National Audit Office

Report
by the Comptroller
and Auditor General

Department for Business, Energy & Industrial Strategy

Hinkley Point C

HC 40 SESSION 2017-18 23 JUNE 2017

Our vision is to help the nation spend wisely.

Our public audit perspective helps Parliament hold government to account and improve public services.

National Audit Office

Department for Business, Energy & Industrial Strategy

Hinkley Point C

Report by the Comptroller and Auditor General

Ordered by the House of Commons
to be printed on 21 June 2017

This report has been prepared under Section 6 of the National Audit Act 1983 for presentation to the House of Commons in accordance with Section 9 of the Act

Sir Amyas Morse KCB
Comptroller and Auditor General
National Audit Office

12 June 2017

HC 40 | £10.00

This report assesses the government's case for its deal to support the Hinkley Point C nuclear power station, its approach to reaching the deal, and its arrangements for managing remaining risks to electricity consumers and taxpayers.

11471 06/17 NAO

Contents

The National Audit Office study team consisted of:
Simon Bittlestone, Gregor Botlik, Andrea Demurtas, Kenneth Foreman, Algirdas Glemza, Peter Kitson, Stanley Kwong and Ffion Owen, under the direction of Michael Kell.

This report can be found on the National Audit Office website at www.nao.org.uk

For further information about the National Audit Office please contact:

National Audit Office
Press Office
157–197 Buckingham Palace Road
Victoria
London
SW1W 9SP

Tel: 020 7798 7400

Enquiries: www.nao.org.uk/contact-us

Website: www.nao.org.uk

Twitter: @NAOorguk

Key facts

£18bn

estimated cost to construct Hinkley Point C (in 2016 prices)

7%

proportion of Great Britain's estimated electricity requirement met by output from Hinkley Point C in the mid-2020s

£92.50

price (in 2012 prices) to be paid to NNB Generation Company (HPC) Limited (Hinkley Point C's operator) per megawatt hour of electricity generated for the first 35 years

£30 billion	estimated present value in March 2016 of future top-up payments under the Hinkley Point C contract for difference (2015-16 prices discounted to 2015)
9%	the expected return to Hinkley Point C's investors net of the impact of taxation (nominal post-tax equity return on the project)
£10–£15	Department for Business, Energy & Industrial Strategy's (the Department's) estimate of the amount from the average annual household electricity bill that will go towards supporting Hinkley Point C up to 2030
£21–£24	the Department's estimate of the average increase on annual electricity bills up to 2030 if Hinkley Point C is delayed by three years and replaced by low-carbon alternatives
£7.3 billion	NNB Generation Company (HPC) Limited's (NNBG's) estimate of the costs of decommissioning Hinkley Point C and managing its waste (in 2016 prices)
£79.7 billion	NNBG's estimate of the net project cash flows by the end of Hinkley Point C's operational life in 2085 (in 2016 prices)

The timeline for the Hinkley Point C project is shown in **Figure 1**.

Figure 1
Timeline for Hinkley Point C (HPC)

The HPC project has been in development since 2007

July 2006	The government's *Energy Challenge* review sets out potential for new nuclear power build.
September 2007	EDF/AREVA NP submit European Pressurised Water Reactor (EPR) design to the regulator (Office for Nuclear Regulation) for safety checks.
January 2008	Government publishes its white paper – *Meeting the energy challenge: A White Paper on Nuclear Power* – and, in response, the industry announces plans to develop 16 gigawatts of new nuclear capacity by the end of 2025.
January 2009	EDF purchases British Energy and its eight power stations for £12.5 billion.
April 2009	Government nominates HPC as one of 11 potential sites for a new nuclear power plant.
March 2011	Fukushima disaster prompts re-examination of safety of nuclear power.
July 2011	Government publishes *National Policy Statement for Nuclear Power Generation*. The Statement identified eight potential sites for the deployment of new nuclear power stations.
November 2012	Government starts exploratory discussions with EDF over the terms of support for HPC.
November 2012	Office for Nuclear Regulation (ONR) grants site licence for HPC.
December 2012	ONR grants design acceptance confirmation for the EPR reactor design.
March 2013	Government publishes nuclear industrial strategy setting out key actions and milestones.
October 2013	Government and EDF agree on strike price for power from HPC of £92.50/MWh (in 2012 prices).[1]
October 2014	European Commission gives State Aid approval decision for HPC project.
September 2015	Government announces £2 billion debt guarantee for HPC.
October 2015	China General Nuclear Power Group (CGN) agrees to invest £6 billion in the project.
July 2016	EDF Board approves the HPC project to go ahead and takes final investment decision.
September 2016	Government approves its deal for HPC after a two-month pause to consider all component parts of the deal.

Note

1 Strike price will reduce to £89.50/MWh (in 2012 prices) if EDF takes a final investment decision on its Sizewell C nuclear power station project.

Source: National Audit Office

Summary

1 The Department for Business, Energy & Industrial Strategy (the Department) announced on 29 September 2016 that it had reached a deal to support construction of the Hinkley Point C (HPC) nuclear power station. HPC will be the first new nuclear power station built in the UK since 1995. The Department expects that it will generate around 7% of Great Britain's anticipated electricity requirement from the mid-2020s. The Department hopes that the successful conclusion to the HPC deal will also help to generate wider investor confidence and pave the way for other new nuclear projects. The Department sees HPC and other planned nuclear projects as central to its strategic aim of managing the energy 'trilemma': providing a supply of electricity that is secure, isaffordable for consumers and contributes to the UK's statutory decarbonisation target to reduce carbon dioxide emissions by 80% in 2050 compared with 1990 levels.

