information systems for defence and security, aerospace and transportation; able to develop and deploy dual civil and military technologies	THALES Group	performer
NDA Estate (Performer)	TWI	One of the world's foremost independent research and technology organisations, with expertise in solving problems in all aspects of manufacturing, fabrication and whole-life integrity management technologies.	-	performer
National Labs	National Nuclear Laboratory (NNL)	UK's national civil nuclear laboratory; A GOCO managed and operated by consortium of Serco, Battelle, University of Manchester; Leading nuclear technology services provider.	Serco, Battelle, University of Manchester. ShEx, DECC	yes, performer

National Labs	Health and Safety Laboratory (HSL)	HSL is an Agency of Health and Safety Executive (HSE); mission is to support the HSE Mission and directly help organisations become healthier, safer and therefore, more productive places in which to work; performs nuclear programme R&D for ONR and HSE	HSE	performer
National Labs	National Physical Laboratory (NPL)	UK's National Measurement Institute; operated on behalf of the National Measurement Office by NPL Management Limited, a wholly owned subsidiary of Serco Group plc; To provide the measurement capability that underpins the UK's prosperity and quality of life	NPL management Ltd; NMO	performer
Private	NPL Management Ltd	operator of NPL on behalf of NMO; a wholly owned subsidiary of Serco Group plc;	Serco	no
National Labs	Defence Science & Technology Laboratory (DSTL)	Aims to maximise the impact of science and technology for the defence and security of the UK;	MOD	yes
National Labs	Atomic Weapons Establishment (AWE)	Providing and maintaining the warheads for the country's nuclear deterrent; work at AWE covers the entire life cycle of nuclear warheads; from initial concept, assessment and design, through to component manufacture and assembly, in-service support, and finally decommissioning and disposal; managed for MOD through a contractor-operated arrangement-sites and facilities remain in government ownership yet management, operations and the maintenance of Britain's nuclear stockpile is contracted to a private company AWE ML.	MOD, AWE ML, AWE plc	yes
Private	AWE Management Limited (AWE ML)	AWE ML is formed of three equal shareholders – Serco, Lockheed Martin and Jacobs Engineering Group; AWE ML awarded contract to manage AWE until March 2025. AWE plc is the company that AWE ML has delegated to deliver the contract.	Serco, Lockheed Martin and Jacobs Engineering Group, MOD	no

Private/ PBO	Jacobs Engineering Group Inc.	Jacobs Engineering Group Inc. is one of the world's largest and most diverse providers of technical, professional, and construction services, including all aspects of architecture, engineering and construction, operations and maintenance, as well as scientific and specialty consulting. We serve a broad range of companies and organizations, including industrial, commercial, and government clients across multiple markets and geographies.; headquarters California, USA; PBO for AWE	-	no
Private/ PBO	Serco Group plc	Serco is an international service company that improves the quality and efficiency of essential services that matter to millions of people around the world; PBO for AWE, NNL	-	no
Private/ PBO	Lockheed Martin UK Ltd	an American global aerospace, defence, security, and advanced technology company with worldwide interests; PBO for AWE	Lockheed Martin Corporation	no
Private/ PBO	Battelle UK Ltd	Battelle Memorial Institute is the world's largest non-profit R&D organisation; manages the world's leading national laboratories and maintains a contract research portfolio spanning National Security; Health & Life Sciences; Energy, Environment & Material Sciences; and Education.; PBO for NNL	Battelle	no
Private	URENCO	Operates worldwide uranium enrichment businesses to provide fuel for nuclear power utilities, through four operational enrichment plants in the UK (URENCO UK), Germany (URENCO Deutschland), the Netherlands (URENCO Nederland) and the US (URENCO USA). ; URENCO's shares are ultimately held one-third by the UK government, one-third by the Dutch government and one-third by German utilities.	ShEx	no
Private	Rolls Royce nuclear	world-leading provider of power systems and services for use on land, at sea and in the air,; operations in 4 global markets - civil aerospace, defence aerospace, marine and energy and nuclear (civil and defence)	-	potential

