

Long-term Nuclear Energy Strategy



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Introduction

The Government believes that nuclear energy has an important role to play in delivering our long term objective of a secure, low carbon, affordable, energy future. For nuclear energy to reach its full potential, significant challenges need to be met, both in the short term and for the longer term to 2050 and beyond. This document sets out the Government's vision for the future of nuclear energy in the UK and our strategy to ensure nuclear has the best prospect of reaching its full potential.

Government has an important role to play. Successful delivery of the strategy will also require action from regulators, industry, academia and other interested parties. Delivery of the strategy will need secure underpinning in research and development. The document provides a clear framework against which decisions and priorities for policy and research can be assessed in a coordinated manner, guiding the development of detailed plans and actions.

This document covers the role of nuclear power in the UK electricity mix and the role of the UK nuclear sector in the global economy. It identifies the key priorities and what Government will do to make its vision for the future a reality.

Vision for nuclear energy

The Government's vision for nuclear energy is to have a nuclear sector that:

- has safety and security as its highest priorities, with the UK leading the world in safe and secure operations across the whole fuel cycle.
- continues to contribute to a low carbon and secure energy future, with nuclear energy being deployed efficiently and effectively, competing successfully with other low carbon technologies.
- leads the way in successfully decommissioning redundant nuclear facilities, including the environmentally safe disposal of nuclear waste.
- contributes to employment and prosperity in the UK including by exporting to overseas markets, respecting the imperative of not proliferating nuclear weapons.
- continues to command public confidence, by operating safely, securely, sustainably and transparently.

Key Priorities

Achieving this vision will require action from Government and others to make progress against a number of key strategic priorities and enablers. The priorities are

1. Nuclear power making a significant contribution to secure, low carbon generation, now and through a successful Generation III programme built over the next two decades.
2. Maintaining options for nuclear making a major contribution to the longer term energy mix.
3. Development and maintenance of an effective and expanding UK-based supply chain, competing successfully for work at home and abroad, contributing positively to the UK economy.
4. Decommissioning the UK's nuclear legacy, including through safe and secure interim storage of waste and spent fuel, pending the availability of long-term disposal.
5. Planning for wastes arising from nuclear new build.
6. Achieving the long-term management of nuclear waste.
7. Effective and well-resourced regulatory bodies, to protect the environment and society from the hazards of nuclear power.
8. Management of the UK's civil plutonium.
9. Government continuing to play an effective and pro-active role in the sector.

These priorities will be supported by the following enablers:

10. Research and Development.
11. Skills development.
12. International collaboration.

These key priorities are examined in more detail below.

Nuclear power making a significant contribution to secure, low carbon generation, now and through a successful Generation III programme built over the next two decades

Government has previously set out its policy¹ that nuclear energy should play an important role – alongside renewable energy and Carbon Capture and Storage (CCS) – in the UK's energy mix, both now and in the future.

The Government's policy is that for the longer term, low carbon technologies should compete directly to supply the electricity market. The reform of the electricity market is intended to ensure the transition to such a market. A key element of the reform is to enable long term contracts (Contracts for Difference) which ensure price stability to support long term investment. This is important for low carbon technologies such as nuclear² which have high upfront capital costs but low running costs over many decades of generation.

Within this framework, the future of nuclear power will depend on it being able to compete effectively against other forms of low carbon electricity generation.

A key priority in ensuring the future of nuclear power will be the success of developers' current plans to deploy up to 16GW of nuclear capacity using Generation III designs based on existing light water reactor (LWR) technologies. Success in this initial programme, with deployment running through the 2020s, in turn will depend on the ability of developers to build efficiently to time and to budget, and the ability of the supply chain to meet exacting technical standards.

The January 2008 white paper on nuclear power³ set out a number of key facilitative actions which government has been taking forward to provide a framework in which investors can take forward new nuclear build. Government has also recently published a Nuclear Supply Chain Action Plan⁴, developed in collaboration with UK industry.

A related priority is ensuring the ongoing maintenance and operation of the UK's existing power stations including any extensions to planned lifetimes, in line with regulatory requirements on safety, security and environmental impacts.

¹ Meeting the Energy Challenge – A White paper on Nuclear power
(<http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file43006.pdf>)

The Coalition: Our programme for Government
(http://www.direct.gov.uk/prod_consum_dg/groups/dg_digitalassets/@dg/@en/documents/digitalasset/dg_187876.pdf)

² <http://www.world-nuclear.org/education/comparativeco2.html>

³ Meeting the Energy Challenge – A White paper on Nuclear power

(<http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file43006.pdf>)

⁴ <http://www.decc.gov.uk/assets/decc/11/meeting-energy-demand/nuclear/7176-nuclear-supply-chain-action-plan.pdf>

Ensuring a full understanding of reactor characteristics will continue to be an important part of this.

Maintaining options for nuclear making a major contribution to the longer term energy mix

The Carbon Plan sets out a long term vision for reducing UK CO₂ emissions to 2050. It envisages that new low carbon power stations – a mix of carbon capture and storage, renewables and nuclear power – will be built, and models a number of potential 2050 scenarios for how the energy mix may develop in the longer-term.

The potential extent of the nuclear programme to 2050 varies significantly. This is because it is the Government's policy that, for the longer term, there should be competition between forms of low carbon electricity generation. The Government does not set targets for the deployment of nuclear power. Rather, the size of the nuclear programme will depend on the effectiveness of developers initially being able to build to time and budget, and subsequently being able progressively to reduce costs through experience and economies of scale.

