UK Nuclear Waste Policy: 50 Wasted Years

8

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> There should be no commitment to a large programme of nuclear fission power until it has been demonstrated beyond reasonable doubt that a method exists to ensure the safe containment of long-lived, highly radioactive waste for the indefinite future.
> (Royal Commission on Environmental Pollution, 1976, p. 131),

8.1 Introduction

In 2003, an energy policy White Paper, published by Tony Blair's UK government, stated:

Although nuclear power produces no carbon dioxide, its current economics make new nuclear build an unattractive option and there are important issues of nuclear waste to be resolved. Against this background, we conclude it is right to concentrate our efforts on energy efficiency and renewables. We do not, therefore, propose to support new nuclear build now. But we will keep the option open (Department of Trade and Industry, 2003, p. 12).

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Yet only two years later, Tony Blair told a conference: nuclear energy was "*back on the policy agenda with a vengeance*", with a review to be undertaken to determine whether the 2003 policy on nuclear should be reversed (Tempest, 2005). This announcement begged the question what actions were planned to resolve the issues on nuclear waste. This chapter focuses on UK nuclear waste policy from 2005 to 2022 and whether the policy on nuclear waste that emerged after 2005 is well founded. The focus is mainly on high-level waste (HLW) and intermediate-level waste (ILW), as these present the most intractable issues.

Sections 2 and 3 provide an overview of the UK's civil and military nuclear programmes and catalogues the attempts up to 2005 to identify sites for waste. Sections 4 and 5 examine the attempt started in 2005 by the Blair government to restart nuclear construction and the corresponding measures taken to deal with waste. Sections 6 and 7 examine the inventory of material that will go into a Geological Disposal Facility (GDF) and the design features of the GDF. The key feature of the current policy on waste, that the site selection process should be driven by consent by host communities rather than imposed by central government, is then examined.

8.2 Military and Civil Nuclear Programmes

Blair's 2005 announcement came after 50 years of nuclear power generation in the UK, which has determined the volume and type of waste that had to be dealt with. The civil nuclear power programme up to 2005 is summarised in Table 8.1.

The military programme predates the civil nuclear programme, and the HLW and ILW from this will be placed in the same repository as the civil waste. Military waste comprises material from the nuclear weapons programme, with the first weapons test taking place in 1952, and spent fuel and waste from submarines, with the first nuclear submarine being commissioned in 1963. These wastes will continue to be generated regardless of any decisions in the civil nuclear sector. The Ministry of Defence is expected to pay its share of the disposal costs.

The first civil reactors used the 'Magnox' design.[1] Twenty-six reactors of this design ranging from 60-600 MWe were built, the first entering service in 1956

[1] The Magnox design was named after the magnesium–aluminium alloy used to clad the fuel. The reactors use unenriched uranium and were cooled using carbon dioxide and moderated using graphite.

Table 8.1 The UK nuclear programme: Key dates and policy decisions

1956	First of 11 (5 GW) Magnox stations (CO_2 cooled, graphite moderated, natural U) enters service. Last Magnox completed 1972 & closed in 2015. Fuel must be reprocessed because of corrosion
1959	Nuclear Installations Inspectorate, part of the government Health & Safety Executive (HSE), created to regulate nuclear plants. 2011, renamed Office of Nuclear Regulation (ONR) and separated from HSE in 2013
1965	Advanced Gas-cooled Reactor (AGR) technology chosen. CO_2 cooled, graphite moderated, enriched U. 5 stations ordered 1965–1969, entered service 1976–89. First 3 stations to be retired in 2021–22, other 2 closed by 2024. Fuel initially reprocessed.
1977	Dual reactor strategy comprising preparations to build Westinghouse Pressurised Water Reactors (PWRs) & orders for 2 AGRs to give interim work to UK nuclear industry, 1979, in service 1989, to be closed by 2028
1977	Commercial Fast Reactor 1 expected to be ordered soon, put on hold 1982. UK merged FBR expertise with that of France & Germany in 1988, no reactors built.
1979	Margaret Thatcher launches programme of PWR orders, 1 per year for 10 years, first order to be placed 1981. Only 1 PWR (Sizewell B) ordered, 1987, completed 1995
1990	Attempt to privatise electricity industry reveals operating cost alone of Magnox & AGRs double the expected wholesale electricity price. 1990–1996, 10% of electricity bills paid to nuclear to cover costs. Nuclear plants remained publicly owned. Expectation that nuclear would all be closed by 2000
1995	UK Atomic Energy Authority (UKAEA) split and commercial activities privatised. Privatised company ceases nuclear work
1996	AGR reliability improved enough for them to be privatised with Sizewell B, as British Energy
2002	British Energy collapses when wholesale electricity price not high enough to cover costs. Rescued by government & relaunched 2005
2002	British Nuclear Fuels Limited (BNFL) insolvent, plans to privatise it intact abandoned and the company broken up with commercial activities privatised. Ownership of all existing civil nuclear facilities passed to new public organisation, Nuclear Decommissioning Authority (NDA)
2003	Energy White Paper states "[nuclear power's] current economics make it an unattractive option for new, carbon-free generating capacity" and "we conclude it is right to concentrate our efforts on energy efficiency and renewables"
2006	Tony Blair announces nuclear "back on the policy agenda with a vengeance". New nuclear would be competitive & given no public subsidies

(continued)

Table 8.1 (continued)

2008	Nuclear White Paper states 'nuclear is currently one of the cheapest low-carbon electricity generation technologies, so could help us deliver our goals cost effectively.' And 'nuclear power is likely to be cost-competitive with other sources of electricity in most scenarios.'
2009	EDF buys relaunched British Energy comprising 7 AGRs, a PWR and sites to build new reactors
2009	3 competing consortia set up comprising 7 large European utilities each expecting to build 2–3 reactors on each of 5 sites, 16 GW, by 2030
2013	Deal for first project, Hinkley Point C, 2 Areva European Pressurised Reactors (EPRs) agreed with EDF-led consortia, contracts signed, first power 2023, expected construction cost £14bn (£16.4bn 2020 prices), take-or-pay power purchase agreement for 35 years at fixed real price of £92.5/MWh (2012 money)
2013/14	6 European utilities pull out of their consortia and 2 consortia are sold, 1 to Toshiba to build Westinghouse AP1000 and 1 to Hitachi to build A*dvanced Boiling Water Reactor* (ABWR)
2015	Government launches attempt to commercialise Small Modular Reactors (SMR) in UK
2016	Bradwell site allocated to China General Nuclear (CGN) to build 2 reactors using Chinese technology
2016/17	Westinghouse & Areva both collapse. Areva taken over by EDF
2018/19	Hitachi & Toshiba abandon their 3 projects. EDF acknowledges it cannot finance its 2nd project, Sizewell C, and proposes Regulated Asset Base model with institutional investors owning the plant
2020	Small amounts of public money for SMR programme given to Rolls Royce PWR SMR, U-Battery HTGR & Westinghouse lead-cooled fast reactor
2021	CGN stops work on Bradwell B project. Dungeness B AGR closed
2022	Hunterston B and Hinkley Point B AGRs retired.5.0 GW of nuclear capacity in operation, 3.2 GW under construction. Remaining AGRs expected to close 2024–2028, Sizewell B will operate till 2045. 3 of 6 new nuclear projects abandoned, 2 of 6 in serious doubt. SMR programme lacking direction. By 2030, maximum nuclear capacity only 1.2 GW
2022	Hinkley Point C delayed to 2027–28 and cost up to £25–26.7bn