Private	EnergySolutions Inc	headquartered in Salt Lake City; worldwide leader in the safe recycling, processing and disposal of nuclear material, we provide innovations and technologies to the U.S. Department of Energy, commercial utilities, medical and research facilities	-	yes
Private	EDF Energy	EDF Energy is one of the UK's largest energy companies and its largest producer of low-carbon electricity. A wholly-owned subsidiary of the EDF Energy Group, one of Europe's largest energy groups. Generates around one fifth of the UK's electricity and employ around 15,000 people. Operates UK's AGRs and PWR.	EDF Energy	yes
Private	EDF Energy	EDF Energy Group's activities include generation, trading, transmission, distribution, supply and other energy services. Key business interests in France, Germany, Italy and UK. A French public limited company (EDF Energy SA). Has a significant R&D programme in support of the company's activities, including energy generation and distribution, transport, sales and developing the product portfolio in short term as well as preparing for future challenges.	French State	no
Private	GE Hitachi Nuclear Energy	a provider of advanced reactors and nuclear services. GEH is a global nuclear alliance created by General Electric and Hitachi.	General electric, Hitachi	potential
Private, Performer	Studsvik AB	offers a range of advanced technical services to the international nuclear power industry in such areas as waste treatment, decommissioning, engineering & services, and operating efficiency; undertakes Post-Irradiation Examination (PIE) and Testing	-	non-UK performer
Private	Small Medium Enterprises	Various small to medium businesses active in nuclear industry; sponsored by TSB	-	performer
International Government Affiliation	European Commission-Directorate General RTD (DG-RTD)	The Directorate-General for Research and Innovation's mission is to develop and implement the European research and innovation policy with a view to achieving the goals of Europe 2020 and the Innovation Union	European Commission	yes

International Government Affiliation	European Commission-Directorate General ENER (DG-ENER)	The Directorate-General for Energy is responsible for developing and implementing a European energy policy. Support the Europe 2020 programme which, for energy, is captured in the Energy 2020 strategy.	European Commission	no
International Government Affiliation	European Commission-Directorate General DEVCO (DG_DEVCO)	Development and Cooperation – EuropeAid is a new Directorate–General (DG) responsible for designing EU development policies and delivering aid through programmes and projects across the world. It incorporates the former Development and Europeaid DGs.	European Commission	yes
International Government Affiliation	Fusion for Energy Agency	Fusion for Energy (F4E) is the European Union's Joint Undertaking for ITER and the Development of Fusion Energy. The organisation was created under the Euratom Treaty by a decision of the Council of the European Union	European Union	no
International Government Affiliation	Joint Research Centre (JRC)	The Joint Research Centre is a Directorate-General of the European Commission and is the scientific and technical arm of the European Commission. It is providing the scientific advice and technical know-how to support a wide range of EU policies. It has status as a Commission service, which guarantees independence from private or national interests.	European Commission	no
International Government Affiliation	Institute for Transuranium Elements (ITU)	The Institute for Transuranium Elements is one of 7 JRC institutes. Mission of JRC-ITU is to provide the scientific foundation for the protection of the European citizen against risks associated with the handling and storage of highly radioactive material. JRC-ITU's prime objectives are to serve as a reference centre for basic actinide research, to contribute to an effective safety and safeguards system for the nuclear fuel cycle, and to study technological and medical applications of radionuclides/actinides	European Commission	non-UK performer
International Government Affiliation	European External Action Service	Serves as a foreign ministry and diplomatic corps for the EU, implementing the EU's Common Foreign and Security Policy and other areas of the EU's external representation.	European Union	yes

International Government Affiliation	European Space Agency	ESA is an intergovernmental organisation; aims to provide for, and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems	-	yea
International Government Affiliation	Electric Power Research Institute (EPRI)	The Electric Power Research Institute (EPRI) is an independent, non-profit company performing research, development and demonstration in the electricity sector for the benefit of the public.	-	ye
International Government Affiliation	Pacific Northwest National Laboratory	a U.S. Department of Energy national laboratory; operated by Battelle	US DOE-Office of Science, Battelle	non-UK performer
International Government Affiliation	Idaho National Laboratory	Science-based, applied engineering national laboratory dedicated to supporting the U.S. Department of Energy's missions in nuclear and energy research, science, and national defence. INL is operated for the Department of Energy (DOE) by Battelle Energy Alliance (BEA) and partners	US DOE, Battelle Energy Alliance	non-UK performer
International Government Affiliation	International Atomic Energy Agency (IAEA)	The IAEA is the world's centre of cooperation in the nuclear field. It was set up in 1957 as the world's "Atoms for Peace" organization within the United Nations family. The Agency works with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies	-	no
International Government Affiliation	Organisation for Economic Co-operation and Development - Nuclear Energy Agency (OECD-NEA)	The Nuclear Energy Agency (NEA) is a specialised agency within the Organisation for Economic Co-operation and Development (OECD), an intergovernmental organisation of industrialised countries, based in Paris, France	OECD	no
International Government Affiliation	United Nations	an international organization whose stated aims are facilitating cooperation in international law, international security, economic development, social progress, human rights, and achievement of world peace	-	no