2 NNB Generation Company (HPC) Limited (NNBG) will build and operate HPC. NNBG is owned 66.5% by EDF and 33.5% by China General Nuclear Power Group (CGN). NNBG expects it will cost some £18 billion (in 2016 prices) to build HPC, financed in full by its two investors. The first permanent concrete for the power station was poured in March 2017, and EDF expects that it will generate electricity from 2025 to 2085.

3 In recent years, it has not been commercially viable for private developers to build new generating capacity in the UK, including nuclear power stations, without government support. The forecast revenues available in the wholesale electricity market do not cover the high upfront costs and other risks of building, operating and decommissioning low-carbon power plants. To support HPC, the government has agreed a four-part deal:

- The main element is a 'contract for difference' (CfD). CfDs offer developers greater certainty and stability of revenues, reflecting the cost of investing in low-carbon technologies, by setting a 'strike price' that the developer receives for a set period. For HPC, NNBG will receive £92.50 (in 2012 prices) for each megawatt hour (MWh) of electricity from HPC that it sells into the market for 35 years. NNBG will receive top-up payments if the market price is lower, which are ultimately paid for by electricity bill-payers. Conversely, payments will flow in the opposite direction if wholesale prices rise above the strike price.

- NNBG must set aside a proportion of its revenues, up to the value of £7.3 billion (in 2016 prices), to cover the costs of dealing with HPC's nuclear waste and decommissioning the plant once it stops generating electricity.

- HM Treasury has provisionally agreed to guarantee up to £2 billion in 2018 of bonds that NNBG issues to finance construction, subject to some conditions. EDF has said it does not expect NNBG to use this facility.

- A Secretary of State Investor Agreement (SoSIA) through which the government underwrites the payment of compensation to NNBG if government policy changes result in the shutdown of HPC. If this were to occur, the Department estimates it could cost up to £22 billion (in 2012 prices).

4 The Department subjected the deal to four value-for-money tests: that the return to HPC's investors was fair; that HPC is cost-competitive with other options for generating power; that it brings net societal benefits by reducing the cost of the electricity system; and that it is affordable for electricity consumers. The government's case for proceeding with the deal was also subject to wider strategic, deliverability and affordability considerations.

Our report

5 This report assesses the government's deal for HPC and makes recommendations for how it now oversees the project and how it agrees deals for other major projects. It:

- sets out the terms of the HPC deal, why the government is supporting nuclear power and the Department's approach to negotiating the deal (Part One);
- assesses the Department's case for supporting HPC and how this has changed since it agreed key commercial terms in 2013 (Part Two); and
- describes the residual value-for-money risks of the deal for consumers and taxpayers, and considers how the Department plans to manage them (Part Three).

6 The current structure of the deal means that the costs of HPC will be met by electricity consumers rather than taxpayers. A failure by government to assess the impact of its policies on consumers could lead to consumers facing financial hardship, and unplanned taxpayer support being required. We have therefore considered the financial impact of the deal on consumers as part of our conclusion on value for money. We set out our audit approach in Appendix One and our methodology in Appendix Two.

Key findings

The case for new nuclear

7 The government wants nuclear power to form part of a low-carbon generating mix, despite the economics of nuclear power deteriorating in recent years. In a 2008 white paper, the government set out its strategic case for new nuclear build contributing to carbon emissions reductions and security of supply, while being cost-competitive. Since then, the economics of nuclear power have deteriorated: estimated construction costs have increased while alternative low-carbon technologies have become cheaper. At the same time, fossil-fuel price projections have fallen, improving the economic case for traditional power generators such as gas. Although the Department has not fully reappraised the government's strategic case, its analysis still shows that new nuclear power should play a role in the UK achieving its 2050 decarbonisation target at least cost. This aligns with the views of most independent energy sector analysts (paragraphs 1.9 to 1.12).

The approach to the HPC deal

8 **The Department aligned its approach to the HPC deal with its support for other low-carbon technologies**. The 2010 Coalition Government agreement stated there would be no subsidy for nuclear power. This led the Department to negotiate a deal for HPC replicating as far as possible its contracts to support other low-carbon technologies, such as wind and solar. These contracts mean the private sector financing construction and taking all the risk during this phase of the project, in return for a guaranteed price for the electricity generated once completed. This is the first time such a financing approach has been used for nuclear power anywhere in the world (paragraphs 1.13 to 1.15).

9 **The Department did not assess the potential value-for-money implications for bill-payers of using alternative financing models.** Alternative financing models would have exposed consumers and/or taxpayers to the risks of the project running over budget and increased the risk of the project needing to be on the government's balance sheet. But our analysis suggests alternative approaches could have reduced the total project cost. The Department did not assess whether the reduced cost balanced against the increased exposure to risk would have resulted in better value for money for electricity consumers (paragraphs 1.16 to 1.19).

10 **The government opted to negotiate bilaterally with EDF, rather than wait for competition between nuclear developers**. The government's preferred approach for supporting investment in new low-carbon technologies is to create competition between projects to minimise costs for consumers. Experience with renewables since 2014 shows that significantly lower strike prices can be achieved when contracts are auctioned competitively. But in 2012 EDF was the only nuclear developer ready to take forward a new nuclear project, and the Department's analysis suggested there would be overall costs to society in delaying new nuclear capacity (paragraphs 1.20 to 1.22).