Source: Author's research

and the last closing in 2015. Reprocessing the spent fuel to separate the plutonium was required. This was partly because it was assumed the spent fuel was prone to corrosion and could not be disposed of directly. It was also to provide

plutonium for the weapons programme,[2] and because of a perception that world reserves of uranium were so limited as to require an early transition to fast reactors fuelled by plutonium. A reprocessing plant (B204) had been in operation since 1952 using fuel from non-power reactors, replaced in 1964 by the B205 plant, which reprocessed Magnox fuel. B205 closed in July 2022 (Her Majesty's Government, 2022).

By 1964, it was clear the Magnox design was not commercially competitive, and a government decision was taken to replace it with another UK design, the Advanced Gas-cooled Reactor (AGR).[3] Five stations were ordered, comprising two reactors each of about 600 MW, but it soon became apparent the design was poor, and the procurement strategy misconceived (Williams, 1979). The five stations are the most delayed and unreliable set of reactors built in the world. This was followed by three more government reactor choices: the Steam Generating Heavy Water Reactor in 1969, the dual AGR/Pressurised Water Reactor (PWR) policy of 1977, and the PWR programme of 1979. However, these attempts all largely failed, and resulted in two more AGRs and one PWR (Sizewell B) being built, completed in 1989 and 1995 respectively.

The fast reactor programme with its need for plutonium remained a strong influence on nuclear policy, and a proposal was made to build a new reprocessing plant to deal with fuel from the AGRs and PWRs[4] as well as imported spent fuel. It was subject to a Public Inquiry in 1977 (The Windscale Inquiry, 1978). The verdict was in favour of the Thermal Oxide Reprocessing Plant (THORP), but construction did not start for another decade, with completion in 1994. THORP only started up in 1997, it never operated as designed, underwent continual breakdowns, and was closed in 2018 when it had fulfilled its contracts to reprocess non-UK spent fuel. Unlike Magnox fuel, which was claimed to require reprocessing, there is no need to reprocess AGR or PWR fuel. By the late 1980s, the fast reactor programme had been essentially abandoned and the need for plutonium for civil reactors no longer existed.

There were several consequences for waste disposal from this history of reprocessing. By 2020, the UK had built up a stockpile of separated civil plutonium

[2] It was claimed that civil spent fuel was not used to make weapons plutonium, but the distinction was a materials accounting one. There was one reprocessing plant and there was no segregation of military spent fuel.

[3] The AGR reactors are cooled using carbon dioxide and moderated using graphite and used enriched uranium.

[4] The B205 reprocessing plant was not suitable for fuel from AGRs and PWRs.

of about 140 tonnes, with no apparent use (Fichtlscherer et al., 2020). Despite this, the UK does not categorise spent fuel or plutonium as radioactive waste. The stock of plutonium is sufficient for a significant programme of fast reactors so it is unlikely the spent fuel will not be classified as waste for direct disposal. The 2005 rescue of the collapsed privatised nuclear power company, British Energy (see below), led to an end to reprocessing for AGR fuel because of the high cost (European Commission, 2005, p. 33). In effect, this means that fuel loaded into AGRs after 2005 was not reprocessed, and none of the Sizewell B PWR fuel was reprocessed.

The privatisation of the British electricity industry in 1990, one of the last acts of the Thatcher government, was intended to include the existing nuclear capacity, with a commitment to build at least three more PWRs to follow on from Sizewell B. The information gathered to allow the sale of the nuclear reactors revealed that the operating cost alone of the Magnoxes and AGRs was double the expected wholesale electricity price. It was also clear that private investors were unwilling to take on the risk of building new reactors, and the nuclear sector remained in public ownership. The failure to sell the nuclear capacity was a crushing blow to the credibility of the UK nuclear industry. The performance of the AGRs and Sizewell B had improved sufficiently for them to be privatised in 1996 but with no obligation to build new reactors, while the Magnox plants remained in public ownership. The illusion that nuclear power was cheap was exposed and the decision in 2003 not to pursue nuclear power seemed inevitable.

8.3 Attempts to Identify Waste Disposal Sites

In 1976, the UK government appointed a Royal Commission on Environmental Pollution to examine the environmental impact of nuclear power. Its seminal report, commonly known as the Flowers Report (Royal Commission on Environmental Pollution, 1976), was a comprehensive and thorough review of the impact of nuclear power, but the statement that resonates today is the one quoted at the start of this chapter, that nuclear power should not be pursued until there is a clear solution to the waste issue.

In the wake of this influential report, efforts to identify new sites for disposal of low-, intermediate- and high-level waste (LLW, ILW and HLW) began (see Table 8.2). For LLW, the Drigg site in Cumbria was established in 1959, and by 1980 there was an apparent need to build a new facility. In 1986, four sites, none of which had any existing nuclear facilities, were identified by the Thatcher government as sites for a shallow burial site for LLW. This led to immediate