Within 3 of the 4 key Carbon Plan scenarios, nuclear energy is envisaged as delivering a much larger amount of generation than that available now, with the potential to deliver up to 75GW of the UK's energy needs.

In order to potentially deliver against the upper end of this scope it is likely that more advanced and diverse options will need to be explored in terms of nuclear technology.

Such options may include: development of newer fission technologies such as evolutionary LWR's, small modular reactors (SMRs) or Generation IV ; options for closing the uranium fuel cycle and reprocessing spent fuel; progressing the development of fusion; and consideration of alternative fuel cycles. Ensuring that these options are not foreclosed or essential skills lost will be an important long term objective.

The UK is a signatory and an active participant to a number of international treaties and agreements on the non-proliferation of nuclear technologies and resources. The UK takes its responsibilities under such agreements very seriously and it is highly unlikely that this will diminish in the future. Indeed as new technologies and fuel cycles are developed, the focus on non-proliferation is likely to increase further.

Public confidence in the ability of nuclear power to deliver against the long-term vision is, and will continue to be, essential. The development, deployment,

operation and decommissioning of the UK's future nuclear programme will need to be undertaken with a view to openness and transparency, and with the wider interests of the public at its heart.

Developments in nuclear technologies, together with their associated benefits and risks, will need to be clearly communicated in a manner that provides sufficient information for the Government, politicians and the public to make informed and intelligent decisions.

Development and maintenance of an effective and expanding UK-based supply chain, competing successfully for work at home and abroad, contributing positively to the UK economy

Nuclear power generation carries with it significant potential for economic growth and job creation. Each of the new sites planned for the next fleet will deliver investment equivalent to that for the 2012 Olympics⁵ and could create 5,000 construction jobs at peak, and employ a thousand people in operation. Equally, the NDA is currently spending £3bn per year, largely on managing the legacy of the UK civil nuclear operations, decommissioning and R&D.

It is important that we should aim to maximise the economic benefit for the UK from such significant investments, by generating jobs and prosperity.

The Government wishes to see a strong, UK-based supply chain providing an increasing amount of input and content into existing and new build projects, both domestically and through exporting services and skills into the wider global market⁶.

We also wish to see industry implementing innovation from research and development in fields such as advanced manufacturing.

⁵ Anticipated industry investment in approximately 16GW of new capacity before 2030 equates to almost £60bn, which is equivalent to five new multiple-reactor nuclear power stations each with on average capital investment requirements of around £12.0bn. This compares to an overall cost of around £9bn for the London 2012 Olympic and Paralympic Games.

⁶ The IEA has predicted scenarios for global nuclear deployment ranging from 482-1973 GW by 2050, which illustrates the potential international opportunity.

Decommissioning the UK's nuclear legacy, including through safe and secure interim storage of waste and spent fuel, pending the availability of long-term disposal

The UK has a considerable civil nuclear legacy, some of it dating back to the 1940s, that is being managed and decommissioned by the NDA (Nuclear Decommissioning Authority), which was created through the Energy Act 2004.

Prior to emplacement in a Geological Disposal Facility (GDF), wastes and spent fuel will need to be managed in a manner that continues to protect people and the environment, whilst ensuring that the wastes remain in a suitable condition to enable final emplacement.

This work will continue to focus on the need to deal with the legacy higher-activity wastes associated with the last 60 years of the development and use of nuclear energy in the UK, in particular the Legacy Ponds and Silos at Sellafield.

Key to this will be our understanding of the characterisation and nature of wastes, during decommissioning and over the period of storage. Ongoing R&D will be essential to underpin this understanding and develop solutions for handling, management and final encapsulation of wastes.

Planning for wastes arising from nuclear new build

Any nuclear programme to 2050 and beyond will need to take into account the need for the minimisation and management of any arising wastes and spent fuels, through planning for decommissioning and waste routes early in the design process.

Equally, operators of new nuclear sites must have secure financing arrangements in place to meet the full costs of decommissioning, and their full share of waste management and disposal costs. The Energy Act 2008 requires prospective operators of new nuclear power stations in the UK to have an approved Funded Decommissioning Programme (FDP) setting out the operator's costed plans for decommissioning the power station and managing and disposing of the waste it will produce and making prudent financial provision for those costs.

In delivering this, operators will also need to demonstrate that they have a credible plan for the long term management of their wastes, particularly their "higher activity" wastes, which are intermediate level waste (ILW) and spent fuel.

Achieving the long-term management of nuclear waste

The Government's policy for the long-term, safe and secure management of higher activity radioactive waste in the UK, excluding Scotland⁷, is to place it deep underground in a geological disposal facility (GDF)⁸, sited and developed in partnership with a willing UK community.

Demonstrating that the UK has a credible programme to deliver a disposal route for higher activity wastes and have it in operation as soon as safely practical is therefore a foundation stone for the UK's short, medium and long term nuclear strategies. The key needs in the disposal programme are a willing host community with suitable geology.

Current planning assumptions made by the NDA suggest first waste emplacement will take place by 2040 with legacy High Level Waste emplacement beginning around 2075 and disposal of legacy waste estimated to be completed by about 2130.

Development of such a facility, together with the characterisation and encapsulation of the wastes to be stored within it, presents a significant challenge and will require the combination of expertise from the nuclear field together with other areas such as mining, geology and conventional materials science. A number of similar projects are being undertaken across the globe and lessons learned will need to be shared internationally.

Effective and well-resourced regulatory bodies, to protect the environment and society from the hazards of nuclear power

Safety, security and protecting the environment are our highest priorities for nuclear sites and the effective and efficient operation of the UK's regulatory framework remain a key contributor towards ongoing public confidence in nuclear power.