11 **The Department put in place mechanisms to mitigate the risk that negotiating a deal bilaterally would not minimise the cost to consumers:**

- The Department commissioned advisers to validate NNBG's estimates of building, running and decommissioning costs. The Department found that its advisers on NNBG's cost estimates – LeighFisher – had a potential conflict of interest. Although LeighFisher notified the Department of this in its proposal for the work in July 2012, the Department's monitoring and management of the potential conflict was insufficient (paragraphs 1.24 to 1.27; Appendix Three).
- The Department recognised that the advisers' validation provides relatively limited assurance because of a lack of reliable benchmarks. It therefore negotiated a construction gain-share clause in the CfD. This means that consumers will share the benefits if NNBG's actual construction costs are less than forecast (paragraph 1.26).
- The Department made clear throughout the HPC negotiations that the finalisation of any deal was always subject to value-for-money assessment. The Department's four value-for-money tests captured the main economic impacts of HPC that it could reasonably quantify, and it refined its analysis during the negotiations as new evidence emerged (paragraphs 1.28 and 1.29).

The case for proceeding with the HPC deal

12 **When the Department finalised the deal in 2016, its value-for-money tests showed the economic case for HPC was marginal and subject to significant uncertainty.** According to the first test, the investors are projected to make a return of 9.04%, which is in line with comparator projects. Consumers stand to benefit through a gain-share mechanism if the return is higher than forecast. For the second test, the Department's modelling shows that scenarios involving some new nuclear power generating from the mid-2020s were marginally less expensive overall than most, but not all, alternative scenarios. For its third test, although the Department concludes the CfD strike price is competitive with alternative low-carbon options, this is partly a result of it having a longer duration than the standard CfD term, which spreads the cost. We discuss the fourth test below. Overall, the Department's economic case is marginal. Less favourable, but reasonable, assumptions about future fossil fuel prices, renewables costs and follow-on nuclear projects would have meant the deal was not value for money according to the Department's tests (paragraphs 2.2 to 2.15).

13 **The Department has not sufficiently considered the costs and risks of its deal for consumers.** In testing the deal's affordability, the Department developed two related tests:

- First, the Department compared forecast CfD top-up payments for HPC with the amount it had allocated to pay for supporting nuclear power under its Levy Control Framework (the Framework). The Department uses the Framework to control the cost of its policies that pass costs onto bills. By September 2016 falling wholesale prices had reduced expected bills overall, but meant that forecast top-up payments for HPC had increased to being clearly above the amount the Department had previously set aside in the Framework. However, the Department did not conclude whether this meant that the deal was now unaffordable for consumers.

- Second, the Department compared the impact on household electricity bills up to 2030 of scenarios where HPC is built with scenarios where it is not. The Department estimates that around £10–£15 from the average bill will go towards supporting HPC in 2030. It calculates that annual bills during this time would be on average more than £20 higher if HPC is delayed and replaced with low-carbon alternatives. But this analysis does not take account of the fact that consumers are locked into paying for HPC, even if other technologies have become better value, long after 2030. The Department expects, for example, that offshore wind costs will be lower than the CfD strike price less than halfway through its 35-year term (paragraphs 2.16 to 2.20).

14 The Department's overall case for HPC has weakened since it agreed key commercial terms on the deal in 2013. The expected future costs of most low-carbon alternatives to nuclear power have fallen more than expected. Delays have pushed back HPC's expected construction schedule, reducing the case for paying a premium for it to be built before other nuclear power projects were able to compete for government support. There are now two other nuclear power developers with plans to complete projects around the same time as HPC, although this is subject to significant uncertainty given the inherent challenges of new nuclear projects. Significant reductions in expected fossil fuel prices mean that the present value of the expected cost of top-up payments under the HPC CfD increased from £6 billion to £30 billion (paragraphs 2.21 to 2.26).

15 The Department's capacity to take alternative approaches to the deal was limited after it agreed terms with EDF in 2013. As the Department's case for HPC weakened, there may have been upsides if it could have negotiated a better deal. But there were several potential downsides if the Department had deviated from the deal, particularly once terms had been agreed. This would have damaged investors' confidence about engaging with the government on other large projects. The Department also considered it extremely unlikely that terms could be renegotiated in its favour as HPC's investors' expected return on the project fell, with EDF facing internal opposition to the existing deal's terms. The Department was concerned that nuclear deployment had already been delayed for more than a decade and further delays could create risks for energy security in the late 2020s. These considerations meant the Department was less able to consider altering the deal or pursuing alternatives even if they would have resulted in better value for consumers (paragraphs 2.34 and 2.35).

16 Other parts of government reviewed the deal but did not sufficiently consider its costs and risks for consumers:

- HM Treasury reviewed the deal during negotiations and emphasised different considerations at various times. In 2013, it considered the deal's potential value for money and noted that it appeared expensive, particularly compared with gas-fired power stations. In its September 2015 review, HM Treasury primarily considered the risk that the deal could mean HPC coming onto government's balance sheet. In September 2016, HM Treasury highlighted how the value-for-money case for HPC had weakened. But it concluded that the legal, reputational, investor and diplomatic ramifications of not proceeding meant it was, on balance, better to continue with the deal.

