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delivering best value

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Contents

Executive summary

Nuclear power currently provides 19.2% of the UK's electricity, behind coal and natural gas fired generation.[1] Unlike solar and wind, only nuclear can currently provide the low-CO_2 generation at the scale and with the continuous generation required for the UK to meet its CO_2 emissions targets at a price that is affordable. New nuclear build is now essential as 82% of existing nuclear capacity is due to decommission by 2023.[2]

Sizewell B in Suffolk is the only nuclear power station to have been commissioned since 1990, and was intended to be the first of several new UK reactors to the same design. After electricity privatisation, inexpensive North Sea gas and the low capital costs of gas turbine power stations meant that no new nuclear power stations were built. This hiatus has led to limited UK nuclear build capacity across the domestic supply chain.

The challenge for policy makers is to find the most cost effective long-term method of replacing the UK's retiring nuclear power stations. Options are limited: given the lead time to build new power stations, construction is time critical even if the existing stations can be life-extended to 2028. The time lost to inaction under the Major, Blair and Brown governments increased both the risk of electricity cuts and nuclear replacement costs today.

The first new nuclear power station at Hinkley Point in Somerset will meet 7% of the UK's electricity needs. But there are also limitations to a solution without an auction: the cost is more than twice existing wholesale electricity price. Not only has the Hinkley Point C deal fallen foul of the initial EU State Aid rules, a lack of competition has meant that it is hard to show the that price guaranteed for 35 years represents value for money. European Commission analysis suggests that British taxpayers are effectively buying the power

1 CentreForum analysis of 2013 Digest of United Kingdom Energy Statistics (DUKES), Chapter 5, paragraphs 5.25 and 5.27, p. 116.

2 Based on NMWe. CentreForum analysis of 2013 DUKES, table 5.11, pp. 143 – 150.

station for the plants' owners in the first 35 years of its 60-year life with the risk that they will make super profits over the remaining 25.

There is a better way. Under the far-reaching UK Electricity Market Reform (EMR) future subsidy regimes are to be auctioned from 2017. Currently, nuclear is excluded because it is considered an immature technology. Whilst this could apply to unproven nuclear fuels (eg Thorium), with four similar power stations under construction worldwide, it is harder to claim that Hinkley Point C's EPR design is immature. The same goes for the other UK considered designs from CANDU, Hitachi and Toshiba-Westinghouse, making an auction credible and desirable. To ensure value for money, these auctions should also include a credible public sector comparator based on an arms-length agency purchasing and operating the power station with the same guarantees offered to the private sector.

Any options selection needs to focus on maximising value for money to taxpayers. This should include the value of existing UK nuclear sites, including the costs of upgrading the transmission grid for power stations proposed on each site and monetising the UK's plutonium stockpile if it is used as Mixed Oxide (MOX) fuel, as the Nuclear Decommissioning Agency proposes. The plutonium stockpile costs approximately £40 million per annum to store, and will need another £500 million spent on new long term storage facilities if it is not disposed of through being burnt as MOX fuel. Options which can reduce or avoid this spend should be credited with these avoided costs in the options appraisal. Similarly, MOX fuel plant costs vary, so these price variations should be included in the options assessment.

Finally, some new nuclear reactor designs can make a contribution to decommissioning of the UK's existing nuclear legacy. Technologies that significantly reduce the cost of disposing and decommissioning the UK's legacy nuclear waste should benefit from these cost savings at the options appraisal stage.

Recommendations

Set new nuclear strike prices by auction

The Electricity Market Reform (EMR) makes it clear that the future support prices in the form of Contracts for Difference (CfD) strike prices should be run by auction for "mature technologies". As the EPR design proposed for Hinkley Point C is already under construction at four sites and the CANDU EC6 is derived from 11 similar reactors operating in five countries, nuclear power is clearly a mature technology and therefore should be included in the support auction process.

Create a credible public sector comparator / arms length operator

Provision of a credible public sector comparator / arms length operator that could purchase nuclear plants and have them operated at arms' length in the manner of Network Rail would ensure the provision of the most cost effective infrastructure. Unlike Network Rail, such an entity would be profit-earning over the long term, and would be able to repay its capital and operating costs.[3]

Realise the value of future nuclear plant sites

Maximise VfM through selling leases on publicly owned sites designated for new nuclear build (eg NDA sites and other brownfield sites owned by others such as Hartlepool & Heysham). Government should be open to monetisation taking the form of cash up front, lease payments, through a capital stake in the owning consortium or through a transparent gainshare arrangement. In all cases the valuation should be determined by a competitive process with a public-sector comparator.

Realise value from the UK's plutonium stocks

The UK plutonium stockpile needs to be dealt with, and currently costs approximately £40 million per annum in storage costs, and future secure storage could add another £500 million in capital costs. For as long as MOX is the preferred option to dispose of the plutonium stockpile, cost effective proposals to burn the plutonium stocks as MOX fuel in nuclear new-build should be encouraged. Bidders including pricing mechanisms in their proposals.

Prioritise the plutonium use from 2030

The NDA continues to work on a plutonium disposal option, with burning more than 85% of the plutonium stockpile as MOX remaining its favoured option. Given that nuclear decay makes the MOX option more difficult/expensive with time, MOX burning should be prioritised.

3 This is important in that Network Rail is unlikely to be able to repay its current £30bn debt based on income that is not publicly supported. http://www.theguardian.com/business/2013/dec/17/network-rail-public-body-uk-national-debt

MOX proposals to include MOX plant costs

Where MOX fuel is included in the project proposals, the costs of the MOX fuel fabrication facility and the incremental waste processing costs should also be included in the financial options analysis.

Encourage solutions that facilitate nuclear waste transmutation as and when the technology demonstrates its technical readiness.

The UK faces long term costs of nuclear waste disposal. Government policy should favour those nuclear new-build proposals that can reduce the costs of the clean up by burning existing high-level nuclear wastes, and incorporate these savings into the financial assessment.

Build long term UK human and physical nuclear infrastructure

Nuclear will remain a critical component of the UK's low carbon energy mix for the next 50 years. It is essential to ensure that the whole nuclear infrastructure, including the research and national laboratories, is renewed to support the industry. Investment in university research and training and in the existing national laboratories[4] should continue.