Table 8.2 The UK nuclear waste disposal programme

1952	B204 reprocessing plant opened to reprocess spent fuel to separate Pu, closed 1964 & converted to pre-handling plant to allow Advanced Gas-cooled Reactor (AGR) fuel reprocessing in B205, re-opening 1969. Explosion in 1973 contaminating the whole plant & 34 workers led to permanent closure of the plant.
1964	B205 reprocessing plant opened to reprocess Magnox fuel, expected to close 2021 when last Magnox fuel reprocessing complete.
1971	British Nuclear Fuels Limited (BNFL) separated from UK Atomic Energy Authority (UKAEA).
1976	Royal Commission on Environmental Pollution recommends: "There should be no commitment to a large program of nuclear fission power until it has been demonstrated beyond reasonable doubt that a method exists to ensure the safe containment of long lived, highly radioactive waste for the indefinite future."
1977	Public inquiry into proposal to build a reprocessing plant, Thermal Oxide Reprocessing Plant (THORP), opened. Approval given 1978. Economic case based on contracts to reprocess foreign fuel. Pu to be sent back to country of origin.
1982	Nuclear Industry Radioactive Waste Executive (NIREX) created to examine options for radioactive waste disposal. Absorbed into Nuclear Decommissioning Authority (NDA) 2007.
1986	4 sites identified as potentially suitable for Intermediate-level Waste (ILW) Geological Disposal Facilities (GDF). Quickly abandoned.
1994	THORP completed, enters service in 1997, but never operates as designed. In 2005 suffered a major leak of Pu, contained but undetected for 10 months. Closed 2018.
1995	Proposal to investigate using Sellafield for GDF by NIREX sent to Public Inquiry. Proposal rejected.
1997	Plant to make Mixed Oxide fuel completed but did not enter service till 2002. Designed to produce 120 tonnes fuel per year but in its 5 years of operation, made only 5 tonnes total.
2001	Committee on Radioactive Waste Management (CoRWM) set up to advise government on best option to deal with ***'legacy'*** waste.
2003	Energy White Paper states "there are also important issues of nuclear waste to be resolved. These issues include our legacy waste."
2006	CoRWM reports that GDF are the best option for ***legacy*** waste.
2008	Nuclear White Paper states, "Government believes that it is technically possible to dispose of new higher-activity radioactive waste in a geological disposal facility and that this would be a viable solution and the right approach for managing waste from any new nuclear power stations." And, "We consider that it would be desirable to dispose of both ***new and legacy*** waste in the same repository facilities."

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Table 8.2 (continued)

2012	Nuclear Decommissioning Authority (NDA) launches consultation on how to deal with stockpile of separated plutonium, put it 'beyond reach'. 3 options considered: burning in a Hitachi PRISM FBR, burning in a Candu 6, used to make MOX fuel. Consultation not completed but 'burning' options rejected.
2018	THORP closes when foreign contracts fulfilled. Most Pu not sent back to country of origin, but equivalent quantity of radioactivity sent back leaving UK with total stockpile of separated Pu of about 140 tonnes.

Source: Author's research

and determined local opposition. Just before the next General Election in 1987, evaluation of all four sites was abandoned and LLW was expected to be dealt with along with ILW in deep burial sites. Despite Drigg being reportedly close to capacity for decades, compaction has meant it continues in operation, with no immediate plans to close and replace it with a new facility.

In 1982, the nuclear industry, primarily then publicly owned, set up the Nuclear Industry Radioactive Waste Executive, Nirex Ltd, to examine methods for waste disposal. In 1989, Nirex began to look for sites for deep geological disposal of LLW and ILW, and targeted two sites, both with existing nuclear facilities, Dounreay (on the north coast of Scotland) and Sellafield (in Cumbria on the northwest coast of England), both remote and sites of previous nuclear accidents that had contaminated the land with plutonium. This contamination means there is no prospect that either site could be cleaned up sufficiently to allow its release for unrestricted use. In 1992, Nirex announced plans to build a Rock Characterisation Facility at Sellafield. This would monitor conditions at the depth a GDF would be built in order to assess the suitability of the site. The county council for the area, Cumbria, turned down the application, and in September 1995, a Public Inquiry into the rejection of the proposal was opened, running for five months. Nirex's proposal was turned down by the Public Inquiry[5] (Cumbria County Council, 1996), and an appeal by Nirex to the Secretary of State against this verdict was also rejected. The Inquiry Inspector was highly critical of the case made by Nirex.

In 2003, an energy policy White Paper concluded nuclear power was "an unattractive option and there are important issues of nuclear waste to be resolved" (Department for Trade and Industry, 2003, p. 12). To deal with the waste issue,

[5] Public inquiries are formal investigations into major developments, convened by a government minister.

the UK government set up the Committee on Radioactive Waste Management (CoRWM) in 2003, with a brief: "to make recommendations for the long-term management of the UK's higher activity wastes that would both protect the public and the environment and inspire public confidence" (Committee on Radioactive Waste Management, 2006, p. 2). The committee emphasised that "CoRWM's recommendations are directed to existing and committed waste arisings. CoRWM believes that its recommendations should not be seen as either a red or green light for nuclear new build" (Committee on Radioactive Waste Management, 2006, p. 13).

CoRWM's main recommendation was:

Within the present state of knowledge, CoRWM considers geological disposal to be the best available approach for the long-term management of all the material categorised as waste in the CoRWM inventory when compared with the risks associated with other methods of management. The aim should be to progress to disposal as soon as practicable, consistent with developing and maintaining public and stakeholder confidence. (Committee on Radioactive Waste Management, 2006, p. 96)

There was disagreement within the Committee about whether the facility should be immediately sealed when it was full or kept open for several hundred years. The Committee was unable to agree on this.

By the time of the 2005 Blair announcement, experience had shown that attempting to site waste facilities even at existing nuclear sites, and even for the technologically relatively straightforward LLWs would be bitterly contested. The moves to fulfil the duty to deal with the existing and committed wastes in an appropriately responsible manner, such as the CoRWM exercise, were immediately derailed by Blair's announcement. Attempts to site waste facilities were, as a result, seen by critics of nuclear power as 'door-opening' measures for new nuclear build, rather than an attempt to deal responsibly with existing waste.

8.4 The Blair Programme

The 2003 energy policy White Paper had promised:

Before any decision to proceed with the building of new nuclear power stations, there will need to be the fullest public consultation and the publication of a further white paper setting out our proposals (Department of Trade and Industry, 2003, p. 12).

So, the 2005 Blair policy speech could not be immediately turned into a programme of new reactor build. A White Paper on nuclear power policy was

published in 2008 (Department for Business Enterprise and Regulatory Reform, 2008).

The detailed history of the Blair programme is outside the scope of this chapter but, like the five previous attempts to re-launch a UK nuclear power programme, it largely failed. The 2008 nuclear power policy White Paper led to a government projection that 16 GW of new nuclear capacity, with 11 reactors at five sites, could be in operation by 2025, with an additional site for two reactors, 2.3 GW, added later.