International Government Affiliation	Nuclear Security Summit	the largest summit in the security field that discusses international cooperative measures to protect nuclear materials and facilities from terrorist groups, with participation from more than 53 heads of state and international organizations.	-	no
International Government Affiliation	US Department of Energy - Office of Nuclear Energy	The Office of Nuclear Energy (NE) promotes nuclear power as a resource capable of meeting the Nation's energy, environmental and national security needs by resolving technical and regulatory barriers through research, development and demonstration.	US DOE	yes
International Government Affiliation	US Department of Energy - Office of Environmental Management	The mission of the Office of Environmental Management (EM) is to complete the safe cleanup of the environmental legacy brought about from five decades of nuclear weapons development and government-sponsored nuclear energy research	US DOE	yes
International Government Affiliation	ITER	an international nuclear fusion research and engineering project, which is currently building the world's largest and most advanced experimental tokamak nuclear fusion reactor at the Cadarache facility in the south of France.[	-	no
Skills and Training	National Skills Academy for Nuclear (NSAN)	The lead strategic body that represents the industry to stimulate coordinate and enable excellence in skills to support the nuclear programme.	Nuclear Industry	No

Annex F: Additional Diagrams and Data to Complement Chapter 6

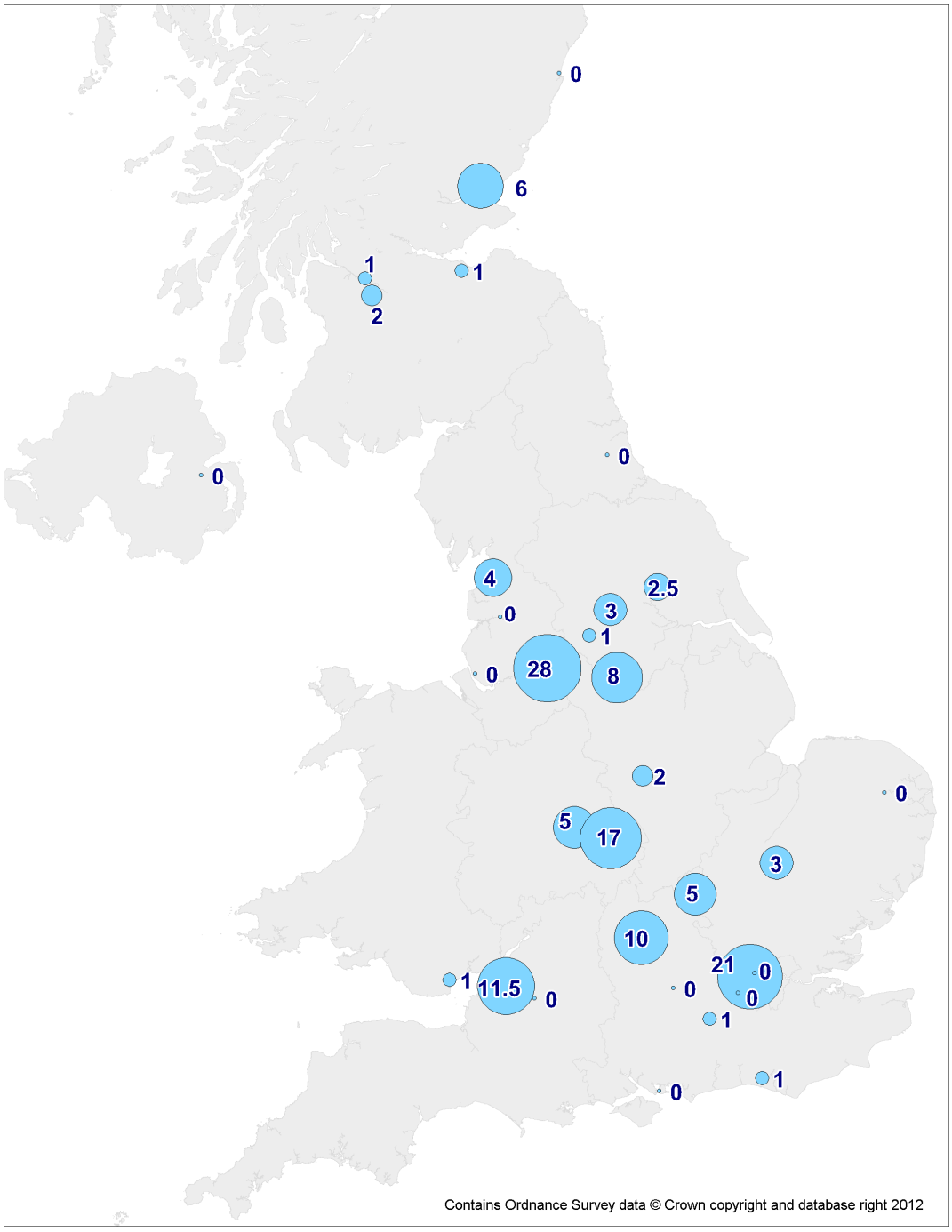

Figure F.1 The size of the university post-doctoral nuclear R&D workforce in the UK, totalling 134 individuals.

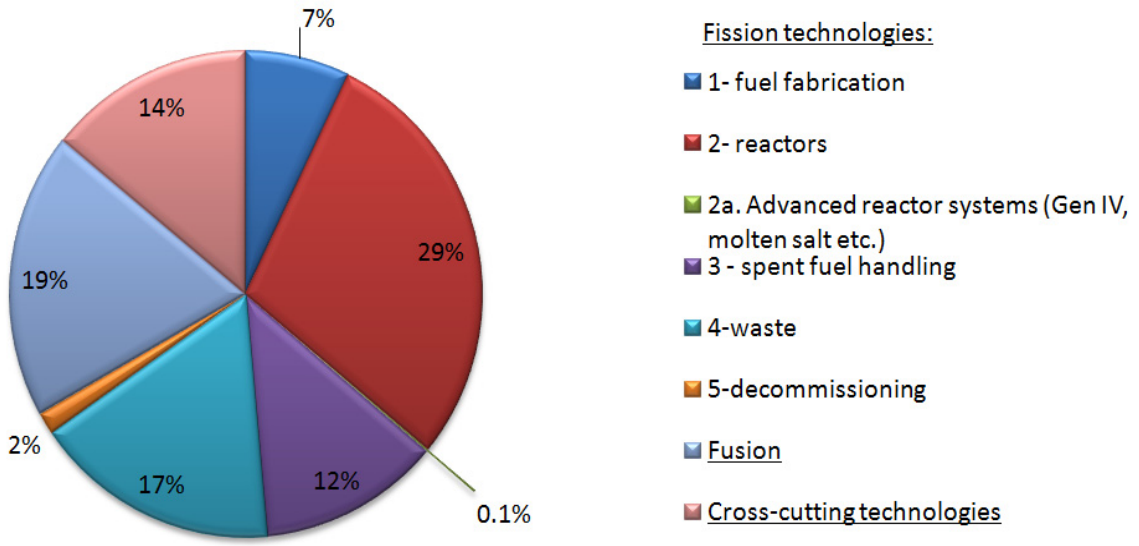

Figure F.2: The subject focus of post-doctoral researchers in nuclear R&D in the UK, totalling 134 individuals.

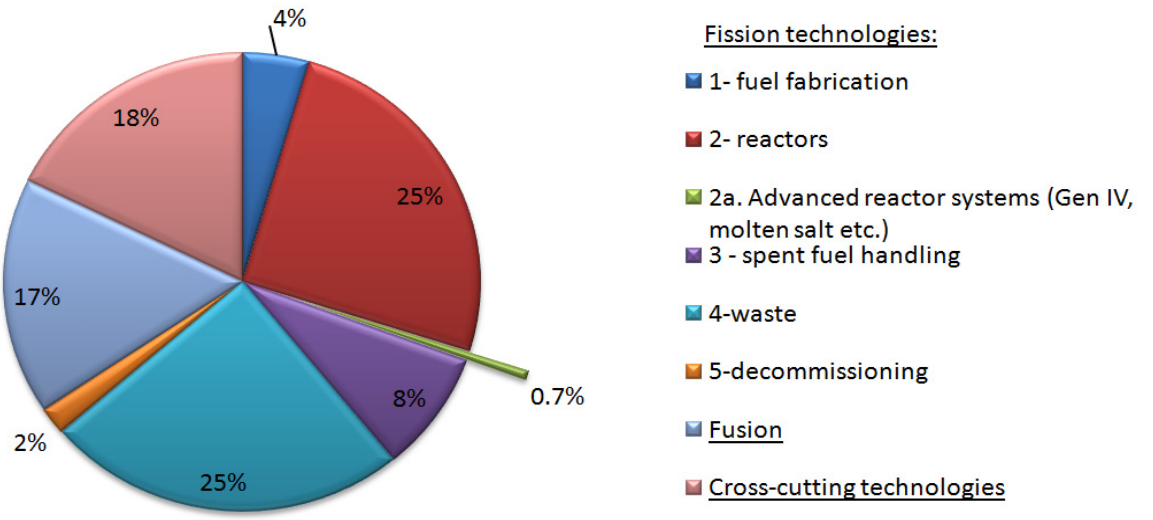

Figure F.3: The subject focus of PhD students in nuclear R&D in the UK, totalling 627 individuals.