4 Notably Culham and the National Nuclear Laboratory.

Introduction

Britain has a long history with nuclear power: in 1956 Sellafield's Calder Hall Nuclear Power Station was the first nuclear power station to produce electricity on an industrial scale.[5] In 2012, nuclear generation accounted for 19.2% of UK electricity production[6] and 63% of low CO_2 generation.[7] UK nuclear stations are ageing, with 82% of UK nuclear capacity scheduled to be retired by 2023.[8]

This paper considers the case for future nuclear power, and then looks at the most cost effective methods of providing it. It considers the deal for the new Hinkley Point C power station, the role of a public sector comparator, the value of the UK's plutonium stockpile, and the contribution of new nuclear build to existing nuclear decommissioning.

It then makes recommendations to maximise Value for Money (VfM) in the new nuclear programme.

5 The Engineer, 5 October 1956, p. 464.
6 CentreForum analysis of 2013 Digest of United Kingdom Energy Statistics (DUKES), Chapter 5, paragraphs 5.25 and 5.27, p. 116.
7 Low CO2 includes biomass, renewables and nuclear generation. CentreForum analysis of 2013 DUKES, paragraph 5.32, p. 117.
8 Based on NMWe. CentreForum analysis of 2013 DUKES, table 5.11, pp. 143 – 150.

The case for new nuclear in the UK

The role of nuclear power in the future UK energy mix has been debated for more than a decade. It has pitted concerns over nuclear waste disposal and construction costs against growing UK electricity demand, retirement of existing UK nuclear capacity, CO_2 reduction targets and the cost of other low-CO_2 alternatives.

In 2012, nuclear power provided 19.2% of total UK electricity generation, and represented 63% of low-CO_2 electricity generation. However, the UK's nuclear plants are ageing, and with an average age of 30 years, 82% of existing nuclear capacity are scheduled to be decommissioned by 2023. Additionally, nine coal and oil fired generating plants are being closed[9] by 2015 under the EU's Large Combustion Plant Directive,[10] taking retirements by 2023 to 18.9% of 2011 UK generation capacity. These retirements have catalysed decision-making, leading to contracts to build new nuclear stations at Hinkley Point, Somerset, Wylfa, Anglesey in 2013.[11]

Currently there is approximately 12GW of new UK nuclear capacity in active projects at different stages in the development process in three consortia. Each of these three – Électricité de France (EdF), Hitachi-Horizon and NuGeneration (NuGen)[12] committed to UK development – is proposing a different reactor design, providing the UK has a mix of nuclear technologies to choose from. It also underlines the firm and growing international interest in the UK new nuclear programme.

9 See "Power stations expected to close before 2025", Energy UK for the nine opted-out plants.

10 Large Combustion Plant Directive (LCPD), 2001/80/EC. The Directive allows existing plants to be exempted from compliance with the emission limits and from inclusion in the national emission reduction plan on condition that the operator undertakes not to operate the plant for more than 20,000 hours between 1 January 2008 and 31 December 2015. To date, 76% of the capacity of the UK's nine opted-out stations have reached the 20,000 hour limit and have been closed.

11 www.gov.uk/government/news/initial-agreement-reached-on-new-nuclear-power-station-at-hinkley

12 NuGen is a consortium of Toshiba Westinghouse (60%) and GDF Suez (40%). NuGen plans to build a 3.4GW power station comprising 3 Westinghouse AP1000 reactors at Moorside on the Sellafield site with power production from 2024. See First AP1000 at Moorside online by 2024, Westinghouse says, Nuclear Engineering International, 14 Jan 14.

Renewables vs new nuclear

It could be argued that investment in renewable resources made nuclear new build unnecessary. Renewables capacity is growing rapidly, with 2012 generation 19% higher than 2011.[13] However, this rapid growth is from a low base, with renewables making up only 10.8% of the current UK electricity production.[14] Replacing nuclear with renewables would therefore require a near-180% increase in renewable capacity, even if renewables were generating continuously.

Unfortunately, solar and wind renewables alone don't. Wind turbines don't turn on still days, and solar cells don't generate at night – meaning that renewables require large capacity energy storage systems if they are to provide a dependable contribution to baseload. Other than pump-storage hydro, such large-scale energy storage systems are in their infancy. Thus, managing the intermittency inherent with renewables significantly adds to the cost of the overall system cost of a renewable-only solution.

Renewable are also comparatively expensive. Offshore wind, the least contentious option, is currently more than three times the wholesale cost of electricity.[15] Thus, even if the energy storage mechanisms were in place to make it achievable, renewables replacing nuclear for baseload would currently come at an uneconomically high price.

Starkly, without nuclear, the UK faces the choice between meeting its climate change goals, absorbing the significantly higher costs from current renewable technologies, reducing electricity demand by nearly 16%, or keeping the lights on. This is not hyperbole: indeed, leading environmentalist George Monbiot – historically anti-nuclear – recently described opposition to nuclear new-build as "madness".[16]

Therefore, a range of economic, social and environmental factors underwrites the requirement for new build nuclear. But decisions on which proposals proceed with taxpayer subsidy need to be driven by Value for Money (VfM), deliverability and broader economic considerations.

13 This includes the conversion of existing coal-fired powerplants to Biomass at Tilbury B and (partially) at Drax which are broadly carbon neutral, though not zero-emission.

14 2013 DUKES Table 6A, p. 159.

15 The strike price for offshore wind has been confirmed as £155 / megawatt hour (MWh) of electricity generated in 2015-16, falling to £150 in 2016-17 and £140 from 2017-19. Hinkley-C was set at £92.50 At £95/MWh 2014-17 falling to £90 / MWh from 2017-19, onshore wind is on a par with Hinkey Point C; at £120 / MWh (2014-16), £115 (2016/17) and £110 (2017-19), large-scale solar electricity is sits between the other technologies. See: www.greenwisebusiness.co.uk/news/government-unveils-new-strike-prices-for-renewable-energy-4187.aspx#.UrhSc_b767I

16 www.theguardian.com/commentisfree/2013/oct/21/farce-hinckley-nuclear-reactor-haunt-britain

Route to new build nuclear power

Following UK electricity privatisation in 1990, government has had limited powers to intervene in the generation industry. Since then, the government has relied on privatised utilities to provide new UK electricity generation capacity. In large part this was successful, with changes in planning and easy access to cheap North Sea gas resulting in so-called "Dash for Gas". This saw the opening of 39 gas-fired power stations of 22 Gigawatts (GW) capacity by 2002 – producing 40% of UK electricity in 2011.[17] In the deregulated UK electricity market, this worked well for price-competitive technologies in a stable environment with only slowly changing and predictable economic factors, but it has meant that no new nuclear or large-scale renewables had been privately built for the National Grid.