- The Major Projects Authority (MPA) and the Major Projects Review Group (MPRG) also reviewed the deal. The MPA took assurance from the Department's value-for-money tests that it was worth proceeding with the deal. Its recommendations, along with those of the MPRG, mainly focused on whether the Department had the resources to bring the negotiations to a conclusion and then manage the remaining risks (paragraph 2.31 to 2.33; Figure 11).

17 **The government has increasingly emphasised HPC's unquantified strategic benefits, but it has little control over these and no plan yet in place to realise them**. In continuing to conclude in favour of proceeding with HPC as the value-for-money case weakened, the government put more weight on the wider, unquantified strategic benefits of proceeding with the deal. These include the 'option value' of having new nuclear power in the generating mix, which could be more achievable if the HPC deal stimulates a pipeline of nuclear investments. But the recent financial difficulties of Toshiba, the main investor in the Moorside project, illustrate the uncertainties surrounding follow-on nuclear projects, regardless of the outcome of HPC. The Department also expects HPC to develop the UK nuclear supply chain, although competition rules preclude the Department from obligating EDF to contract with UK companies for a proportion of the project's contracts. Despite the importance of these strategic benefits, the Department does not have a benefit realisation plan in place, although it is developing one (paragraphs 2.28 to 2.30).

Risks to be managed during construction

18 **The reactor design for HPC is unproven and other projects that incorporate it are experiencing difficulties**. There are no examples of HPC's reactor technology (the European Pressurised Water Reactor, EPR) working anywhere in the world. Other projects to build nuclear power stations using EPR technology in France, Finland and China have been beset by delays and cost overruns (paragraphs 3.3, 3.4 and Appendix Five).

19 **EDF's financial position has weakened since 2013**. EDF has posted persistent negative cash flows with higher levels of capital expenditure than expected and earnings below financial analysts' expectations, which has reduced its credit rating in recent years. It recently announced a detailed strategy to address this, which included a capital injection by the French State. A further deterioration of EDF's financial profile or costs escalating at HPC could raise questions about its ability to fund HPC's construction (paragraph 3.7).

20 **These factors mean there is a risk that NNBG will seek further financial support from the government, notwithstanding the contractual terms of the deal**. NNBG carries all the risk of the project being on time and to budget as it will not receive payments through the CfD until HPC is generating power. But there are recent examples of large-scale UK infrastructure projects where risks intended to be borne by the private sector have been passed back to consumers and taxpayers to enable the projects to continue. If the HPC project or developer runs into difficulties, the UK government could come under pressure to provide more support or take on additional risk, particularly given HPC's potential importance for ensuring energy security. Providing more support could mean exposing taxpayers to more risk and increase the chances that HPC comes onto the government's balance sheet (paragraphs 3.5 and 3.6).

21 The Department plans to develop and maintain alternative ways of ensuring energy security to mitigate the risk of needing to provide additional support for HPC. Having alternative ways to ensure energy security would mean that the government is not reliant on electricity generated from HPC. This would put it in a stronger position if the investors were to seek to renegotiate the terms of the deal, although it could add to consumers' costs overall (paragraph 3.9).

22 The government's oversight arrangements of HPC's construction will also be vital. The Low Carbon Contracts Company (LCCC, a government company that the Department has created) has primary responsibility for overseeing the project as the counterparty to the CfD. HPC is a complex project and it will be challenging for LCCC to interpret the information NNBG provides. It needs to do this to ensure that consumers benefit from the construction gain-share mechanism, and to get early and accurate understanding of any significant delays or cost overruns. These risks may be greater later on during construction when there will be less time to deploy alternative ways of ensuring there is sufficient generating capacity (paragraphs 3.10 to 3.13).

Risks to be managed after construction

23 The Department will only maximise consumers' value if it maintains effective oversight of the contractual arrangements over several decades. Conditions of the CfD could result in adjustments to the strike price over the 35-year term of the contract. The equity-gain share mechanism could lead to the shareholders of NNBG making a lump-sum payment through the life of the project after construction (paragraphs 3.14 to 3.17).

24 The Department has aimed to protect taxpayers from exposure to the waste and decommissioning liabilities of HPC, but it is impossible to protect them entirely. All new nuclear deals will include a Funded Decommissioning Programme, whereby the developer sets aside funds to pay for handling waste and decommissioning. The Department and NNBG have agreed a cap to the price for dealing with waste but there is substantial uncertainty about what the actual costs will be. Taxpayers could be exposed if actual costs are higher than the cap, or if HPC closes before NNBG has built up a sufficient fund to cover costs. The Department has calculated that the probability of these events occurring is remote (paragraphs 3.18 to 3.22).

Conclusion on value for money

25 It is a widely shared view that the UK needs some new nuclear power to ensure the lowest-cost route to decarbonisation. But the Department's deal for HPC has locked consumers into a risky and expensive project with uncertain strategic and economic benefits. While committing the developer to bearing the construction risks means taxpayers and consumers are protected from costs overrunning, consumers could end up paying more for HPC's electricity than if the government had shared these risks. Past experience shows that ultimately these risks could shift back to taxpayers or consumers. If the project runs into trouble, the government may need to fund alternatives to ensure secure supply, or come under pressure to renegotiate its deal. The Department did not sufficiently appraise alternative ways to structure the deal.