Going forward, the UK's nuclear regulators⁹ will need to meet the challenges of new build whilst maintaining sufficient flexibility, resources and expertise to ensure that the UK existing fleet and legacy are managed in a way that continues to protect the public and the environment.

⁷ The Scottish government has a separate, devolved policy for higher activity radioactive wastes which can be found at <http://www.scotland.gov.uk/Topics/Environment/waste-and-pollution/Waste-1/16293/higheractivitywastepolicy/hawpolicy2011>

⁸ Managing Radioactive Waste Safely - A Framework for Implementing Geological Disposal (<http://mrws.decc.gov.uk/assets/decc/mrws/white-paper-final.pdf>)

⁹ The Office for Nuclear Regulation, The Environment Agency, Natural Resources Wales, Scottish Environmental Protection Agency (existing operations only)

The establishment of the Office for Nuclear Regulation (ONR) as an independent statutory corporation is intended, not only to strengthen regulation, but also to ensure that future needs are assessed and the resources (especially skilled personnel and suitable facilities) to meet the potential demand are planned for in a strategic manner.

Management of the UK's civil plutonium

The UK currently stores a significant amount of plutonium, produced as a by-product of reprocessing spent nuclear fuel, the long-term management of which is a key priority in terms of both security risks and proliferation sensitivities for future generations to manage. This stockpile also presents potential opportunities in terms of use in fuel production.

The Government's preferred method of management is to reuse the plutonium as mixed oxide fuel (MOX) for use in civil nuclear reactors.

However, this is a long term policy and remains subject to further work to confirm that it can be implemented safely and securely, that it is affordable, deliverable, and offers value for money. Other options have not been ruled out, and the NDA continues to assess, on behalf of Government, whether there may be credible alternatives which better meet these objectives.

Government continuing to play an effective and pro-active role in the sector

The UK's nuclear energy sector has evolved significantly from its state-led beginnings to the market-led structure that is in effect today and which, with the current reforms to the electricity market, will continue in a low-carbon world.

Within this framework, Government has a pro-active role to play in addressing all of the above key priorities. Particularly in terms of:

- direct involvement (areas such as decommissioning and long-term disposal);
- providing support and facilitation to enable industry and the research community to deliver new nuclear power as part of our long-term energy mix;
- coordinating Government and other stakeholder efforts towards realisation of the long-term vision;
- ensuring the regulatory framework remains robust and fit for purpose;
- fulfilling the UK's duties in terms of non-proliferation agreements;

- and, as with this document, setting out a clear vision and policy framework in which the nuclear industry may work to achieve its full potential;

In providing all of these functions, Government needs to maintain its own access to resources, developing expertise and up-to-date knowledge in order to ensure that it can discharge its duties to Parliament and the public.

Key enablers and drivers

Research and Development

Ongoing nuclear R&D will play a vital role in ensuring that the expertise, skilled people and technology options are in place that will be needed to progress the above priorities and thereby ensure that the Government's long term vision can be realised.

Given the wide scope in estimating the composition of the 2050 energy mix and the rate of technological development (both for nuclear and other technologies), it will be prudent to hedge against the risk that the technologies needed to support any one particular future scenario may not be available at the point that the market sees a need to deploy them.

As such, it will be important that the UK's R&D base works towards maximising the number of credible options open to both the market and future Governments for all elements of the nuclear fuel cycle. However, funds are limited, particularly in the current climate, and the Government is committed to working with industry and academia to prioritise limited funds.

Research Councils coordinate funding for energy research through the RCUK Energy Programme which brings together all facets of energy research, knowledge transfer, engagement, and training across the Councils, in a programme which includes nuclear fission power and fusion.

The R&D Roadmap¹⁰ and the Industrial Vision Statement¹¹ will be instrumental in providing guidance to the Councils in that they will set out both the decision pathways for credible technologies and the preferred direction of industry.

A strategic approach is also needed to maximise the socio-economic impact of research and development through enhancing industry innovation, creating growth and enabling small and medium size enterprises to benefit from improved manufacturing processes.

¹⁰ Nuclear Energy Research and Development Roadmap: Future Pathways - URN BIS/13/632 - <https://www.gov.uk/government/publications/nuclear-energy-research-and-development-roadmap-future-pathways>

¹¹ Nuclear Industrial Vision Statement - URN BIS/13/629 - <https://www.gov.uk/government/publications/nuclear-industrial-vision-statement>

Skills development

The continued contribution of nuclear power in the energy mix and the realisation of the Government's long-term vision will require sufficient skilled people to construct, operate, decommission and regulate the UK's nuclear facilities. As well as providing knowledge and data that can be applied to underpin or provide new options to current nuclear activities, another key output from undertaking coordinated R&D is to provide a starting ground for the next generation of such staff for the sector.

The development of suitably qualified and experienced personnel (SQEP) for the nuclear industry requires around five to ten years of experience. The development of nationally or internationally renowned subject matter experts (SME) takes longer and requires engagement in leading edge R&D.

The industry itself is facing a significant skills challenge due to the demographics of the workforce with circa 55% of employees being over 45 years old. This will result in a large attrition of skills and expertise over the next decade.

The R&D community has historically provided a good training ground to export such staff into the wider nuclear community, including the nuclear regulators. The community itself also requires personnel developed in applied R&D skills, recruited both from education and re-trained into the nuclear research sector from other areas.

International collaboration

The UK is part of a much larger global nuclear market, which provides opportunities and challenges for investment, development and collaboration. The UK cannot act alone in aiming to realise the Government's long-term vision, but must work with others to provide a positive and informed political environment both domestically and globally.