Without a carbon price that captures all of the negative externalities, nuclear is always likely to be comparatively expensive compared with unabated gas or coal electricity generation. Short of establishing a publicly owned subsidiary, government has turned to incentives and a very different market structure to prompt private capital to deliver nuclear and renewable infrastructure to meet emissions targets. To overcome EU state-aid concerns, this has been delivered through fixed prices for 35 years in the form of Contracts for Difference (CfD). Under CfD, the fixed price is known as the "strike price".[18]

Under the strike price regime, the Government underwrites a minimum price. If the market price is lower than the strike price, the power station operator is paid the strike price; if the market price is higher than the strike price, then consumers will be reimbursed the difference.[19] The strike price regime is designed to reduce investor's risk for assets that are characterised by high fixed up-front capital costs and relatively low running costs. Such assets – of which nuclear power stations are a prime example – cannot readily manage price volatility by reducing production as prices fall. Without some form of guaranteed revenue, the cost of capital for these projects becomes uneconomically high as investors limit their risks to those they can genuinely manage and control.

17 2013 DUKES Chart 5.2, p. 117.
18 NB Hinkley Point C's strike price has been referred to EU for a determination of state aid considerations.
19 The mechanism by which surpluses would be redistributed if the market price exceeded the strike price is currently unclear.

For Hinkley Point C, the strike price has been set at 8.95 pence per kilowatt-hour (p/kWh), approximately twice the current wholesale cost of electricity.[20] An additional 0.3p/kWh is payable if a second similar reactor at Sizewell, Suffolk, is not proceeded with.[21] These support levels are indexed to the Consumer Price Index to 2058.[22] In 2013 pounds, this initial price of 9.25 p/kWh is 54% higher than the 6.0 p/kWh[23] cost estimated by the Government's Performance and Innovation Unit in 2002. Capital costs have driven this increase. For Hinkley Point C, capital costs in 2013 are estimated at £16bn[24] or almost quadruple the estimate of £4.1bn set out in the previous government's 2008 White Paper.[25]

Even if the EDF-led consortium builds a second reactor at Sizewell and the combined strike price is set at 8.95 p/kWh, these unexpectedly high levels of subsidy will be index-linked to the consumer prices index for the first 35 years of the project's 60-year life.[26] With Hinkley Point C expected to provide some 7% of total UK generation, the strike price locks Britain's consumers into high-cost electricity for more than a generation.[27]

As nuclear is essential to achieving the Government's climate change goals, nuclear therefore requires public subsidy. Government accepted the principle of this in the Electricity Market Reform (EMR) from 2017, but the Department for Energy and Climate Change (DECC) has limited the auction to "mature technologies", by which it means solar photovoltaics (Solar PV) and onshore wind.[28]

20 See www.ft.com/cms/s/0/00eff456-3979-11e3-a3a4-00144feab7de.html#axzz2piyVsjEI

21 EDF has been granted a premium for Hinkley Point C reflecting its "first of type" in the UK with higher costs. As subsequent units will not incur design and licensing costs, the strike price for all plants will be lower. See www.ft.com/cms/s/0/00eff456-3979-11e3-a3a4-00144feab7de.html#axzz2piyVsjEI

22 State aid SA.34947 (2013/C) (ex 2013/N) – United Kingdom Investment Contract (early Contract for Difference) for the Hinkley Point C New Nuclear Power Station, European Commission, Brussels, 18 December 2013, p. 12.

23 CentreForum analysis of PIU 2002 nuclear cost estimates in 2013 values via New Economics Foundation Mirage and Oasis, Andrew Simms & Petra Kjell, June 2005. This compares 9.25 p/kWh agreed for Hinkley Point C with the PIU 2002 estimate for nuclear new-build of 3-4p/kWh discounted to 2013 prices using HM Treasury discounting tables via MeasuringWorth.com to 6.0p/kWh.

24 www.bbc.co.uk/news/business-24604218

25 See Meeting the Energy Challenge: A White Paper on Nuclear Power, Department of Business, Enterprise and Regulatory Reform, January 2008, paragraph 2.48, page 61 estimated construction costs at £1,250/KW. Hinkley Point C's £16bn raises this to more than £4,900/KW. A first-of-type plant like Hinkley Point C would be in the region of £4.1bn.

26 State Aid SA.34947 (2013/C), p. 6.

27 www.bbc.co.uk/news/business-25390456

28 Electricity Market Reform: Policy Overview, Command 8498, Department for Energy and Climate Change, November 2012, p. 16

Is nuclear power a mature technology?

Given that Calder Hall was connected to the grid in 1956, that the UK has built an additional 18 nuclear plants in three generations, at one level this seems an odd question. None of the proposed designs for UK new build nuclear are untried designs: the EPR design proposed for Hinkley Point C already under construction at four sites worldwide[29], Hitachi-Horizon's ABWR is based on an operating reactor, CANDU's Enhanced C6 (EC6) is developed from the successful CANDU C6 design which has been operating since 1983, and NuGen's Westinghouse AP1000 is derived from its AP600 design and has eight reactors under construction.[30] Against this backdrop, it is hard to conclude that the nuclear power designs in the UK programme are immature. Whilst it can be argued that the UK needs to rebuild nuclear construction skillsets and reinvigorate the nuclear engineering supply chain, these risks are mitigated by international expertise.

In a worrying reversal of decades of best practice in public sector procurement, there is no obvious market mechanism determining these support levels. With so much public money at stake over such a long period, transparency, competition and accountability in the subsidy setting process is especially important. The Hinkley Point C agreement currently has none of these attributes. Assurances that refinancing the debt after generation starts will reduce the level of taxpayers support are unconvincing, given the financial structure remains opaque and the refinancings themselves are subject to gain-sharing with the developer.

In short, it is hard to understand why an auction under EMR could not be conducted. This lack of competitive tendering is picked up by the European Commission in their critique of the Hinkley Point C deal as one element that is likely to violate Article 8 of the 2009 Electricity Directive.[31]

29 EPRs are under construction at Olkiluoto-3 (Finland), Flamanville-3 (France), Taishan 1 & 2 (China).

30 Two reactors are under construction at each of Haiyang and Sanmen, PR China, and VC Summer, Jenkinsville, South Carolina, and Vogtle, Wanyesboro, Georgia, USA. See www.ap1000.westinghousenuclear.com/ap1000_nui_ic.html

31 Directive 2009/72/EC Of The European Parliament and Of The Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC (2009/72/EC); see also State Aid SA.34947 (2013/C), Paragraph 330, p. 51.