By 2022, only one station, Hinkley Point C (3.2 GW) had started construction and will not be completed before 2027. Three of the sites have been abandoned, and the other two remain in serious doubt. In April 2021, the UK minister Gerry Grimstone said: "*If you read the energy white paper [Department for Business, Energy & Industrial Strategy, 2020] […] it's by no means certain that this country is going to be building large nuclear power stations.*" (Thomas & Pickard, 2021).

However, in response to high energy prices from 2021, the Boris Johnson government announced a new attempt to restart nuclear ordering, with a target of 24 GW of nuclear capacity to be completed by 2050, with the first new reactor entering service in the mid-2030s (Department for Business, Energy & Industrial Strategy, 2022). It is hard to see why this new attempt should be any more successful than its predecessors.

A major barrier to a relaunch of nuclear power ordering was the financial collapse in 2002 of the two key civil nuclear companies, British Energy (the privatised owner of the newer nuclear power stations) and British Nuclear Fuels Limited (BNFL). British Energy was relaunched in 2005, having satisfied the European Commission that its rescue did not constitute unfair state aid (European Commission, 2005). The price for this public intervention was that 65% of the shares in British Energy were taken by the government. In 2008, EDF (Électricité de France, a multinational electric utility company, largely owned by the French state) bought out the British government, taking an 80% stake in British Energy.[6] This gave it access to the six AGR sites, most of which were seen as suitable for new nuclear capacity.

BNFL was split into eight parts, with the skills and capabilities privatised, but ownership of the sites going to a new government-owned body, the Nuclear

[6] The other 20% was taken by and remains with the British energy company, Centrica.

Decommissioning Authority (NDA). Most of these facilities were retired or near retirement and the sites represented major liabilities because of the need to clean them up. At the time of its creation in 2005, NDA's liabilities were estimated to be about £53bn (Nuclear Decommissioning Authority, 2006, p. 70). By 2021, despite 15 years of decommissioning work, the estimated remaining liability had increased to £131.5bn (Nuclear Decommissioning Authority, 2021a, b).

The planning system was seen by the Blair government as a major barrier to large projects, introducing delay and uncertainty. A particular concern was the Public Inquiry system, which was often blamed for the delays building the Sizewell B nuclear power plant and THORP, and the failed attempt to build a deep nuclear waste disposal facility at the Sellafield site. These claims of delays caused by Public Inquiries were however misleading, as the public inquiries represented only a small part of the delays. In 2007, a White Paper introducing a streamlined process was published, *Planning for a Sustainable Future* (Her Majesty's Government, 2007). Under the new procedures, for nationally 'significant infrastructure projects' major Public Inquiries would not take place and there would be a new single consent regime and an independent commission to determine applications.

8.4.1 Resolving Important Issues of Nuclear Waste

The concerns about waste expressed in the 2003 White Paper (Department of Trade and Industry, 2003) needed to be addressed. The 2008 nuclear power policy White Paper (Department for Business, Enterprise & Regulatory Reform, 2008) cited the CoRWM report (2006) as supporting a view that a GDF was the appropriate way to dispose of ILW and HLW but ignored the condition that CoRWM was only mandated to recommend solutions for existing and committed waste. In 2006, CoRWM had reiterated that its conclusions were not applicable to waste from new build:

> *The main concern in the present context is that the proposals might be seized upon as providing a green light for new build. That is far from the case. New build wastes would extend the timescales for implementation, possibly for very long, but essentially unknowable, future periods. Further, the political and ethical issues raised by the creation of more wastes are quite different from those relating to committed – and, therefore, unavoidable – wastes. Should a new build programme be introduced, in CoRWM's view it would require a quite separate process to test and validate proposals for the management of the wastes arising. (CoRWM, 2006, p. 13).*

In the *Draft National Policy Statement on Nuclear Power Generation* (Department of Energy & Climate Change, 2009, p. 22), the government, then headed by Blair's successor, Gordon Brown, again cited CoRWM as supporting the use of GDFs for ILW and HLW disposal. Four members of the original CoRWM body subsequently wrote to the government expressing dissatisfaction with how their work had been represented.[7]

A White Paper published by the Brown government specifically on waste policy (Department of the Environment & BERR, 2008), elaborated on the nuclear power policy White Paper (Department for Business, Enterprise & Regulatory Reform, 2008), specifically identifying the GDF as the chosen option. Key points from the waste policy White Paper were:

- reflecting the discussions in CoRWM about when the GDF should be closed and the waste made irretrievable, the government said the decision need not be taken now;
- a new division of NDA, the Radioactive Waste Management Directorate (RWM), was set up to replace Nirex using some of Nirex's resources; and,
- while the White Paper sought to stress consultation with the public, it was clear nothing similar to the Public Inquiry system would be allowed. (Department of the Environment & BERR, 2008)

However, the most substantive proposals concerned the site selection and site assessment processes, and while they have been revised several times, the 2008 proposals still form the basis of policy in 2022. At the heart of the proposed process was 'voluntarism and partnership', so that those hosting the GDF would be 'volunteers', unlike the previous process under which a candidate site was selected with no reference to those directly affected. In the 2008 White Paper on waste policy, (Department of the Environment & BERR, 2008), the government identified three sets of local communities: the host community; the town or village where the GDF would be situated; the decision-making body, the local government body for the host community; and wider local interests such as adjoining towns, villages, and districts. The process would begin with a local community making an 'expression of interest', followed by a 'decision to participate' that would commit them to participate in the siting process while still retaining a right

[7] http://www.nuclearwasteadvisory.co.uk/wp-content/uploads/2011/06/CoRWM1_Letter_201109.pdf.

of withdrawal, which would apply up to the start of underground testing to determine the suitability of the site. When the decision to participate was taken, a local 'community siting partnership' would be set up.

As incentives, there was an 'engagement package' under which communities' costs would be met and a 'benefits package' provided. The latter included facilities such as transport infrastructure that would be needed for construction, but there would also be 'benefits which may be commensurate with developing the social and economic wellbeing of a community that has decided to fulfil such an essential service to the nation.' Details on what these benefits might be were not specified.

Once the local community had taken a decision to participate, the three stages in the site assessment were a basic screening by means of desk-based studies of the site undertaken to ensure it was suitable, followed by surface investigations and underground operations.

8.5 Developments Since 2008

In 2008, three local councils[8] in the region where Sellafield is sited volunteered to consider hosting a GDF (see Roche et al, 2019). They set up the West Cumbria Managing Radioactive Waste Safely Partnership which met about every six weeks for three years before Cumbria County Council, rejected the plans and the attempt collapsed.