The UK can contribute a significant amount of knowledge and experience in operations and decommissioning, and the UK's nuclear regulators are well regarded on the world stage, with their advice and experience being sought particularly by countries which are themselves new entrants to the market.

Equally, there is significant potential to learn from, and benchmark against, the experience of other countries and international bodies, both in research and deployment of nuclear technologies.

The current, tight, global fiscal climate has heightened the need to show that existing funds, and sources of funding, can be used effectively and efficiently in order to continue attracting scarce, further investment opportunities. This climate has also increased the impetus for international collaborations in terms

of: existing operations and decommissioning; new build; and R&D, particularly for capital-intensive facilities.

Delivery of the long-term vision

Government Policies facilitating nuclear power as a low carbon option

The Government is committed to ensuring the highest standards of operational safety for existing nuclear power plants and continued effort to decommission the legacy of the last century's civil nuclear programme, including giving priority to reducing the risk of the most hazardous facilities at Sellafield. Successive Governments have also seen nuclear as a vital part of future low carbon energy supply. Given that the newest of the current nuclear fleet started operations nearly 18 years ago, this means facilitating a new nuclear build programme.

Key Government work includes:

- The ongoing mission of DECC's Office for Nuclear Development to set the framework, and facilitate the construction and operation of nuclear power.
- Government's commitment to securing a volunteer community and taking forward the siting of a Geological Disposal Facility.
- Plans to create the Office for Nuclear Regulation as an independent statutory corporation.
- Implementation of Nuclear Supply Chain Action Plan including the ongoing work of the recently created Nuclear Industry Council.

A summary of these and other existing policies, together with references for further information can be found at **Annex A**.

Over the last 2 years a number of groups and organisations have given their consideration to the structure and future of the UK's nuclear sector, including the House of Lords Science and Technology committee report on "Nuclear Research and Development Capabilities" (November 2011). A summary of their key findings can be found at **Annex B**.

The Government said in February 2012 that it agreed that more thought needed to be given to the role of R&D in achieving its nuclear programme and has been working closely with Sir John Beddington's Advisory Board during 2012.

Initial investment in UK R&D

DECC, through the office of its chief scientific adviser, David MacKay, have worked with other Government departments to undertake a number of key short term investments in the UK civil nuclear sector, primarily through the work of the National Nuclear Laboratories. These include:

- Joint funding of a £15 million cross Government competition “developing the civil nuclear supply chain” to stimulate innovation in the civil nuclear sector. Led by the TSB and co-funded by DECC, EPSRC and NDA. Projects will be funded from early in 2013.
- DECC have a contract with NNL and Dalton Institute to carry out a 9 month programme of R&D into nuclear energy life-cycles.
- DECC have provided NNL with a grant to contribute towards their subscription to the Halden Research Reactor, based in Norway.

Initial Investment in UK Skills Development

BIS via the Skills Funding Agency and the UKCES have made a number of investments in support of the nuclear skills agenda including:

- National Skills Academy for Nuclear
 - £6.5m capital on flagship training centres
 - £3.5m Skills Academy set up and operational costs
 - £2m – Transformational Growth in the Nuclear Industry Supply Chain
 - £1m Expansion into Manufacturing for Nuclear
- Cogent SSC: £1m Employer Investment Fund and DECC funding including:
 - The Nuclear Workforce Tool
 - The Nuclear Island
 - Nuclear Industry Training Framework

International engagement

The Government commits to further increasing its presence and impact into associated international forums, in particular those relating to nuclear R&D where government representation has waned over the last decade.

At an EU level, the Government will work with like minded nations to provide a positive and informed political environment for the civil use of nuclear power both domestically and globally. We will develop and implement broader strategic relationships with nuclear interested countries through a programme of coordinated and proactive engagement that can help shape EU policy and that enables nuclear power to continue to have a role in the energy mix and harnesses economic opportunities.

Working with embassies, UKTI, industry, NSA Nuclear and academia, we will explore options to better showcase the UK's knowledge, expertise and facilities to the international market.

Cost Reduction programme

Government challenges the nuclear industry to reduce the levelised costs of new nuclear generation and will work with the Nuclear Industry council and the R&D community to do this. The key role of this work will be to recommend areas to be targeted by industry and government for potential cost reduction, to enable the UK to unlock the full potential of the UK's civil nuclear sector.

Regulatory advisory panel

In the last two years the Office for Nuclear Regulations chief nuclear inspector has convened two short term technical advisory panels, to assist him in his work of both the lessons learned from the Fukushima accident and aircraft risk to nuclear installations. These panels have consisted of technical experts nominated by a range of stakeholders and have proved to be very successful.

From this experience, and in light of one of the recommendation of the House of Lords report, the ONR are now in the process of setting in place a standing Chief Nuclear Inspector Advisory Panel with a broadly-based membership. The ONR will seek the Panel's views on a wide range of regulatory issues including significant reports. Additionally, this Panel will provide technical advice and commentary to the Chief Nuclear Inspector on the adequacy and balance of ONR's research programme.

The arrangements that ONR will put in place for the Panel will ensure that, in line with the Select Committee's recommendation, the Panel's advice is independent and transparent, and it provides suitable external review without impinging on ONR's regulatory duties and responsibilities. The ONR intend to have the panel in operation from spring 2013 and that will meet at least half-yearly.

Regulating for the future

HMG will work with the UK's nuclear regulators to identify potential obstacles and opportunities to regulating anywhere between 16 and 75 GW of nuclear generation, together with ongoing waste and decommissioning, by 2050. This will include consideration of the skills, resources and framework that will need to be developed to provide sufficient flexibility as the nuclear sector itself develops.