Case Study: EU State Aid and Hinkley Point C

The EU generally bans State Aid to companies, as it provides an unfair advantage to one company over another, and distorts the EU's internal market. However, there are circumstances where State Aid is permitted, subject to the rules laid out in s107 of Treaty on the Functioning of the European Union.[32] EU State Aid has the following features:

- an intervention by the State or through State resources which can take a variety of forms;
- the intervention gives the recipient an advantage on a selective basis, for example to specific companies or industry sectors, or to companies located in specific regions
- competition has been or may be distorted;
- the intervention is likely to affect trade between Member States.

The CfD and debt guarantees led the Hinkley Point C deal to be referred to the European Commission's competition authorities for State Aid clearance. The Commission provided its interim report in January 2014.[33]

The highlight is that the Commission has calculated the consortium's rate of return at 9.75% – 10.25% per annum for 35 years, underwritten by the UK taxpayer.[34] This translates into a cash value of up to £17.62bn,[35] more than the £16bn capital cost of the power station.[36] As a result of this underwriting, the risk profile can be considered to be UK government debt plus technical risk; with current 30 year gilt returning 3.54%, thus the UK Government prices this technical risk at 6.21%. Moreover, the Commission believes that the discount rates used by the UK Government in assessing the risk are probably too generous, overstating the cost of the project, and therefore creating the risk of super profits.[37]

32 Availablefrom:eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:12008E107:EN:NOT

33 State Aid SA.34947 (2013/C) (ex 2013/N) – United Kingdom Investment Contract (early Contract for Difference) for the Hinkley Point C New Nuclear Power Station, C(2013) 9073 final, European Commission, Brussels, 18 December 2013.

34 See State Aid SA.34947 (2013/C), Paragraph 338, p. 52.

35 Under the DECC medium price / constant carbon price model. See State Aid SA.34947 (2013/C), Paragraph 361, p. 56.

36 http://www.telegraph.co.uk/finance/newsbysector/energy/10611003/Nuclear-setback-as-EC-attacks-Hinkley-Point-subsidy-deal.html

37 See State Aid SA.34947 (2013/C), Paragraph 367, p. 57.

The European Commission notes that the CfD period leaves open the risk of over-compensation for the remaining 25 or more years of the plant's life. The Commission is not convinced that nuclear electricity generation is a Service of General Economic Interest (SGEI)[38] which could qualify for State Aid, leading to an apparent divergence with the Altmark state-aid criteria.[39] Worse for the UK, the Commission correctly notes that the combination of loan underwriting and CfD essentially eliminates all but construction risk for the project,[40] especially as other projects to the same design as proposed at Hinkley Point C in Flamanville-3, France, and Olkiluoto-3, Finland, have been undertaken without similar support.[41]

As over-compensation[42] is illegal under the SGEI framework, the potential for significantly higher returns to the Hinkley Point C developers makes the case for the proposed CfD regime hard to justify. In particular, the Commission is uncertain why there is a residual market failure given that the UK is setting an independent Carbon Price floor to overcome oversupply in the EU Emissions Trading Scheme (EU ETS) market.

Consequently, the EU's interim conclusion is that "substantial distortive effects appear to be linked the design of the CfD",[43] a position backed by external expert opinion.[44] A full State Aid investigation is required; Vice-President of the Commission Joaquin Alumnia anticipates a decision on the State Aid by the end of 2014.[45]

Effect of non-market feed-in tariffs

The impact of non-market based Feed In Tariffs (FITs) was demonstrated by the experience with large-scale ground-mounted solar energy ("solar farms") earlier in this Parliament. The initial feed-in tariffs were too generous, leading to very high returns to investors, generating a boom. Concerned that the resulting subsidy

38 http://ec.europa.eu/competition/state_aid/overview/public_services_en.html
39 See State Aid SA.34947 (2013/C), Sections 6.1, 6.2, pp. 16 – 19; Paragraph 430, p. 67.
40 See State Aid SA.34947 (2013/C), Paragraph 326, p. 50.
41 See State Aid SA.34947 (2013/C), Paragraph 337, p. 52.
42 Defined for these purposes as a cost greater than the applicable swap rate + 100 basis points (1%).
43 See State Aid SA.34947 (2013/C), Paragraph 399, p. 61.
44 See State Aid SA.34947 (2013/C), Paragraph 415, p. 65.
45 See utilityweek.co.uk/news/hinkley-point-c-state-aid-decision-due-by-the-end-of-2014/975982

levels would be unaffordable, Government cut the FITs in the spring of 2011, and the market crashed. The absence of a progressive gainshare mechanism, has meant super-profits for early projects, resulting in short-notice changes to FITs. Even when the economic rights of these early projects are respected, such changes generate uncertainty for investors increasing the risk – and cost – for subsequent projects.

The current model of nuclear strike-price determination relies on private, commercially sensitive, talks with individual bidders on specific projects. This makes ensuring that the lowest support price is achieved difficult for each project, and with it, ensuring that the new-build nuclear programme provides VfM to bill-payers.

Role of the carbon price floor

Theoretically, there are two generic VfM methodologies to overcome this lack of market testing. First, the cost of the support package can be compared against the least-cost low-CO_2 alternative. This is in effect the central counter-factual of the EU's initial State Aid assessment.[46]

Second, the cheapest fossil fuel alternative plus the relevant carbon price – at the moment, the UK Carbon Price Floor (CPF)[47], a tax on carbon emitted in electricity generation which is payable to top up the EU Emissions Trading Scheme (EU ETS) to £4.94 / tonne of CO_2 (tCO_2) in 2013[48], rising to £9.55 / tCO_2 from 1 April 2014[49], with an indicative price of £14.86 / tCO_2 in 2016-17.[50] Unlike other UK environmental taxes, HM Treasury retains the revenue from the CPF. HM Treasury expects the CPF to raise approximately £2bn per annum from 2015-16.[51] However, the CPF is not designed to incentivise low-CO_2 generation, and is neither targeted at low-CO_2 alternatives nor set at a level to incentivise these low-CO_2 alternatives.

As a result, in effect a monopsony at the project level is created. When combined with a clear deadline for new nuclear generation as existing nuclear plants are decommissioned, this translates into pricing power that lies largely with the developers.

46 See State Aid SA.34947 (2013/C), Paragraph 330, p. 51.
47 The Carbon Price Floor scheme was introduced from 1 April 2013, and will increase in line with the schedule in Section 2.3 of the guidance note. The scheme is outlined at www.hmrc.gov.uk/climate-change-levy/carbon-pf.htm, and it does not apply in Northern Ireland.
48 See Carbon Price Floor – Commons Library Standard Note, House of Commons Library, 7 November 2013, p. 1.
49 See Carbon Price Floor, p. 1.
50 See Carbon Price Floor, p. 10.
51 HM Treasury CPF revenue estimates (cash): 2013-14, £0.98bn; 2014-15, £1.42bn; 2015-16, £2.03bn; 2016-17, £2.08bn; 2017-18 £2.20bn. See Carbon Price Floor, p. 10.