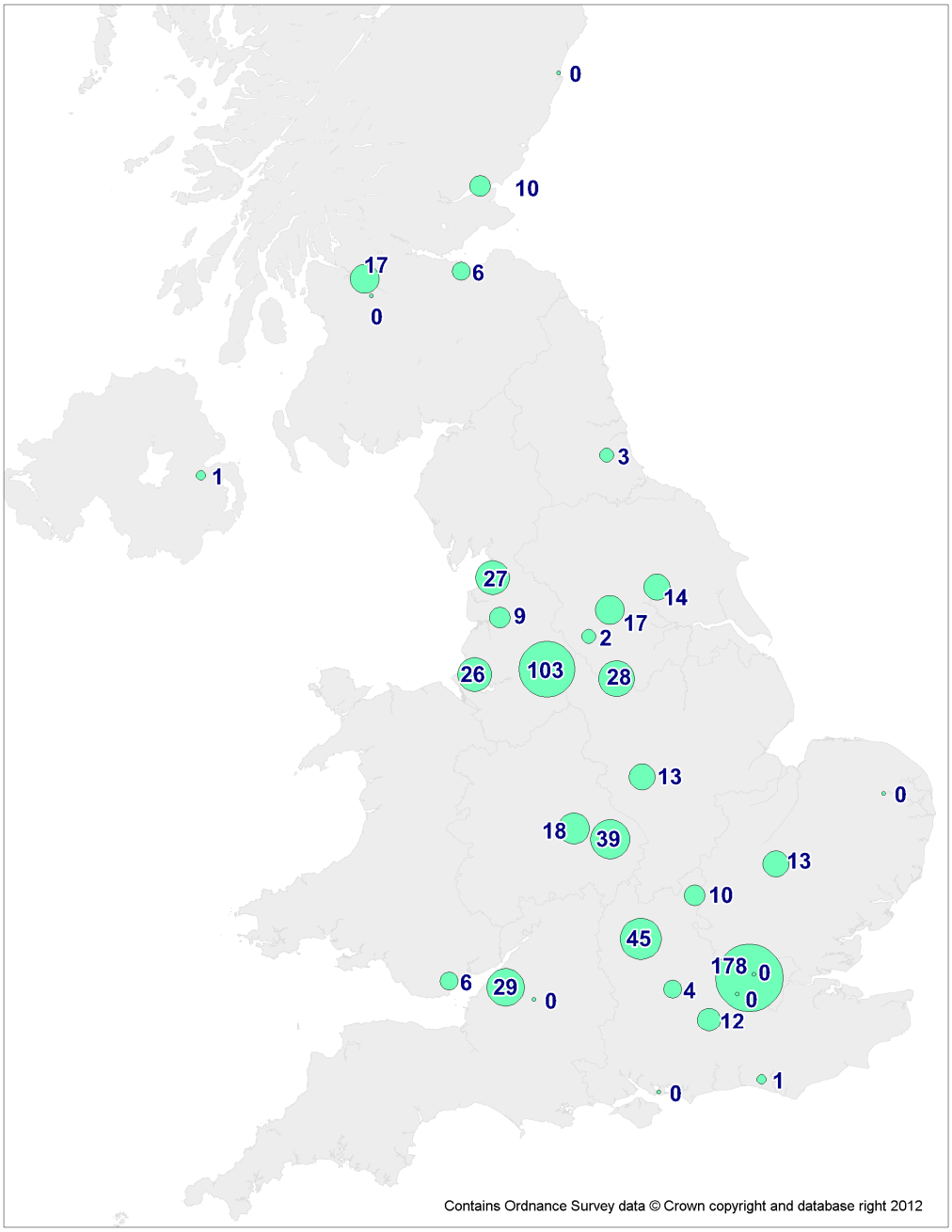

Figure F.4: PhD students involved in nuclear R&D in the UK, totalling 628 individuals.

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