This work will commence with a scoping exercise over the next year to identify any potential short term actions and longer term pathways.

Annex A – Current policy

In order to set out a long-term strategy for the future, it is important to understand the context and the policies of the present.

The UK's current policies on nuclear generation have developed alongside the technology itself and, to a large extent, our understanding of it. They have been influenced and will continue to be influenced by the context of the national and global environment.

A number of commentators have noted that government policy for nuclear is spread across departments, publications and timelines. The Landscape Review undertaken as part of the Nuclear R&D Capabilities Programme also makes note of this.

This annex aims to address some of those issues by drawing together the various strands of UK nuclear policy, summarising the key policies in one place, and setting out where more detail can be found. We envisage that this will be a living document and will provide updates and amendments as necessary.

Further details on the UK policy and R&D landscape can be found in the Landscape Review, undertaken by the government in conjunction with the research and industrial communities.¹²

New Build

Nuclear is vital for our energy security now and we want it to be part of the energy mix in the future alongside renewables and clean coal and gas. Nuclear is cost competitive with other generation technologies and in the future it is expected to be the cheapest low-carbon source of electricity, so it can keep bills down and the lights on.

The January 2008 white paper on nuclear power¹³ set out the overarching policy for new nuclear power. This stated,

- new nuclear power stations should have a role to play in this country's future energy mix, alongside other low-carbon sources

¹² A Review of the Civil Nuclear R&D Landscape in the UK – URN BIS/13/631 - <https://www.gov.uk/government/publications/civil-nuclear-research-and-development-landscape-in-the-uk-a-review>

¹³ Meeting the Energy Challenge – A White paper on Nuclear power (<http://webarchive.nationalarchives.gov.uk/+http://www.berr.gov.uk/files/file43006.pdf>)

- it would be in the public interest to allow energy companies the option of investing in new nuclear power stations
- the Government should take active steps to facilitate this
- it will be for energy companies to fund, develop and build new nuclear power stations in the UK, including meeting the full costs of their decommissioning and their full share of waste management costs.

In June 2010, the Coalition Government published its programme of policies¹⁴. This re-iterated the vision that nuclear should play an important role – alongside renewable energy and Carbon Capture and Storage (CCS) – in the UK’s future energy mix and that energy companies can build new nuclear power stations provided they are subject to the normal planning process for major projects and receive no direct public subsidy.

The issue of “no public subsidy” was further defined by the Secretary of State for DECC in a written ministerial statement on 10th October 2010¹⁵.

The long term vision is a market where low carbon generators compete fairly under a robust and stable carbon price, and it is Government policy that new nuclear power should be able to contribute as much as possible to the UK’s need for new capacity under this framework.

Waste and Spent Fuel

Geological Disposal

Government policy for the long-term, safe and secure management of higher activity radioactive waste in the UK, excluding Scotland, is to place it deep underground in a geological disposal facility (GDF). The policy was set out in the June 2008 White Paper Managing Radioactive Waste Safely: A Framework for Implementing Geological Disposal¹⁶. Geological disposal involves isolating radioactive waste within engineered multi barrier facilities, typically between 200m and 1000m deep, inside a suitable rock formation, to ensure that no harmful quantities of radioactivity ever reach the surface environment.

The White Paper sets out the six stages of the Government’s approach to implementing geological disposal - a community led approach based on a commitment to voluntarism and partnership working. This means allowing willing communities to come forward to take part in the process and work with the Government and others on the siting of a geological disposal facility. The

¹⁴ The Coalition: Our programme for Government
(http://www.direct.gov.uk/prod_consum_dg/groups/dg_digitalassets/@dg/@en/documents/digitalasset/dg_187876.pdf)

¹⁵ http://www.decc.gov.uk/en/content/cms/news/en_statement/en_statement.aspx

¹⁶ Managing Radioactive Waste Safely - A Framework for Implementing Geological Disposal
(<http://mrws.decc.gov.uk/assets/decc/mrws/white-paper-final.pdf>)

invitation to communities to come forward and enter into non-committal discussions with Government on the possibility of hosting a GDF remains open.

It is Government policy that before consents for new nuclear power stations are granted, it will need to be satisfied that effective arrangements exist – or will exist – to manage and dispose of the waste they produce. The ability to demonstrate that the UK has a credible programme to deliver a disposal route for higher activity radioactive waste is, therefore, an important enabler of new nuclear build.

LLW

In 2007, the UK Government and devolved administrations agreed to seek to divert Low Level Wastes (LLW) away from the Low Level Repository (LLWR) near Drigg, Cumbria and use more conventional methods for disposing of LLW. The policy emphasizes applying the waste hierarchy of recycling, incineration and landfill¹⁷ for the disposal of LLW.

If the integrated waste management strategy cannot be employed, then disposal of LLW should be minimised through decay storage, re-use and/or recycling. As part of the integrated waste management strategy, all nuclear licensed sites should have a plan for the management of their LLW holdings and predicted future volumes. Such a waste management strategy is also required from contractors who are working under the auspices of the NDA. For those working with the NDA, this covers solid radioactive waste in all waste categories - LLW, ILW, HLW.

There has been some progress in opening up new conventional disposal capacity. It is vital that we continue to pursue and implement more conventional means for disposing of LLW.