Towards a public sector comparator

The difficulties in price discovery that have become apparent though the EU State Aid clearance process, and the current low rates for UK Government debt, poses the question of whether the UK government should simply establish an arms length body to procure and operate the required new nuclear plants.

Measured against the EU's SGEI requirements and the Altmark criteria, there is sufficient headroom for an arms length body not only to deliver low CO_2 energy, but also to provide cheaper power than the current Hinkley Point C deal. Indeed, if the 4.475 p/kWh modelled CfD strike price from year 36 onwards[52] truly represents the marginal cost of operating Hinkley Point C, then if the £16bn construction price were wholly funded at today's 30 year gilt rates of 3.58%[53], the first 30 years' generation could indicatively lower the cost from 8.95 p/kWh to a fully absorbed cost of less than 8.1 p/kWh[54] – a 9.5% reduction on the minimum cost of power from Hinkley Point C, and a 12.4% reduction on the guaranteed cost of Hinkley Point C electricity if Sizewell C does not proceed.

Even on the lower CfD price, the annual saving to British consumers would be £221m, or a total of £6.6bn over 30 years.[55] A 30-year structure would also bring forward the drop to marginal cost by five years compared to the proposed CfD, saving British consumers

52 See State Aid SA.34947 (2013/C), Paragraph 406 (v), p. 63.

53 For the financial model, the following rates were used: 20 years, 3.36%; 15 years, 3.15%; 10 years, 2.80%; 9 years, 2.66%; 8 years, 2.43%; 7 years, 2.23%; 5 years, 1.68%; 4 years, 1.33%; 3 years, 0.81%; 2 years, 0.52%; 1 year, 0.38%. All rates from the Financial Times, 20 February 2014.

54 CentreForum analysis based on Hinkley Point C producing 26TWh of electricity per annum at 8.09 p/KWh. See State Aid SA.34947 (2013/C), Paragraph 24, page 5, and generally, http://www.dmo.gov.uk/index.aspx?page=gilts/about_gilts. The CentreForum is a conservative limiting case by borrowing all £16bn up front even though in reality the borrowing (and associated interest costs) would be phased with construction spend. As a result, the actual costs would probably be lower.

55 CentreForum analysis. At a price 8.09p/KWh versus 8.95p/KWh under the CfD regime if Sizewell C is built. At 26TWh per annum, this 0.85p/KWh is worth £221m per annum, or £6.63bn over 30 years.

at least another £5.8bn.[56] In total, the savings to British consumers could reach £12.4bn over 35 years[57] compared with the current CfD arrangement, or an average of £15.71 per household per annum.[58]

How would this work?

Under this proposal, a Government-backed entity becomes the customer, but one that can reduce the risk of specific projects considerably by taking projects through planning permission. Moreover, such an operator would able to benefit – as the private sector producers are – from loan guarantees, and securitising future revenue streams against the CfD price.

Such an arrangement need not be novel. State-Owned Enterprises are major players in the worldwide nuclear industry, with Hinkley Point C's consortium being a partnership between EdF (85% state owned) and the China National Nuclear Corporation and China General Nuclear Power Corporation (both 100% state owned).[59] Elsewhere in Europe, EdF operates 58 nuclear power stations in France[60], and in the Czech Republic, CEZ (approximately 70% state owned)[61] is a likely purchaser of two new reactors for the Temelin power station over the next decade if state guarantees are in place.[62]

Beyond equity investment, direct UK Government involvement could take three other forms: provision of land on existing nuclear sites and the supply of plutonium from the UK stockpile to become mixed oxide fuel.

Provision of new nuclear sites

Building future nuclear power stations on existing nuclear sites has social and technical benefits. Socially, it provides additional and/ or replacement employment in communities with nuclear power experience, in contrast with the lack of public support for shale gas exploration through fracking. Familiarity with the risks and benefits of nuclear power makes future nuclear build more acceptable on these sites than for those communities without a history of engagement with the nuclear industry.

56 The difference between 8.95p/KWh and 4.475p/KWh is 4.475p/KWh; at an annual production rate of 26TWh this differential is worth £1.16bn and over five years, a total of £5.82bn.
57 CenterForum analysis. Savings due to lower price total £6.63bn over 30 years, and moving to the marginal cost at year 31 instead of year 36 saves an additional £5.82bn, totalling £12.45bn.
58 Based on 2013 ONS estimate of 26.4 million UK households, the average additional cost would be £15.71 per household per annum. This would fall mostly in years 31-35.
59 www.bbc.co.uk/news/business-24604218.
60 See EDF Energy's technical expertise
61 See www.cez.cz/en/cez-group/cez-group.html
62 www.bloomberg.com/news/2013-12-05/czech-atomic-expansion-deemed-hopeless-by-cez-without-aid.html

Technically, existing nuclear sites have access to sufficient cooling water to operate nuclear power stations of similar power to those previously on the site, and have existing connections to the national grid. Both offer opportunities for considerable savings, providing that the replacement capacity is of a similar size to the previously installed nuclear plant.

This translates into the Government owning a suite of valuable land, and led to eight sites[63] being nominated by the Government for future nuclear build in 2010.[64] Of these eight, two (Hinkley Point and Wylfa) were given the go-ahead in 2013. Payment to the government for the land could be in cash, but is more likely to be in the form of an equity stake or profit-sharing model, to reduce the upfront capital costs to the developer. Nonetheless, similarly to the strike price, details over what options the government had for the land, and what price it received for the land should be as transparent as possible, in order to show that the selected course of action represents optimal VfM for taxpayers.

Joined up thinking on site allocation

For the future nuclear build programme, choices will have to be made to match projects to sites. Not all sites are created equal. Whilst coastal and estuarine sites have sufficient supplies of cooling water that any likely power station could be accommodated, the same is not true for other elements, notably grid connections. Upgrading the grid connections in order to support larger power stations than were previously operating on a site can be expensive, and these costs should be included in the programmes fully absorbed costs.

63 Bradwell (Essex), Hartlepool (County Durham), Heysham (Lancashire), Hinkley Point (Somerset), Oldbury (Gloucestershire), Sellafield (Cumbria), Sizewell (Suffolk), Wylfa (Anglsey).