This represented a major setback. Not only had the partnership failed, but the process had revealed serious doubts about the suitability of sites in Cumbria, which are widely seen as by far the most politically feasible because the historic employment offered by the Sellafield complex means there is some local support for new nuclear facilities there.

In 2014, soon after this collapse, the government published another White Paper on waste policy, *Implementing Geological Disposal* (Department of Energy & Climate Change, 2014). This included a national screening process to be carried out by RWM; bringing all facilities associated with a GDF under the 'Nationally Significant Infrastructure Projects' as set out in the planning system reforms introduced in 2008. How relations between government and local communities would operate was also amplified, for example on community representation, how money would be invested in local communities, and establishing a means for local

[8] Allerdale Borough Council, Copeland Borough Council and Cumbria County Council.

communities to access independent expertise. No attempt was made to identify potential sites based on this new White Paper.

In 2018, the 2014 White Paper (Department of Energy & Climate Change, 2014) was updated as *Implementing Geological Disposal: Working with communities* (Department for Business, Energy & Industrial Strategy, 2018). This launched the sixth attempt to find a suitable site for a waste disposal facility (see Table 8.3). RWM identified three areas as worthy of investigation for a GDF in England, Cumbria (in the Northwest), Hartlepool and Theddlethorpe (both on the East Coast). By early 2022, three separate Community Partnerships had been set up in Cumbria, in Allerdale (Allerdale Geological Disposal Facility Community Partnership, 2022), Mid Copeland (Mid Copeland GDF Community Partnership, n.d.), and South Copeland (South Copeland GDF Community Partnership, n.d.) and in June 2022 a Community Partnership was set up for the Theddlethorpe site (Theddlethorpe GDF Community Partnership, n.d.). No progress had been made at Hartlepool, and that site seems unlikely to progress. Little has been done other than to set up these Community Partnerships and it is too early to make judgements on them.

8.6 What Material is to Be Disposed of in a GDF?

8.6.1 Legacy Waste

The UK's 2018 White Paper (Department for Business, Energy & Industrial Strategy, 2018), identified three streams of waste that would go into a GDF. HLW is spent fuel or material recovered from reprocessing spent fuel. It generates a large amount of heat as well as a high level of radioactivity. ILW does not generate much heat and arises from reprocessing and from decommissioning of retired reactors. LLW waste can generally be stored in surface stores as the radioactivity decays relatively quickly, but some wastes with long-lived radioactive isotopes are expected to be placed in a GDF.

The position on HLW is complicated by the long history of reprocessing. Spent fuel and separated plutonium are not categorised as waste. The 2018 White Paper says:

> *In addition to existing wastes, there are some radioactive materials that are not currently classified as waste, but would, if it were decided at some point that they had no further use, need to be managed as wastes through geological disposal. These include spent fuel (including spent fuel from new nuclear power stations), plutonium and uranium. (Department for Business, Energy & Industrial Strategy, 2018, p. 12)*

Table 8.3 Implementation stages for GDF: site selection, site assessment, construction, operation, closure.

Stages in implementing a GDF	Estimated time-line	Main issues/activities
Pre-operation		
Site selection	5 years: Radioactive Waste Management (RWM) identifies potential sites. An individual or a group of people who want to propose an area, be it a few fields or an entire county, for consideration sets up a local group to advance the proposal. RWM reviews the specific sites proposed.	Voluntarism • Expression of interest • Decision to participate • Difficult for communities to object Community Partnership • Gains access to resources. Authorities opposing the proposal have no access to such resources. • Money to build local public facilities Right of withdrawal • In practice it appears to be difficult for members of the partnership to withdraw.
Site assessment	15 years	If, after further investigation by RWM, the site appears promising and there is still local interest, deep investigative boreholes will be drilled by RWM, conditional on consent by the relevant government minister and by the Environment Agency. If these further investigations, expected to take about 15 years, show a Geological Disposal Facility (GDF) is viable, RWM must obtain an Environment Permit from the Environment Agency and a Nuclear Site License from the Office of Nuclear Regulation (ONR) before construction start. If the site proves unsuitable, a new search must start.
Test of public support	Before construction starts	Form of the test not yet determined. If the test fails, the site is abandoned, and a new search must start.

(continued)

Table 8.3 (continued)

Stages in implementing a GDF	Estimated time-line	Main issues/activities
Construction	10 years	Building the GDF is expected to take a further 10 years before the first waste can be emplaced.
	Estimated subtotal: 30 years	
Operation		
Waste emplacement	100 years for legacy waste. Much longer, perhaps 250 years, if new-build waste is also disposed of depending on the scale of new-build	It is expected the facility would receive waste for long enough to dispose of only the current volume of 'legacy' waste, about 100 years. If new-build waste is emplaced at the same site, the facility would be open for much longer depending on the scale and timing of new-build. The government (Department of Energy & Climate Change, 2014) states it is: "proceeding on the assumption that only one GDF will be necessary." So given the GDF might be open for 200 years or more from around 2050 and would contain waste generated before 1960, the burden on future generations will be substantial and long-lasting. The facility might not be ready for closure till perhaps 250 years from when it was chosen.
	Estimated subtotal: 100–250 years	
Post-operation		

(continued)

Table 8.3 (continued)

Stages in implementing a GDF	Estimated time-line	Main issues/activities
Sealing the facility making waste irretrievable	Seal immediately or after several hundred years	Retrievability: There was disagreement within CoRWM (2006) about whether the facility should be immediately sealed when it was full or kept open for several hundred years. The Committee was unable to agree on this issue. The government claims (Department for Business, Energy & Industrial Strategy, 2018, pp. 25–26): "Permanently closing a GDF at the earliest possible opportunity once operations have ceased provides for greater safety, greater security, and minimises the burden on future generations." The decision can only be taken at the time of closure of the facility.
	Estimated subtotal: 0 – 200 years	
	Estimated total: 130 – 480 years	

Source: Author's research

This appears to create a major uncertainty about the volume of high-level waste that will be disposed of in the GDF. In 2011, the UK government stated its preferred policy for the stockpile of plutonium was that it should be used in mixed oxide (MOX) fuel that could fuel existing conventional reactor designs such as PWRs. The objective was "to implement approaches to put the inventory of separated civil plutonium beyond reach" (Department for Business, Energy & Industrial Strategy, 2018, p. 14). However, by 2022, attempts to find ways of dealing with the plutonium stockpile, either by 'burning it' in fast reactors or turning it into MOX fuel for conventional reactors had come to nothing.