Funded Decommissioning Programme

The Energy Act 2008 requires prospective operators of new nuclear power stations in the UK to have a Funded Decommissioning Programme (FDP) approved by the Secretary of State for Energy and Climate Change before nuclear-related construction can begin. An FDP must set out the operator's costed plans for decommissioning the power station and managing and disposing of the waste it will produce and make prudent financial provision for those costs. The Department of Energy and Climate Change (DECC) published statutory Funded Decommissioning Programme Guidance on 8 December 2011, setting out the overall objective of the regime, the guiding factors that the Secretary of State will use when assessing an FDP, and also

¹⁷ Policy for the Long Term Management of Solid Low Level Radioactive Waste in the UK
<http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/nuclear/radioactivity/llw-policystatement070326.pdf>

provides guidance on the Secretary of State's preferred structure and content of an FDP.¹⁸

During 2011 the Parliament passed an amendment to Section 46 of the Energy Act allowing the Secretary of State to enter into agreement setting out the manner in which he will exercise his powers under the Act to modify an approved FDP. This agreement will be in the form of a contract between the operator and the Secretary of State (hereafter the Section 46 Agreement or S46 Agreement). The Secretary of State cannot enter into such an agreement unless he is satisfied that adequate provision is made for the Modification of the FDP in the event that the arrangements cease to be prudent.

Operators will also need to have a credible plan for the long term management of their wastes, particularly their "higher activity" wastes, which are intermediate level waste (ILW) and spent fuel. The UK Government's policy is that geological disposal is the way higher activity radioactive wastes will be managed in the long term.

Therefore, alongside approval of an operator's FDP, the UK Government will expect to enter into a contract with the operator of that power station regarding the terms on which the Government will take title to and liability for the operator's spent fuel and ILW (the Waste Contract) for disposal in the GDF. In the absence of a credible alternative waste disposal route, it is anticipated that (unless and until alternative disposal routes are developed) all new nuclear operators will enter into a Waste Contract.

The Waste Contract will set out how the price charged for this waste transfer will be determined (the Waste Transfer Price). Alongside the Waste Transfer Price the Government will also provide the Operator with the Government's best estimate of the date on which disposal of the Operator's waste will begin (the "Assumed Disposal Date"). On 8 December 2011 DECC published the Waste Transfer Pricing Methodology, which forms the basis of more detailed provisions to be set out in the Waste Contract that will be agreed between the Government and the Operator¹⁹

Plutonium

The UK is currently storing a significant amount of Plutonium, the long-term management of which is a key priority in terms of both security risks and proliferation sensitivities for future generations to manage.

¹⁸ <http://www.decc.gov.uk/assets/decc/Consultations/fdp-guidance-new-nuclear/3797-guidance-funded-decommissioning-programme-consult.pdf>

¹⁹ <http://www.decc.gov.uk/assets/decc/Consultations/nuclear-waste-transfer-pricing/3798-waste-transfer-pricing-methodology.pdf>

The Government's response to a consultation on the *Management of UK plutonium stocks*²⁰ sets out these issues in more detail and confirms the Government's preferred method of management by reusing the plutonium as mixed oxide fuel (MOX) for use in civil nuclear reactors.

This policy is subject to further work to confirm that it can be implemented safely and securely, that is affordable, deliverable, and offers value for money. If these conditions cannot be met, or should credible alternatives become available that meet these conditions and offer better value for money for the taxpayer, then the Government may revise this policy.

Other work

A more detailed policy guide to "Management of Radioactive Substances, Radioactive Waste and Nuclear Materials in the UK" is currently in development and will be published in due course.

Transport

With the setting up of the Office for Nuclear Regulation (ONR), legislative policy responsibility for transport of radioactive materials by road, rail or inland waterway was transferred from DfT to DECC. While it is true that DECC are also involved in the overseas transport of nuclear materials, and have policy responsibility concerning the repatriation of overseas materials, the legislative policy responsibility for this area still resides with DfT

Security

DECC is responsible for the overall effectiveness of the security regime for the UK's civil nuclear industry. The security regime is kept under continuous review and complies with international standards. DECC works closely with the ONR's Civil Nuclear Security team, as well as the Civil Nuclear Police Authority and the Civil Nuclear Constabulary, to ensure security measures are of the highest possible standard.

Civil nuclear operators are required by law to have site security plans setting out the security arrangements for the protection of nuclear sites and nuclear material on such sites. The arrangements cover, for example, physical protection features such as fencing and turnstile access, the roles of security guards and the Civil Nuclear Constabulary, the protection of proliferation-sensitive data and technologies and the trustworthiness of the individuals with access to sensitive nuclear information and material. Civil nuclear operators are financially and legally responsible for these security measures.

²⁰ <http://www.decc.gov.uk/assets/decc/Consultations/plutonium-stocks/3694-govt-resp-mgmt-of-uk-plutonium-stocks.pdf>

Third Party Liability

The UK is a party to the Paris Convention on nuclear third party liability and its supplementary the Brussels Convention, which establishes a European framework for compensating third parties following a nuclear incident. The UK has been party to the Conventions since the 1960s and is in the process of implementing the most recent amendments made to them in 2004. These changes aim to provide more compensation to more people for a wider scope of nuclear damage. The changes will be implemented in the UK through the Nuclear Installations Act 1965. The changes will apply to both existing nuclear operators as well as new build operators that come forward in the future.

The Government proposals were set out in a public consultation in January 2011²¹. The key changes include increasing the operator liability from currently £140m to €1.2 billion for which operators must have full insurance as a condition of their site licence; widening the types of liabilities for which compensation can be claimed, including those related to the environment, and widening the geographical scope so that in addition to claims from other Paris and Brussels countries, claims may also be made by those with reciprocal arrangements and non-nuclear states.