64 www.bbc.co.uk/news/uk-politics-11564152

Case Study: Moorside Power Station, Sellafield

NuGen's[65] proposed Moorside power station on the Sellafield site will be rated at more than 3GW, overwhelming the existing 132kV transmission grid in Cumbria. To connect Moorside, 214km of existing 132kV distribution cabling will need dismantling and replacing, as well as significant new build 400kV transmission facilities.[66]

If Sellafield is to be used as a new-build nuclear site, it is probable that the existing distribution network would need upgrading.[67] What is less clear is how the options appraisal that led to the selection of NuGen's Moorside project over alternatives that may have had a lower connection cost was run. Specifically, how has the cost of the upgrade been apportioned between:

- business-as-usual for National Grid;
- new transmission capacity specific to Moorside; or
- additional transmission capacity for offshore wind projects' power coming ashore at Heysham?

Set against these costs, can DECC show that the NuGen proposal was the most appropriate one for Sellafield, or that the £70m for the 2009 option for the site represented good value for British taxpayers?[68] At the expiration of the NuGen option in 2014,[69] these questions should be revisited to ensure that future decisions on new build can demonstrate VfM at Sellafield, and methodology incorporating the fully absorbed cost of new build nuclear should be central to future site allocation decisions.

65 NuGen is a consortium of Toshiba Westinghouse (60%), GDF Suez (40%).
66 Annex 26: Cost Impact of Moorside Nuclear Power Station, Electricity North West, July 2013, p. 6.
67 North West Coast Connections Project Preliminary Strategic Options Report for the North West Region, National Grid, May 2012, p. 10.
68 See http://www.nugeneration.com/our_plan.html
69 Interview D, February 2014.

: UK plutonium stockpile

During the Cold War, the UK invested heavily in reprocessing nuclear waste to produce plutonium for civil and military purposes.[70] When military plutonium needs were met, reprocessing continued in the expectation that this would produce cost effective Mixed-Oxide (MOX) nuclear fuel. But the exposure of falsified MOX records in 2000[71] resulted in a Japanese import ban, which combined with the German post-Fukushima decision to end nuclear power by 2022[72] effectively ended the UK's MOX export model. As a result, the Thermal Oxide Reprocessing Plant (THORP) is due to cease reprocessing in 2018, ending UK plutonium production.[73] Currently, there is no intention to reprocess additional spent UK nuclear fuel after THORP closes from either existing or future nuclear power stations.

Today, the UK's 112 tonne civil plutonium stockpile represents more than a third of civil plutonium stocks worldwide.[74] Additionally, the UK stores an additional amount of German and Japanese plutonium from the abortive MOX programme,[75] totalling approximately 140 tonnes by 2018. The UK Nuclear Decommissioning Authority (NDA) has confirmed that it will be managed in the same manner as the UK-owned plutonium, subject to agreeing acceptable commercial terms.[76]

70 The UK's plutonium programme was initially exclusively for the weapons programme, with the ostensibly civilian power stations at Calder Hall and Chapelcross both operating fuel cycles to maximise plutonium production rather than to produce electricity as cheaply and efficiently as possible. Until 1969, the UK programme did not formally differentiate military and civilian plutonium stocks. See Discharges to the Sea from Sellafield , Bellona Foundation, Oslo, 2000, p. 18.

71 See The Legacy of Reprocessing in the United Kingdom, Martin Forwood, Research Report 5, International Panel on Fissile Materials, Princeton, July 2008, p. 22; http://news.bbc.co.uk/1/hi/uk/646230.stm

72 After the 2011 Fukushima, German Chancellor Angela Merkel announced that Germany's 22 nuclear plants would be decommissioned by 2022. (See uk.reuters.com/article/2011/05/30/us-germany-nuclear-idUKTRE74Q2P120110530.)

73 See Oxide Fuels: Credible Options, Nuclear Decommissioning Authority, November 2011. Following the closure of THORP in 2018 the NDA plans to place the remaining Advanced Gas Cooled Reactor (AGR) fuel into interim storage pending conditioning and geological disposal.

74 www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Fuel-Recycling/Mixed-Oxide-Fuel-MOX/ puts the current civil plutonium stockpile at 320 tonnes.

75 Beyond the MOX scandal, Japan's nuclear industry is largely shut down in response to the 2011 Fukushima Daiichi nuclear disaster. (See: www.michaelmeacher.info/weblog/2011/04/2259/)

76 Progress on Approaches to the management of separated plutonium - position paper, Nuclear Decommissioning Authority, January 2014, p. 4.

The Plutonium MOX fuel cycle

Commercial light water nuclear reactors operate with low enriched Uranium, which increases the proportion of fissionable Uranium-235 (U_{235}) from 0.7% to between 3 and 5% with the balance being non-fissionable Uranium-238 (U238). During nuclear fission, some U238 will capture a neutron, which over two days decays into plutonium-239 (Pu239). If low-enriched U235 fuel is burned for three years, about half of the Pu_{239} produced will itself be fissioned, providing about one third of the total energy produced from the fuel.

When spent fuel is removed from the reactor, typically 0.65% will be fissile plutonium. This plutonium, along with unfissioned U_{235}, can be recovered through reprocessing and combined with U238 to produce Mixed Oxide (MOX) fuel. Reprocessing the plutonium in this manner increases the energy derived from the original uranium by some 12%; if the U235 is also recycled this rises to 22%.[77] MOX fuel was first demonstrated in 1963, and came into commercial use during the 1980s.

The UK plutonium stockpile is treated as a "zero-value asset". Storing the plutonium stockpile at Sellafield costs some £40m per annum,[78] and long term storage would require an additional £500mn of capital investment[79] in new storage facilities. As such, the UK plutonium stockpile is currently viewed a liability rather than an asset.

This could change. The UK Nuclear Decommissioning Authority (NDA) has been considering options for plutonium disposal, and currently considers using the plutonium as MOX in new-build UK reactors for disposing of the plutonium stockpile.[80] In January 2014, the NDA indicates that the physical characteristics of between of 10 – 15% of the stockpile make it uneconomic to fabricate as MOX fuel.[81] This leaves MOX burning as the current preferred

77 See www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Fuel-Recycling/Mixed-Oxide-Fuel-MOX/.

78 Currently, the stocks are split between the Sellafield complex, and Dounreay, Caithness. See Progress on Approaches to the management of separated plutonium, p. 5. See also www.bbc.co.uk/news/uk-21505271.

79 Existing plutonium is being centralised at Sellalfield in a Sellafield Product Residue Store (SPRS) at a capital cost of c£0.25bn. Storing the existing plutonium stocks would require two additional SPRS facilities to be built at Sellafield. Interview A, January 2014

80 Progress on Approaches to the management of separated plutonium, p. 3.

81 Progress on Approaches to the management of separated plutonium, p. 6.

disposal method of 85 – 90% of the UK plutonium stockpile. The NDA considers that burning plutonium as MOX fuel is likely to be credible from 2030 – 35[82], meaning that new nuclear build coming on-line in the 2020s will initially operate on conventional Uranium fuel before converting to plutonium MOX.