26 It will not be known for decades whether HPC will be value for money. This will depend on whether the current contractual arrangements endure, along with external factors including fossil-fuel prices, the costs of alternative low-carbon generation, and developments in energy technology and the wider electricity system. However, over the time the Department negotiated the deal, the case for HPC weakened. The Department and other parts of government were concerned primarily with the strategic ramifications of not proceeding and the benefits of keeping the project off the government's balance sheet. They did not consider sufficiently the costs and risks of the deal for consumers. The Department has, however, negotiated a deal that means some terms can be adjusted in consumers' favour in the future. It must now ensure it has the right oversight arrangements in place to manage the contract in a way that maximises HPC's value for consumers and taxpayers.

Recommendations

27 In developing effective oversight and governance arrangements for the HPC project, the Department should draw on best practice from other areas of government and internationally, and in particular:

- **Ensure, as soon as possible, that it and LCCC have the information and skills required to manage the contracts**. This includes having detailed monitoring information against milestones to flag for any deviations from the planned timetable; establishing and safeguarding sufficient capability for LCCC to interpret and, if necessary, challenge NNBG's compliance with its contractual obligations; and having a clear process for identifying and escalating project issues to senior decision-makers.

- **Make clear who in government is accountable for the different aspects of oversight and governance**. This includes who holds ultimate responsibility to represent consumers' and taxpayers' interests during the project.

- **Establish review mechanisms to ensure oversight structures are effective across the lifetime of the project**. The oversight arrangements will need to evolve over time as the project progresses through construction and into the operating stage. There should be a plan in place at the outset for when and how these changes will take place.

- **Develop and implement a plan to track the realisation of the intended benefits from the HPC project**. This includes working with stakeholders to enable national and local benefits for the project. The Department should consider what levers it has to influence the realisation of intended benefits.

28 In pursuing its objectives for the electricity system, the Department should:

- **Ensure it periodically reconsiders its strategic case for supporting nuclear power.** Technological changes or wider economic and political factors could increase or reduce the strength of the government's strategic case for supporting nuclear power investments, requiring changes to its approach. Given the likely rate of change, reassessing the strategic case once each Parliament is likely to be sufficient.
- **Maintain and update a 'Plan B' for achieving its objectives in the event that HPC is delayed or cancelled**. This should set out clear trigger points under which the Department would activate it. The Department's Electricity Policy Board or its equivalent should own this plan. It should be revisited on an ongoing basis to reflect prevailing circumstances.

29 In subsequent deals for any major energy infrastructure project the Department should:

- **Ensure that the cost and timing implications of alternatives are clearly shown to decision-makers when developing its project approach**. Alternative approaches may be outside the normal course of wider policy. But decision-makers should be made aware of the implications of their chosen approach to ensure they are making an informed decision, in particular about the value-for-money implications.
- **Understand and communicate to decision-makers the risk that making commitments to investors can limit flexibility to react to a change in circumstances**. Private investors need signals from government that it is committed to agreeing a deal so they have confidence to engage in negotiations and fund early development costs. But the HPC deal shows that as negotiations progress, particularly through milestones such as agreeing the terms of the deal, the government's flexibility to change course reduces. The implications of this need to be understood and clearly communicated to decision-makers, with the downsides of reduced flexibility being weighed up against the benefits of moving ahead with the deal.
- **Ensure that there is an effective and transparent mechanism for reviewing the value for money and affordability of the deal for consumers**. Any such mechanism should aim to safeguard against the risk that the cost impacts of infrastructure paid for through bills, rather than by taxpayers, receives less government attention. This could be achieved by, for example, producing an impact assessment when support is awarded without competition, or requiring Ofgem, the government's energy market regulator, to publish its assessment of the possible impacts of government decisions on consumers. These were both recent recommendations by the Competition and Markets Authority.

Part One

The Hinkley Point C deal

1.1 In July 2016 we reported on the background to the government's proposed Hinkley Point C (HPC) deal.[1] The government finalised its deal in September 2016. This part of the report:

- describes the terms of the Department for Business, Energy & Industrial Strategy's (the Department's) deal to support HPC;
- sets out the UK's electricity system challenge;
- explains why the government considers nuclear power to be an important part of the solution; and
- assesses the Department's approach to negotiating the HPC deal.

The Hinkley Point C deal

1.2 The Department announced on 29 September 2016 that it had reached a deal with EDF and China General Nuclear Power Group (CGN) to support the construction of HPC.[2] In total, it took the Department and EDF nearly four years to negotiate and finalise the deal for HPC (Figure 1 on page 5).

1.3 HPC will comprise two European Pressurised Water Reactors (EPRs) of 1.6 gigawatts (GW) capacity each. The Department estimates that the two HPC reactors together will be capable of producing some 26 terawatt hours (TWh) of low-carbon, baseload electricity a year. This is equivalent to around 7% of Great Britain's anticipated requirement for electricity in the mid-2020s. A special-purpose project delivery company, NNB Generation Company (HPC) Limited (NNBG), will build and operate HPC. NNBG is owned 66.5% by EDF and 33.5% by CGN. As part of the deal, the Department approved NNBG's plan for funding and undertaking the decommissioning of the power station.

1.4 There are four main components of the government's deal: a contract for difference (CfD); a Funded Decommissioning Programme; a HM Treasury debt guarantee; and a Secretary of State Investor Agreement (SoSIA).