On spent fuel, the reprocessing plants have been closed and the stock of plutonium seems to be sufficient for a significant programme of fast reactors, so it seems unlikely the spent fuel will not ultimately be classified as waste.

The likelihood is therefore that the plutonium stockpile and the spent fuel will be disposed of directly. So, in practice the likely volume of HLW is known. There is some uncertainty about ILW, as the final stage of decommissioning Magnox reactors that will generate large quantities of ILW was not expected to start until 2075, with decommissioning of AGRs likely to follow sometime after 2100. However, this policy of delay was reviewed in 2020 due to deterioration of the Magnox buildings with a much more rapid timetable likely to be required (Nuclear Decommissioning Authority, Sellafield Ltd & Magnox Ltd, 2021). This will increase the volume of ILW as it will have had less time to decay.

8.6.2 New-Build Waste

The scale and type of waste from new-build is unpredictable because of the uncertainty about the type, number and size of the reactors that will be built. In 2021, four different technologies were being promoted by government: large 1000+MWe reactors of various designs; the Rolls Royce small (470 MWe) PWR (Rolls Royce. (n.d.); the U-Battery high temperature gas-cooled reactor (3 MWe) (UBattery, n.d.); and the Westinghouse Lead-cooled Fast Reactor (450 MWe) (Westinghouse, n.d.). The latter three options are a decade or more away from commercial deployment with uncertainty about whether they will be pursued. Of the large reactors, there is one station, Hinkley Point C, under construction comprising two European Pressurised Reactors (EPR), expected to be completed before 2030, and two other specific projects (Sizewell C (two EPRs) and Bradwell B (two Chinese-design Hualong One reactors) that might be pursued, but for completion well after 2030.

The 2008 White Paper (Department for Business, Enterprise & Regulatory Reform, 2008, p. 30) stated: "Our view remains that in the absence of any proposals from industry, new nuclear power stations built in the UK should proceed on the basis that spent fuel will not be reprocessed." The Generic Design Assessments by the Office of Nuclear Regulation (ONR) of the reactor designs proposed have been based on disposal of the spent fuel directly into a GDF (see, for example, Nuclear Decommissioning Authority, 2014a). The RWM states: "spent fuel from a new build programme is assumed to be managed by direct disposal after a period of interim storage" (Radioactive Waste Management, 2021, p. 3). The current assumption in government remains that spent fuel would be disposed of rather than reprocessed.

The two EPR projects will use high-burn-up fuel expected to achieve 60 + gigawatt-days per metric ton of uranium (GWd/MTU),[9] more than any commercially operating reactor.[10] High burn-up fuel would be much hotter and more radioactive than conventional spent fuel requiring much longer in intermediate store, perhaps 140 years,[11] before the fuel is stable enough to consider final disposal. There are also concerns that the fuel would become fragile due to fission gases being released in the fuel (see for example Pastore et al., 2017), and that the cladding would become brittle. These factors might make it unwise to dispose of the fuel directly (United States Nuclear Regulatory Commission, 2018), In its assessment of the EPR, the RWM concludes that:

> *ILW and spent fuel from operation and decommissioning of an EPR should be compatible with plans for transport and geological disposal of higher activity wastes and spent fuel. It is expected that these conclusions eventually would be supported and substantiated by future refinements of the assumed radionuclide inventories of*

[9] Typical existing reactors have a burn-up of 35–45 gigawatt-days per metric ton of uranium (GWd/MTU). By increasing the enrichment of the uranium in the fuel, it is possible to get to higher burn-ups, meaning the reactor can operate for longer before refuelling is required

[10] Two other designs, the Westinghouse AP1000 and the Hitachi-GE ABWR were approved by the UK safety regulator, ONR, based on using burn-ups of 60 GWd/tU. The projects expected to use these designs have since collapsed although the design approval remains valid. The Hualong One design proposed for Bradwell is expected to have fuel burn-up of about 50 GWd/tU.

[11] RWM states: it would require of order of 140 years for the activity, and hence heat output, of the EPR fuel [with a maximum burn-up of 65 GWd/tU] to decay sufficiently to meet this temperature criterion (NDA, 2014b).

> *the higher activity wastes and spent fuel, complemented by the development of more detailed proposals for the packaging of the wastes and spent fuel and better understanding of the expected performance of the waste packages (Nuclear Decommissioning Authority, 2014b, p. 8).*

The UK White Papers of 2008, 2014 and 2018 on waste disposal make no mention of burn-up and the issues it raises.

8.6.3 Military Waste

Military waste from the weapons and submarine programmes will form a significant part of the waste disposed of in the GDF, but no details have been published about the volume and characteristics of this waste.

8.7 The Proposed Geological Disposal Facility

8.7.1 Design

Only one GDF is proposed, albeit with separate areas to take the different categories of waste. The 2018 White Paper (Department for Business, Energy & Industrial Strategy, 2018) suggested there might be a system of vaults for the disposal of ILW, and an array of engineered tunnels for the disposal of HLW. These could be at different depths, for example 200 m for ILW and 1 km for the higher activity wastes. There would be substantial surface facilities, for example rail and road links for delivery of the waste. The packaged volume of the waste is estimated to be about 750,000 cubic metres, equivalent to 70% of the volume of the Wembley football stadium.

8.7.2 Cost and Employment

The 2018 White Paper stresses the employment impact of the GDF: "Current estimates are it will directly employ around 600 skilled, well-paid staff per year, over the duration of the project, with workforce numbers rising to more than 1000 during construction and early operations." The jobs would be provided for "more than 100 years" (Department for Business, Energy & Industrial Strategy, 2018, p. 54). However, on cost, the White Paper says: "The precise costs of develop-

ing a GDF will depend on a number of factors, including the type of rock in which the facility is constructed and exactly how long it operates before being closed." (Department for Business, Energy & Industrial Strategy, 2018, p. 25).In the 2021 GDF annual report, the Nuclear Waste Services (NWS) division of NDA stated the cost of the GDF: "is estimated to be in the region of £20-£53bn", compared to its previous estimate of only £12bn. NWS explained the increase: "This was because that figure [£12bn] only represented a lower-end single-point estimate based on the costs of disposing of legacy waste only alongside some basic assumptions about a single type of geology and depth" (Nuclear Waste Services, 2022, pp. 24–26).

The overwhelming majority of the waste generated will be owned by the NDA, the Ministry of Defence, and the UK government, which will take title to the waste from EDF's nuclear power stations when they are retired.