The changes to the Nuclear Installations Act will be made at the turn of 2012/13 but will not come into force until the revised Conventions have been jointly ratified by all the EU Contracting Parties. No date has been agreed on when this may happen but could be in 2014.

Regulation

The principal regulators of the nuclear industry are the Office for Nuclear Regulation (ONR) (nuclear safety and security) and the environment agencies (radioactive waste disposal and environmental protection).

Formerly the Health and Safety Executive's Nuclear Directorate, ONR was established in April 2011 as an agency of HSE pending legislation to establish it as a statutory body. The regime enforced by ONR has been subject to development over the last 5 years. In 2007 HSE's Nuclear Directorate was extended to include the Office for Civil Nuclear Security and the UK Safeguards Office alongside the existing Nuclear Installations Inspectorate (NII). The Department for Transport's Radioactive Materials Transport Team also joined ONR in October 2011 bringing these two regulatory strands together for the first time.

The Government intends that the Energy Bill currently going through Parliament will create the ONR as an independent, statutory entity by 2014. As a statutory

²¹ http://www.decc.gov.uk/en/content/cms/consultations/paris_brussels/paris_brussels.aspx

body ONR will retain the best of current practice whilst creating a modern independent regulator based on the better regulation principles of transparency, accountability, proportionality, targeting and consistency. ONR will build on its current strengths as a world-class regulator and will be better placed to respond quickly and flexibly to current and future regulatory challenges while retaining its focus on the protection of people and society from the hazards of nuclear generation. The creation of ONR will not affect the current regulatory requirements or standards with which the nuclear industry must comply. The vast majority of the costs of the regulator will continue to be recovered in fees from operators in the nuclear industry rather than funded by the public purse.

The principal environmental regulators of the nuclear industry are the Environment Agency in England and Wales and the Scottish Environment Protection Agency (SEPA) in Scotland. They are independent regulators, established as executive non-departmental public bodies in 1996 by the Environment Act 1995. They follow the better regulation principles working with industry and others to protect the environment and human health. For nuclear sites they regulate disposals and discharges of radioactive waste and other activities that give rise to non-radioactive emissions such as the discharge of cooling water and operation of plant such as incinerators and standby generators. They derive their income from charges levied on operators for regulatory services.

The Agencies are also responsible for protecting communities, including the areas around nuclear sites, from the risk of flooding. For example, they have important roles in providing strategic oversight of flood and coastal risk management, the consenting of land drainage work and providing general advice.

From 1 April 2013 a new body, 'Natural Resources Wales' will be established bringing together the functions of the Countryside Council for Wales, the Environment Agency Wales, and the Forestry Commission Wales. At that point the Environment Agency will only cover England, although initially at least it will provide agreed services to Natural Resources Wales, including nuclear regulation.

The environment agencies work very closely with the ONR to ensure a co-ordinated approach to the regulation of the nuclear industry.

Reprocessing

Policy on legacy reprocessing is set out in the 2002 *Managing the Nuclear Legacy White Paper*²². It notes that THORP will continue to operate until existing contracts have been completed or the plant is no longer economic.

The January 2008 white paper on nuclear sets out that new nuclear power stations that might be built in the UK should proceed on the basis that spent fuel will not be reprocessed and that plans for, and financing of, waste management should also proceed on this basis.

Should any proposals come forward in the future to reprocess spent fuel from nuclear power stations, they would need to be considered on their merits at the time and the Government would expect to consult on them.

Construction and operation skills

The UK has a high level of expertise in several areas related to the wider nuclear supply chain, including decommissioning. However, the scale of the industry's new build aspirations, the length of time since the last new build project and the high average age of the existing nuclear workforce means that it is essential to take action now to prevent skills gaps developing over the course of the new nuclear programme.

The development of an overarching skills strategy for the Nuclear Industry is the responsibility of the National Skills Academy for Nuclear. The co-ordinated delivery of skills interventions across the sector, including in the key areas of Construction, Engineering Construction and Manufacturing, is facilitated by the Nuclear Energy Skills Alliance (NESA). NESA brings together the relevant skills bodies²³ with Government to ensure an aligned and collaborative approach to addressing the skills challenges facing the industry.

NESA members are working with employers to input relevant research and labour market intelligence into a Nuclear Workforce Tool. This project, led by Cogent SSC with the input of all NESA member skills bodies, will help to define industry-wide skills requirements over the course of the Nuclear Programme acting as a crucial evidence base for skills interventions as well as supporting workforce planning.

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<http://webarchive.nationalarchives.gov.uk/+/http://www.dti.gov.uk/nuclearcleanup/ach/whitepaper.pdf>

²³ Construction Skills, ECITB, Cogent SSC, NSA Nuclear, Semta SSC

Research Councils

Research Councils coordinate funding for energy research through the RCUK Energy Programme which brings together all facets of energy research, knowledge transfer, engagement, and training across the Councils, in a programme which includes nuclear fission power and fusion. The RCUK Energy Programme's primary focus is to deliver against 2050 energy target through world class research and training. The development of a UK research roadmap to 2050 (to be led by the RCUK Energy Fellow, Jim Skea) will set a context within which Research Councils' future investments can be placed.

Funding for this spending review period (2011/12- 2014/15) is £540M - £439M of which is via the EPSRC (£51M BBSRC; £13M ESRC; £20M NERC and £17M STFC). In 2011/12 the RCUK Energy programme spent £170m. Fusion spend was £31.9m and fission spend was £11.7m.