Given the technical challenge posed by the necessary MOX fabrication plant, NDA is continuing to engage with technology suppliers over the next 12 – 24 months.[83] Part of this assessment will include the technical deliverability of the three solutions – Light Water Reactor (LWR) MOX, CANDU MOX (CANMOX) in CANDU EC6 Reactors, and General Electric Hitachi (GEH) PRISM fast reactors.[84] The analysis will include an assessment of the costs of the MOX fuel fabrication facility, which varies dependent on the complexity of the fuel assemblies required. The NDA currently recognise that due to its simpler design, CANMOX is less expensive than LWR MOX and more technically mature than the GEH PRISM proposal.[85]

As CANMOX fuel, analysis suggests that the combined UK, German and Japanese stockpile could produce 23.7 terrawatt hours (TWh) per annum for 30 years[86] – 6.3% of 2012 UK generation.[87] In assessing future nuclear new build proposals, monetisation of the plutonium stocks – and the storage savings – should be included in the overall financial and VfM assessment. And where MOX is proposed to fuel new-build nuclear, the cost of the new MOX fabrication plant that will be required must be incorporated into the financial model and decision-making process. In their February 2014 report into the ongoing Sellafield site cleanup, the House of Commons Public Accounts Committee (PAC) recommended that in light of previous UK experience with MOX fabrication, a premium needed to be placed on a "comprehensive, robust business case" before a decision to proceed with burning the plutonium stockpile as MOX is

82 Progress on Approaches to the management of separated plutonium, p. 5.

83 Progress on Approaches to the management of separated plutonium, pp. 5 – 6.

84 Progress on Approaches to the management of separated plutonium, p. 8.

85 Full details of the NDA's engagement with CANDU and GEH are contained in Appendixes 1 and 2 to the Progress on Approaches to the management of separated plutonium. CANDU CANMOX is assessed to be ready to irradiate first MOX in 10 – 12 years (p. 13). Though GEH Prism claims that the time first MOX irradiation in 14 – 18 years, which the NDA consider to be "ambitious" (p. 17).

86 A CANDU MOX (CANMOX) fuelled Enhanced CANDU 6 reactor installation of 4 x 750MWe could be fuelled by the UK plutonium stockpile for 30 years. Of the rated capacity, 2800MWe is available for sale due to "house loads". Therefore, with a forecast maintenance outage of 30 days every three years and a 1% forced outage rate, a 4x750MWe CANMOX installation will generate an average 23.7TWh per annum. Source: CANDU.

87 CentreForum analysis of 2013 Digest of United Kingdom Energy Statistics (DUKES), Table 5a, p. 113 of 2012 supply of 375.8TWh. CANMOX production of 23.7TWh is 6.31% of this 2012 figure.

finalised.[88] Current estimates of the new MOX fuel plant range from £1bn to £6bn; set against Hinkley Point C's capital cost of £16bn it is clear just how material the MOX plant's capital costs are.[89]

MOX fuel fabrication plant site choice

Burning MOX will require the construction of a new MOX fuel fabrication plant. With a cost spread of £5bn, the choice of technology is the principal fuel fabrication plant cost driver, but site choice also carries cost and VfM implications. Given that the fuel fabrication plant will use the plutonium stockpile over 25 – 30 years, the default position should be to build the fuel fabrication plant alongside the existing plutonium storage facilities at Sellafield. Such a choice limits transport costs with its attendant risks, and removes the need to construct alternative storage facilities at another site at an indicative minimal capital cost of £250m. Given its reprocessing history, Sellafield also has a level of societal acceptance of plutonium operations that should not be assumed for other sites, aiding the planning process.

Taken together, this points to a strong presumption in favour of siting the MOX fuel fabrication plant within the Sellafield complex. Integrating NDA's plutonium disposal plans with the new nuclear decision making process will be critical to minimising the overall cost of both the new-build nuclear and legacy nuclear decommissioning. Where savings can be quantified, they should be included in the new nuclear options appraisal and credited towards lower cost technologies.

Facilitating nuclear decommissioning

The UK is faced with a long term nuclear clean up bill for its historic civil and military nuclear programmes. In 2013, the PAC estimated the cost for the Sellafield site alone at £67.5bn,[90] with indications in early 2014 that the bill has risen beyond £70bn amidst allegations of poor contractor performance.[91] It is important to note in assessing new build nuclear that that the bill for decommissioning Sellafield is so large because of the toxic legacy of both the UK nuclear weapons programme, and of the manner in which the UK's nuclear power stations were operated in response to the 1973/74 and 1984/85 coal

88 Progress at Sellafield, Forty-Third Report of Session 2013–14, House of Commons Committee on Public Accounts, 11 February 2014, p. 7.
89 Interview D, January 2014.
90 Nuclear Decommissioning Authority: Managing risk at Sellafield, Twenty-fourth Report of Session 2012–13, House of Commons Public Accounts Committee, 23 January 2013, p. 3.
91 Progress at Sellafield, p. 4.

miners' strikes.[92] During these strikes, the UK's first generation nuclear power stations were operating at maximum capacity to compensate for reduced coal-fired generation, and resulting in more spent fuel than the reprocessing system was designed to handle.[93]

A large part of the clean up costs will be the provision of a long term geologic storage repository, which has to be able to handle the heat generated by the waste as it undergoes slow nuclear decay. Proposals that reduce the amount of high-level transuranic nuclear wastes that will need to be disposed of should be encouraged, especially if they are able to generate electricity in the process.[94] Where possible, these savings should be quantified and applied to the financial models and the options appraisals.

What next for Hinkley Point C?

Following an announcement in January 2008 by John Hutton,[95] negotiations over Hinkley Point C began in 2008[96], and continued up to the 2010 election under the then-Secretary of State Ed Miliband. Policy at that time was focussed on ensuring that nuclear development was exclusively in the private sector, even if this translated into higher costs.[97] However, Labour's insistence that nuclear had to be built without public sector involvement[98] meant that subsidy had to be delivered without violating State Aid rules, resulting in the complex regime CfD proposed.