1 Comptroller and Auditor General, *Nuclear power in the UK*, Session 2015-16, HC 511, National Audit Office, July 2016.
2 On 14 July 2016, the government announced that the Department of Energy & Climate Change (DECC) would close and its responsibilities for energy markets and climate change would transfer to a new department, the Department for Business, Energy & Industrial Strategy (BEIS). References to 'the Department' throughout this report that relate to events prior to July 2016 are referring to the then DECC.

Contract for Difference

- The Department has agreed that NNBG will receive a ‘strike price’ of £92.50 (in 2012 prices) for each megawatt hour (MWh) produced.[3] This equates to £100.38/MWh in 2017 prices. The average price of electricity on the wholesale market in Great Britain has been around £45/MWh since 2010. The strike price will increase each year in line with price inflation and the CfD will last 35 years from generation starting.[4]
- The costs of fixing the price of electricity that HPC generates through the CfD will ultimately be borne by electricity consumers. NNBG will receive top-up payments for the difference between the wholesale price of electricity and the strike price. Conversely, if market prices are above the strike price, NNBG will be required to pay the difference to the Low Carbon Contracts Company (LCCC) which in turn are passed onto consumers.
- The government has provided similar contracts to 40 other low-carbon electricity generators providing up to 6.7 gigawatts (GW) of new generating capacity. These typically last for 15 years and have strike prices between £80/MWh and £150/MWh (in 2012 prices).
- The HPC contract includes an additional mechanism to ensure bill-payers share some of the benefit if construction costs are less than NNBG expects.

Funded Decommissioning Programme

- NNBG will make provision for the full costs of nuclear waste management and decommissioning HPC at the end of its operating life (see Part Three).

HM Treasury debt guarantee

- HM Treasury has agreed an initial guarantee of up to £2 billion if NNBG decides to issue bonds to finance construction. NNBG must meet a number of conditions by December 2018 to be able to benefit from the guarantee and the bonds must be repaid by the end of 2020. Following this, and subject to meeting an additional number of conditions as well as further ministerial approval, a guarantee of up to £13.1 billion may be considered thereafter. HM Treasury may cancel the subsequent guarantee if it considers that the additional conditions are unlikely to be met. EDF has stated that it does not currently expect NNBG to draw on the initial guarantee.

3 The strike price will be reduced to £89.50/MWh if EDF reaches its final investment decision on Sizewell C, one of its other potential new nuclear power projects.
4 The strike price is linked to the Consumer Prices Index (CPI) rate of inflation.

Secretary of State Investor Agreement

- The SoSIA regulates the relationship between the government, the generator and the project's investors. Among other things, it enables NNBG to be compensated if there is a change in government policy resulting in the shutdown of HPC. If this were to occur, the Department estimates it could cost the government up to £22 billion (in 2012 prices).[5] The SoSIA also includes an equity gain-share clause, which means consumers share the benefit if NNBG's return on the project is higher than a certain threshold.

The cost of HPC to NNBG

1.5 NNBG expects it will cost £18 billion (in constant 2016 prices) to build HPC, financed in full by its two investors (**Figure 2** overleaf).[6] The first permanent concrete for the power station was poured in March 2017 and EDF expects that it will generate electricity from 2025 to 2085, when it will start decommissioning. NNBG forecasts that the project will cost £45.5 billion (in constant 2016 prices) in total over its lifetime, including construction, operating and contributions to the decommissioning fund.

The UK's electricity system challenge

1.6 The Department is supporting HPC as part of its objective to manage the UK's electricity system challenges over the coming decades. The UK's electricity generating sector is undergoing a major transition from old, polluting technologies to cleaner low-carbon sources. Much of the UK's existing electricity generation plant is set to close over the next two decades. At the same time, the government expects electricity demand will increase due to take-up of electricity-based technologies, particularly for transport and heating homes and buildings.

1.7 The Department is responsible for managing the energy 'trilemma' in the context of the electricity supply challenge. It wants to ensure there is an electricity generating mix that:

- has security of supply;
- keeps energy bills as low as possible for households and businesses; and
- helps to achieve the UK's statutory decarbonisation target to reduce carbon dioxide emission in 2050 by 80% compared with 1990 levels.

1.8 The government predicts that investment in new generating capacity may cost around £140 billion to 2030.[7] A further £40 billion of investment could be needed in electricity transmission and distribution infrastructure. The costs of new generating capacity will be borne by private investors and passed to consumers through their electricity bills. However, the current market price for electricity is not sufficient for new low-carbon generating capacity to be profitable for developers. The government therefore intervenes through mechanisms such as CfDs to secure investment in the new low-carbon generation that is required.

5 Also as part of the deal, CGN intends to lead the development of a nuclear power station in Bradwell in partnership with EDF, who would hold a 33.5% stake in the project.

6 This cost estimate is based on a subset of the project work packages being calculated at P80, meaning there is an 80% chance that these packages will cost less than the estimate.

7 Infrastructure and Projects Authority, *National Infrastructure Delivery Plan 2016*, March 2016. Amount shown in 2014-15 prices.