8.7.3 Timing

The White Paper (Department for Business, Energy & Industrial Strategy, 2018) talks about a period of 15–20 years to identify a site and carry out the technical work necessary to prove its suitability (see Table 8.3). There would then be a period of 10 years to construct the first vaults, at which point emplacement of waste would begin in parallel with construction of further capacity. The White Paper claims a GDF could be open in the 2040s. It is expected the facility would receive waste for about 100 years, long enough to dispose of only the current volume of 'legacy' waste. After 100 years, the 2018 White Paper implies the facility would be closed promptly and waste from new-build plants would need another GDF. However, in discussions between RWM and its stakeholder engagement group, it appears that once legacy waste has been disposed of, new vaults would be constructed for new-build waste using the existing shaft. The Johnson government claims: "Permanently closing a GDF at the earliest possible opportunity once operations have ceased provides for greater safety, greater security, and minimises the burden on future generations." (Department for Business, Energy & Industrial Strategy, 2018 pp. 25–26).

The Cameron government (previously stated it is: "*proceeding on the assumption that only one GDF will be necessary.*" Department of Energy & Climate Change, 2014). So given the GDF might be open for 200 years or more from around 2050, and would contain waste generated before 1960, the burden on future generations will clearly be long-lived.

8.7.4 Regulation

The regulatory framework for GDF is expected to be essentially the same as for other nuclear facilities. The ONR will regulate safety and security. The Environment Agency will be responsible for implementing and enforcing environmental protection legislation; its areas of responsibility include environmental pollution, waste management, flood risk management, water resources, fisheries, and conservation. The Health and Safety Executive will ensure the health and safety of workers.

8.7.5 Location

As with previous attempts, the most likely sites to be pursued are those in Cumbria near the Sellafield complex. Proposals to consider sites on the east coast of England (Theddlethorpe and Hartlepool) have attracted little local support and seem unlikely to proceed. RWM have stated: "If the community doesn't want it, it won't be built" (BBC, 2022).

8.7.6 Retrievability

The government states: "The UK Government and regulators agree that the purpose of a GDF is to dispose of waste, not to store it." And that: "Permanently closing a GDF at the earliest possible opportunity once operations have ceased provides for greater safety, greater security, and minimises the burden on future generations" (Department for Business, Energy & Industrial Strategy, 2018, pp. 25–26). However, given that the decision on when to seal the repository will be taken in no less than 150 years from now based on the prevailing conditions, such a statement has little weight.

8.8 Community Consent

Given the hostility previous attempts to impose a disposal facility had generated, ensuring the support of local communities has been at the centre of government proposals since the 2008 White Paper on nuclear waste (Department of the Environment & BERR, 2008). Much of the 2018 White Paper (Department for Business, Energy & Industrial Strategy, 2018) concerns proposals aimed at ensuring

this informed consent is given. This raises the issue of how the process can be run without a serious risk that a previously receptive community could end the process if it changed its mind.

The process is initiated by an individual or a group of people who want to propose an area for consideration, be it a few fields or an entire county. If RWM judges that the site is worthy of further consideration, RWM must inform the relevant local authorities. If, after further investigation by RWM, the site appears promising and there is still local interest, deep investigative boreholes will be drilled by RWM, conditional on consent by the relevant government minister and by the Environment Agency. These further investigations are expected to take about 15 years. If they show a GDF is viable, RWM must obtain an Environment Permit from the Environment Agency and a Nuclear Site License from the ONR. Building the GDF is expected to take a further 10 years before the first waste can be emplaced. Including time to identify potential sites, it appears the whole process is expected to take at least 30 years. The claim in the 2018 White Paper (Department for Business, Energy & Industrial Strategy, 2018) that a GDF could be open in the 2040s therefore looks implausible.

The 2018 White Paper proposes that once a site has passed the initial screening, a Working Group should be formed comprising the person(s) who initially indicated an interest, the RWM, an independent chair, an independent facilitator, and all relevant principal (district or county) local authorities should be invited to be members, although things can proceed if they do not join. The job of the Working Group is essentially to identify potentially suitable sites.

The next step is the formation of a Community Partnership comprising community members, organisations, the RWM and at least one principal local authority. This will be backed up by a Community Partnership Agreement specifying working arrangements. The Community Partnership's job is to share information and to seek answers to questions raised by the community. The Community Partnership will be given funding of up to £1 m per year (Community Investment Funding) in the initial stages, rising to £2.5 m if the proposal progresses to drilling boreholes. This fund can be used for local initiatives, for example, enhancing the natural environment.

8.8.1 Right of Withdrawal

The 2018 White Paper claims: "A community can withdraw from the siting process at any time up until it has taken a Test of Public Support." However, it then appears to contradict that statement: "The decision on whether to withdraw the

community will be taken by the relevant principal local authority, or authorities where there is more than one, on the Community Partnership. Where there is more than one relevant principal local authority on the Community Partnership, all must agree; no single relevant principal local authority will be able to unilaterally invoke the Right of Withdrawal" (Department for Business, Energy & Industrial Strategy, 2018, p. 58). It will therefore be easier to enter the siting process than to exit it.

8.8.2 Test of Public Support

The Test of Public Support of residents in the Potential Host Community will take place at the point RWM is ready to seek regulatory approval and development consent for the GDF, some 20 years after the process started. The Potential Host Community will be determined by the Community Partnership and will include wards (divisions of towns or cities) that will be physically affected by the GDF, either below or above ground, and including required infrastructure such as transport links. The White Paper (Department for Business, Energy & Industrial Strategy, 2018) does not specify the form the Test might take, but suggests it might be a referendum, a consultation or statistically significant polling. The right of withdrawal ceases once a successful test of public support has taken place.

8.8.3 Engagement Funding

The Community Partnership and its Working Groups will have funding available and access to expert bodies to allow them to commission their own work. The scale of this funding is not specified. However, there is no funding for critical groups. This is unlike Sweden, where the MKG (Swedish NGO Office for Nuclear Waste Review), and an alliance of organisations often critical of nuclear power, receives significant government funding.

8.8.4 Community Investment Funding

The White Paper restates the economic benefits of the project to the area, particularly job creation over more than 100 years. It talks of 600 permanent jobs during the operation of the facility with up to 1000 during construction. It also

mentions improvements in infrastructure such as transport links. However, these benefits only begin once construction starts, perhaps 20 years from when the process begins. The government therefore proposes funding of £1 m rising to £2.5 m per year once borehole drilling starts, available to the members of the Community Partnership to be used for projects benefiting the local communities but with no connection to the project.

Once a site has been selected for a GDF and the Community Investment Funding has finished, the local communities will also continue to receive government grants for local projects, amount not specified.