Specific examples of initiatives have included:

- £4 million call in 2011 with Nuclear Decommissioning Authority (50/50) on geological disposal of nuclear waste
- Keeping the Nuclear option open follow up activity 2011 was an £7M Energy programme joint call with RR, EDF and British Energy.
- EPSRC contributed to a £15m TSB programme on developing the civil nuclear power supply chain. EPSRC will fund the academic contributions to successful projects.
- EPSRC's Manufacturing the Future programme announced that they have funded a £4m programme on "New Nuclear Build and Manufacturing (NNUMAN)" which will provide fundamental advances feeding into the NAMRC.
- TSB has highlighted nuclear R&D as one of its key areas for investment in its recently published Energy strategy

Fusion

The Research Councils developed the UK's fusion strategy in 2010²⁴. This strategy is consistent with the EU goal to demonstrate the scientific feasibility of magnetic fusion on ITER in the 2020s and deliver first fusion electricity before 2050. It also seeks to keep the UK at the forefront of inertial confinement fusion.

The UK's national laboratory at the Culham Centre for Fusion Energy (CCFE) and UK universities are expected to continue to play a leading role in the

²⁴ See summary at: <http://www.stfc.ac.uk/resources/pdf/visiondocument.pdf>

development of fusion energy until commercial fusion is delivered. In inertial fusion the Atomic Weapons Establishment and the Central Laser Facility at the Rutherford Appleton Laboratory give the UK a substantial capability. A key strategic focus of the fusion programme is to advance technology that will position UK industry for a substantial share of the future fusion economy. Funding from the European Commission provides a significant amount of the support for the UK's fusion programme.

Annex B - Considered opinion and recommendations

A number of groups and organisations have recently given their consideration the structure and future of the UK's nuclear industry, producing a range of reports and recommendations. These have included:

- House of Lords Science and Technology Committee report on “Nuclear Research & Development Capabilities”. (Nov 2011)
- Royal Society report on Fuel cycle stewardship in a nuclear renaissance (Oct 2011)
- Energy Research Partnership “UK Nuclear Fission Technology Roadmap” (Feb 2012)
- Smith School report “Towards a low carbon pathway for the UK” (Mar 2012)
- Birmingham University Policy Commission on Future of Nuclear Energy in the UK (Jul 2012)

The purpose of this annex is to provide a brief summary of the main findings and recommendations of these various reviews and how these are being considered in developing the Government strategy and the long term roadmap.

All of the reviews have acknowledged the need for nuclear to remain in the energy mix and to grow in the long term to support the challenges of security of supply, tackling fuel poverty and meeting the ambitions set out in the Carbon Plan including the binding target of reducing greenhouse gas emissions to 80% below 1990 levels by 2050.

Each review acknowledges a pressing need for a clear nuclear roadmap set within a long-term Government strategy which defines how R&D across the nuclear fuel cycle will be supported and how the UK's current strengths in nuclear research will continue to be exploited. The other key message from the reviews is the need for active coordination from an enduring body.

The Table below summarises each of the main reviews to date.

Table 1: Summary of Main Reviews

Paper	Published	General View	Recommendations on Government or Market Coordination
<p>Fuel cycle stewardship in a nuclear renaissance</p> <p>The Royal Society Science Policy Centre</p>	<p>Oct-2011</p>	<p>The paper makes a number of best practice and UK specific recommendations in relation to making the nuclear fuel cycle more secure and proliferation resistant.</p>	<p>Need for improved support for the nuclear research base which should be underpinned by long term strategy. In addition a more integrated approach to safety, security and non-proliferation through the whole of the nuclear fuel cycle. Great international collaboration.</p>
<p>Strategic Coordination of UK R&D for the long term management of higher active wastes</p> <p>CoRWM</p>	<p>Dec 2011</p>	<p>The paper makes a number of recommendations related to improving the UK R&D arrangements for the long-term management of higher activity wastes (HAW) including improving the NNL, geological disposal research and coordination with all operators</p>	<p>Strategic need to improve and expand the National Nuclear Laboratory's (NNL's) facilities for research with highly radioactive materials</p> <p>Improvements on existing &D on treatment, packaging, storage and transport of HAW, spent fuels and nuclear materials.</p> <p>NDA Research Board to be expanded to include all prospective operators</p>

Paper	Published	General View	Recommendations on Government or Market Coordination
<p>UK Nuclear Fission Technology Roadmap</p> <p>Energy Research Partnership</p>	<p>Feb-2012</p>	<p>Need for R&D investment and investigation of fuel cycle and GDF sizing if nuclear expands over, say, 40 GW.</p>	<p>The UK Government needs to develop a clearly defined long-term strategy and an R&D Roadmap for the nuclear sector. Forming of an overarching R&D co-ordinating body consisting of Government, industry, NNL, NDA, regulators, academia and research funders, to own, develop and advise Government on a long-term nuclear R&D strategy and roadmap.</p>
<p>Towards a low carbon pathway for the UK</p> <p>Smith School - University of Oxford</p>	<p>Mar-2012</p>	<p>Clear policies and levers for decarbonisation are needed, including investigation into uranium stocks required to understand fuel cycle needs & Mox cost model.</p>	<p>Proposes the Government's proposed Advisory Board on R&D be expanded to be an independent body with the mission to evaluate and impartially advise on long term nuclear strategy, R&D and structural options for the industry.</p>
<p>Future of Nuclear Energy in the UK</p> <p>Birmingham Policy Commission</p>	<p>Jul-2012</p>	<p>Free market approach may not deliver low costs in the long term due to investment into R&D of Gen IV reactors and fuel cycle.</p>	<p>Government and industry need to work together to produce a shared roadmap detailing a coherent long term strategy that can be championed by a statutory Nuclear Policy Council.</p>

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