Figure 2
The expected costs of Hinkley Point C[1]

Stage	Cost	Constant prices (£bn)[2]	Cash prices (£bn)[2]
Construction			
Capital costs	Construction costs	16.6	16.8
Other capital costs	Spare parts, facilities management, insurance during construction, supporting functions and other first core costs	1.6	1.6
	Total construction[3]	**18.2**	**18.4**
Operation			
Operational costs	Fuel costs	6.2	15.8
	Operating costs[3]	11.7	32.8
	Grid charges	2.1	5.9
	Business rates	7.3	20.6
Capital costs	Lifecycle costs	2.0	5.7
	Total operation	**29.3**	**80.8**
Decommissioning fund	Contributions to the fund	4.5	10.6
	Releases and return of surplus from the fund	-6.5	-37.9
	Total decommissioning fund	**-1.9**	**-27.2**
Total project cost to NNBG[4]		**45.5**	**72.0**
Decommissioning	Plant decommissioning	2.7	36.9
	Fuel management[5]	1.8	26.3
	Intermediate-level waste disposal	0.3	3.7
	Fuel disposal	2.6	33.6
	Total decommissioning	**7.3**	**100.5**
	25% uplift on plant decommissioning and fuel management	1.1	15.8
	Total decommissioning plus uplift	**8.5**	**116.3**
Total project cost[6]		**54.8**	**199.7**

Notes

1 Most recent cost estimates available. Figures may not add up due to rounding.

2 Constant prices are expressed in real 2016 money, net of inflation, whereas cash prices include inflation.

3 Total construction cost in constant prices inflated from a value of £17.9 billion in 2015 prices. Operating costs include land lease.

4 During operations, NNB Generation Company (HPC) Limited (NNBG) will commit funds to the decommissioning fund so that it can pay for decommissioning costs at the end of the plant's operational life (see Part Three). NNBG expects that the fund will perform well enough to generate a surplus. This means that part of the fund can be released back to investors; NNBG expects this would happen at the end of the decommissioning period, but it could happen in the latter stages of operations if the fund performs particularly well. Includes a risk fee that the Department charges to cover the possibility that waste disposal costs are higher than initially estimated.

5 The estimated 25% uplift in cash terms assumes a 25% cost addition for each year in which plant decommissioning and fuel management costs are incurred.

6 Total project costs exclude:

- decommissioning fund contributions. This is because decommissioning costs will be met by the fund. Decommissioning costs = contributions to the fund + fund growth – fund releases.
- 25% uplift on plant decommissioning and fuel management costs. This is because the 25% uplift is required as a further reserve in case NNBG's estimates of decommissioning and fuel management costs are inadequate to cover all costs. This will be partly released back to NNBG once it has transferred responsibility for waste.

Source: National Audit Office analysis of NNB Generation Company (HPC) Limited data

The strategic case for new nuclear power

1.9 The Department's deal for HPC is the first for a new nuclear power station since the government set out its strategic case for supporting nuclear power in a 2008 white paper.[8] The government wants nuclear power to form an important part of a 'balanced mix' of generating technologies over the long term. Nuclear can provide reliable 'baseload' electricity, which means it is available almost constantly, complementing intermittent renewable sources that can only provide power when the sun is shining or the wind is blowing. Nuclear is also low-carbon and relatively affordable and so the Department wants it to help the UK achieve its 2050 decarbonisation target at lowest cost. The Department has not formally reviewed and consulted on its published strategic case for nuclear power since the publication of the 2008 white paper.

1.10 The economics of nuclear power projects have deteriorated since 2008:

- Projections of future fossil-fuel prices were higher then, due to expected growth in global demand. Cheaper fossil-fuel prices mean that traditional generating sources, such as gas-fired power stations, are more viable economically.
- Other low-carbon technologies, such as wind and solar power, have fallen significantly in cost.
- The estimated likely costs of electricity from nuclear power stations have more than doubled since the 2008 white paper (**Figure 3** overleaf). Around that time, EDF gave estimates of the likely cost of electricity generation from EPR reactors to investors of around £45/MWh (£48/MWh in 2012 prices).

1.11 Despite these developments, the Department maintains that nuclear power should be part of a future electricity generation mix. The Department's decarbonisation strategy emphasises the importance of keeping several options open including nuclear, renewables and carbon capture and storage (CCS). This would mean the UK is not dependent on only one or two low-carbon technologies to achieve its 2050 carbon-reduction target and ensure energy security. The Department regards nuclear power as increasingly important given the delays to CCS's deployment that will result from HM Treasury's decision in 2015 to withdraw funding from the competition for government support for CCS projects.[9] However, the Department has not quantified this 'option value' of keeping nuclear power in the low-carbon generating mix.