Upon assuming office, the Coalition was faced with pressure to complete the new nuclear build. Under these circumstances, it was reasonable to continue the existing negotiations begun by Labour, rather than unpicking the

92 Interview C, January 2014.
93 Interview C, January 2014.
94 Actinide burnup serves two purposes. First, it transmutes long-lived radioisotopes into shorter-lived ones (eg Americum-241, half-life of 432.2 years to Curium-244, half-life of 18.1 years), which reduces the decay heat load for geologic storage by 70% at 1000 years, significantly increasing the capacity of a given geological storage facility. Transmutation of Americum isotopes is especially important in this process, as they are a major driver of decay heat in the 100 – 1000 year timescale. Second, the burnup itself produces energy, making existing high-level nuclear waste a useful fuel. See "Scenarios for the transmutation of actinides in CANDU reactors" Bronwyn Hyland, Brian Gihm, Nuclear Engineering and Design, Vol 241/12, December 2011. Professor Mujid Kazimi "Actinide Burning in Reactors: Options and Outcomes", MIT, June 2007, IAEA "Actinide Burnup Chain", "Transmutation of Actinides in CANDU reactors", G. Dyck, OECD.
95 UK Government invites new Nuclear Power into the energy mix, Press Release, 10 January 2008. Ed Miliband would take over the newly created Department of Energy and Climate Change in October 2008.
96 www.world-nuclear-news.org/NN_New_dawn_for_UK_nuclear_power_2409081.html
97 Interview D, February 2014.
98 Meeting the Energy Challenge: A White Paper on Nuclear Power, Department of Business, Enterprise and Regulatory Reform, January 2008, p. 119.

deal at that time. The initial pessimistic response from Brussels in January 2014 shows that Labour's approach has failed to convince.

As a long-standing champion of single-market liberalisation, it would be very odd for the UK to pressure the European Commission into accepting this specific State Aid application. Indeed, it would set an unwelcome and unnecessary precedent in an area where bureaucratic fudge rapidly elides into protectionism. Rather than attempting a Treaty change by stealth – and with it, upsetting a decade's worth of case law since the liberalising Altmark[99] decision in 2003 – the UK needs to look at other methods to ensure that new nuclear is built, State Aid distortions are minimised, and taxpayer value for money is maximised.

The simplest and most elegant route would be for the UK to nationalise the Hinkley Point C project, bringing it onto the public sector balance sheet and delivered through an arms length body. Such an organisation would procure and operate the new nuclear build at the minimum cost to consumers, which as has been seen earlier, in Hinkley's case could translate into savings of more than £12bn over the CfD period. Indeed, such are the costs of the CfD solution, VfM considerations alone suggest that there a strong case for moving across to a not-for-profit state-backed company for Hinkley Point and future new build nuclear plants.

99 Altmark Trans GmbH and Regierungspräsidium Magdeburg v Nahverkehrsgesellschaft Altmark GmbH, Case C-280/00, 24 July 2003.

Conclusion

Britain needs new nuclear power stations to support climate change policies and economic growth, but not at any price. The current model at Hinkley Point C is problematic because of the structure imposed on the project by the last Government, and should not be repeated. If State Aid clearance fails, Government should be prepared to take the project over on the public balance sheet. Even if Hinkley Point C passes State Aid clearance, there needs to be further clarity about the gain share and refinancing to maximise VfM.

Three key elements need to drive new nuclear decision making:

- First, there should be an auction to achieve the minimum support price;
- Second, future nuclear new build options assessment needs to reflect all of the knowable costs, which recognises the:
  - value of existing publicly-owned nuclear sites,
  - cost benefits of plutonium disposal as MOX over storage,
  - differential costs of different technologies' MOX infrastructure,
  - differential costs of grid connections, and
  - potential for reducing the costs of long term geologic disposal;
- Third, the auction should contain a real public sector comparator, to ensure that the long term support payments are as low as possible.

Recommendations

Set new nuclear strike prices by auction

The Electricity Market Reform (EMR) makes it clear that the future support prices in the form of Contracts for Difference (CfD) strike prices should be run by auction for "mature technologies". As the EPR design proposed for Hinkley Point C is already under construction at four sites and the CANDU EC6 is derived from 11 similar reactors operating in five countries, nuclear power is clearly a mature technology and therefore over time nuclear should be included in the support auction process.

Create a credible public sector comparator / arms length operator

Provision of a credible public sector comparator/arms-length operator that could purchase nuclear plants and have them operated at arms' length in the manner of Network Rail will ensure the provision of the most cost effective infrastructure. Unlike Network Rail, such an entity would be profit-earning over the long term, and would be able to repay its capital and operating costs.[100] It is sufficient for a credible public sector comparator to exist to ensure VfM; if alternative ownership and delivery models demonstrate better VfM, the public sector comparator will have performed its purpose.

Realise the value of future nuclear plant sites

Maximise VfM through selling leases on publicly owned sites designated for new nuclear build (eg NDA sites including Sellafield, Oldbury and Heysham). Government should be open to monetisation taking the form of cash up front or through a capital stake in the owning consortium or through a transparent gainshare arrangement. In all cases the valuation should be determined by a competitive process with a public-sector comparator.

Realise value from the UK's plutonium stocks

The UK plutonium stockpile needs to be dealt with, and currently costs £40 million per annum in storage costs, and future secure storage could add another £500 million in capital costs. For as

100 This is important in that Network Rail is unlikely to be able to repay its current £30bn debt based on income that is not publicly supported. /www.theguardian.com/business/2013/dec/17/network-rail-public-body-uk-national-debt

long as MOX is the preferred option to dispose of the plutonium stockpile, cost effective proposals to burn the plutonium stocks as MOX fuel in nuclear new-build should be encouraged. Bidders including pricing mechanisms in their proposals.

Prioritise the plutonium use from 2030

The NDA continues to work on plutonium disposal option, with burning more than 85% of the plutonium stockpile as MOX remaining its favoured option. Given that nuclear decay makes the MOX option more difficult with time, MOX burning should be prioritised.

MOX proposals to include MOX plant costs

Where MOX fuel is included in the project proposals, the costs of the MOX fuel fabrication facility and the incremental waste processing costs should also be included in the financial options analysis.

Encourage solutions that facilitate nuclear waste transmutation as and when the technology demonstrates its technical readiness.

The UK faces long term costs of nuclear waste disposal. Government policy should favour those nuclear new-build proposals that can reduce the costs of the clean up by burning existing high-level nuclear wastes, and incorporate these savings into the financial assessment.

Build long term UK human and physical nuclear infrastructure

Nuclear will remain a critical component of the UK's low carbon energy mix for the next 50 years. It is essential to ensure that the whole nuclear infrastructure, including the research and national laboratories, is renewed to support the industry. Investment in university research and training and in the existing national laboratories[101] should continue.

101 Notably Culham and the National Nuclear Laboratory.