8.8.5 Will the New Policy Yield a GDF?

There is a wide gap between the rhetoric of willing communities volunteering to host a GDF and the reality of the procedures. It seems unlikely that any site apart from one in Cumbria will command local support, and even in Cumbria there will also be significant local opposition. So, while two other areas were proposed in 2021 by local groups, these will be bitterly opposed by other local interests.

The earlier 2008 policy quickly failed when one of the local authorities withdrew support. The government responded by making it easier to set up a Community Partnership, and harder to withdraw from one, with increased incentives to make the lengthy and costly procedure less vulnerable to a precipitate collapse. A proposal can now be set up with support of only one or two local individuals or local groups. Provided it can get support from one or two local authorities and regardless of how many local authorities oppose it, a Community Partnership could be set up and gain access to resources to commission their own studies and receive significant public money to build local facilities unconnected with the proposal. Authorities opposing the proposal have no access to such resources. Once a Community Partnership is set up, despite the promise of a right of withdrawal, in practice, it appears it would be impossible for one member of the partnership to withdraw.

These measures make a mockery of claims that a GDF would not be imposed. They are also unlikely to be politically sustainable if it becomes clear that their effect is to impose a GDF on an unwilling community.

The Test of Public Support would only take place when construction of the facility is ready to start, after up to 20 years of investigations. There will inevitably be boundary problems, with communities close to the proposed facility but outside the boundaries feeling disenfranchised.

8.9 Conclusions

Nuclear power has seldom been a major public policy issue in the UK, with conflicts generally being between the nuclear industry trying to site a facility and the planned host community opposing it. For waste, it has been government bodies promoting the siting of waste facilities. The scientific establishment has not been a major voice.

Like other European countries with significant existing quantities of ILW and HLW, UK policy is to dispose of this in a GDF. Policy statements are designed to promote the view that GDFs are the only responsible policy option for these types of waste, and that there are no doubts that disposal in a GDF is viable and would entail negligible risk that harmful material would leak into the environment over the long period required. This assumption is based on several premises. That:

- A site can be identified that meets the geological requirements over a period of hundreds of thousands of years.
- The complex chemical and radiological changes that will occur over this period are well enough understood.
- The packaging arrangements will be able to withstand the intense heat and radiation they will be subjected to.

Assessing these requirements is beyond the scope of this analysis, but the proposals will not only have to achieve a scientific consensus that they meet requirements; they will also have to convince the public. The poor technological record of the British nuclear industry with many serious technological failures, means its credibility is low.

The Government justifies its advocacy of a GDF based on the recommendations of the Committee on Radioactive Waste Management. Since the start of the Blair attempt to relaunch nuclear construction in 2005 successive governments have never acknowledged that the mandate of this Committee was solely to deal with 'legacy' waste. While this is a historic detail that few will be aware of, the underlying difference between a door-opening decision and a decision to discharge a historic responsibility will continue to be a barrier to getting the local consent needed to select sites. The lack of a proven method for dealing with waste also undermines claims by advocates of nuclear power that it is a sustainable technology.

These issues were exacerbated by the ambitions in 2022 of the UK government under Boris Johnson to expand nuclear power. By 2021, the 2006 Blair programme of building 16 GW of large reactors by 2025 was failing, with the only

project to proceed, Hinkley Point C, not forecast to be complete before 2027–28. In its place, the UK government directed public money to Small Modular Reactors (SMR) until 2022, when the Johnson administration launched its own attempt to build large new reactors. The SMR designs are all a decade or more from being deployable and may never be commercially viable. Whether the problems of getting public consent for a GDF would be solved if the UK was to make a decisive decision not to pursue new reactor projects, comparable to the German 'Energiewende', is hard to determine. However, given that the successive failures of nuclear policy dating back to the 1960s do not seem to have dimmed governments of all complexions' appetites to continue to try to launch new nuclear power programmes, such a decision appears implausible.

The history of the British nuclear industry, specifically the policy of reprocessing spent fuel, has also created problems for the UK, notably the huge quantity of separated plutonium. The government's position that spent fuel and plutonium are not categorised as waste causes uncertainty about the quantity and type of high- and intermediate-level waste that will need to be accommodated in a GDF. Radioactive decay of the plutonium means that it will increasingly not be useable as reactor fuel. In practice, it is not clear what the implications over the next decades up to the forecast opening date of a GDF would be, given that a restart of reprocessing and a major fast reactor programme appear to be decades away, if ever. Would the material be stored differently if it was categorised as waste, or as a resource for future use?

The issues raised by the high burn-up fuel, which will be used in Hinkley Point C and any other large reactors built are not addressed by government. These include the very long period, expected to be 140 years, from being removed from the reactor and the spent fuel being ready to be emplaced in a GDF, and the fragility of the fuel and its cladding, which puts into question whether the fuel can be disposed of directly without significant processing.

While RWM has carried out a nationwide survey to identify potential sites, all experience suggests that finding a site that will command local support anywhere other than Cumbria, where the Sellafield complex is sited, will be hard. Sellafield employs about 11,000 people and given the paucity of alternative employment prospects and the closure of many of the facilities at Sellafield, any proposal that offers future employment is likely to receive some support.

The statement in the White Paper that: *"Permanently closing a GDF at the earliest possible opportunity once operations have ceased provides for greater safety, greater security, and minimises the burden on future generations"* (Department for Business, Energy & Industrial Strategy, 2018 pp. 25–26) is rather empty. The facility might not be ready for closure till perhaps 250 years from now.

So, many future generations will have to bear the burden of funding it, operating it and the physical risk that it would pose until it is sealed. When the facility is at the point when it could be permanently sealed, the decision will be taken based on the conditions that prevail then. The intentions stated now will carry no weight.

The alternative to a GDF, of indefinite surface storage, appears to give rise to additional risk because of the accessibility of the material and its vulnerability to natural phenomena such as flooding, and appears to evade our responsibility to clean up the pollution we create. However, it may be the 'least bad' option if emplacement in a misconceived GDF risks radioactive material getting into the environment with no way to mitigate the damage because the material is irretrievable.

The UK has continued to pursue new nuclear power programmes for most of the 45-year period since the Flowers report stated there should be no commitment to new nuclear power plants until there is clear evidence "*that a method exists to ensure the safe containment of long-lived, highly radioactive waste for the indefinite future*." (Royal Commission on Environmental Pollution, 1976, p. 131) There is still no sign this condition can be met, and policymakers continue to make decisions whose consequences will not be known for decades, long after the time they could be held accountable for them.

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