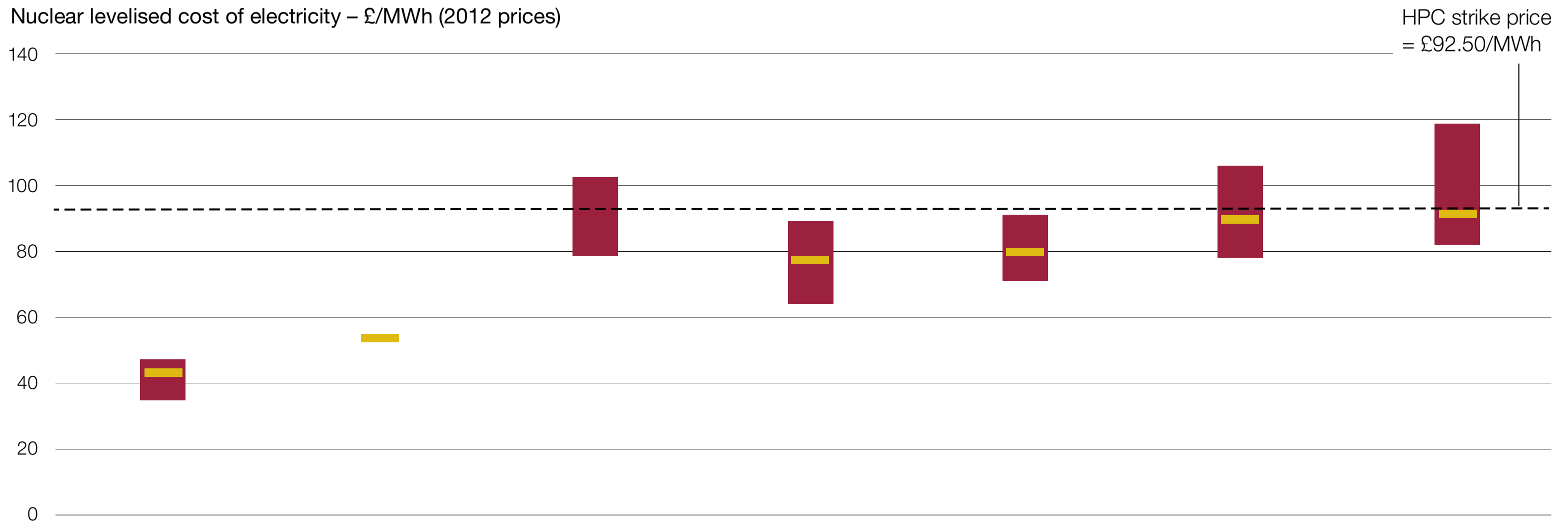
8 Department for Business, Enterprise & Regulatory Reform, *Meeting the energy challenge: A White Paper on Nuclear Power*, January 2008. This white paper built on previous work, in particular the 2006 Energy challenge review that reintroduced the prospect of new nuclear power stations in the UK: Department of Trade and Industry, *The Energy Challenge – Energy Review Report 2006*, Cm 6887, Session 2005-06, July 2006.

9 Comptroller and Auditor General, *Carbon capture and storage: The second competition for government support*, Session 2016-17, HC 950, National Audit Office, January 2017.

Figure 3

Levelised cost of electricity (LCOE) estimates for nuclear new build since 2008

Estimates of the costs of electricity from nuclear power stations have doubled since the government's 2008 *Energy Challenge* white paper



	2008 white paper, LCOE estimate for new nuclear	Committee on Climate Change 2008, LCOE estimate for new nuclear	DECC 2010, LCOE estimate Nuclear FOAK	DECC 2011, LCOE estimate Nuclear FOAK	DECC 2012, LCOE estimate Nuclear EPR FOAK	DECC 2013, LCOE estimate Nuclear FOAK	BEIS 2016, LCOE estimate Nuclear FOAK
Low case	35	–	79	64	71	78	82
Central estimate	43	53	–	77	79	90	92
High case	47	–	103	89	91	106	119

Notes

1 Levelised costs are the average cost per megawatt hour (MWh) over the life of the power station. Levelised costs are shown in 2012 prices. Where a range of costs was calculated, this is shown as a bar in the Figure.

2 Levelised costs are not the same as strike prices. While levelised cost assumptions form an input to the calculation of strike prices, they do not include certain additional costs such as transmission losses and balancing costs; and do not reflect wider market conditions and contract for difference (CfD) terms, including length and risk allocation.

3 Levelised costs are calculated over the expected lifetime of generating plant whereas the HPC strike price (£92.50/MWh) is calculated over the 35-year duration of the HPC CfD.

4 DECC = Department of Energy & Climate Change, BEIS = Department for Business, Energy & Industrial Strategy, FOAK = First of a Kind.

Source: National Audit Office analysis

1.12 The Department's assessment of the need for some nuclear power to meet the UK's emissions reduction target at the lowest cost aligns with that of other energy sector analysts. Organisations including the Committee on Climate Change and National Grid see nuclear playing a role in the generating mix, although they acknowledge it is difficult to predict precisely how much is needed.[10]

The approach to the HPC deal

1.13 The Department entered negotiations with EDF to support HPC in November 2012. New nuclear plant has very high upfront capital costs and long lead times, making it difficult for developers to raise the large sums required to fund those costs. Nuclear is also particularly exposed to political and regulatory risks that may restrict operation or close down plants in the future. The Department aimed to agree a deal that would enable EDF to overcome these barriers. Its approach was framed by two key decisions: the allocation of risks, and entering bilateral negotiations rather than waiting until competition between nuclear projects was possible.

Risk allocation and financing

1.14 The economics of nuclear projects are quite different to renewables such as wind and solar power. They have higher upfront outlays, take longer until revenues are generated, and have unique requirements for funding decommissioning. These factors increase the cost and reduce the choice of financing options available. And some of the risks associated with building nuclear power plants are more difficult for the private sector to manage, such as knowing how much building materials will cost 10 or more years into the future.

1.15 However, the Department's approach to the deal was to align, so far as possible, its support to that which it was proposing for other forms of low-carbon generation, including renewables such as wind and solar. The Coalition Agreement of 2010 permitted new nuclear development only if it received no public subsidy. The Department interpreted the "no subsidy" policy to mean negotiating a deal for HPC that offered similar support to that given to other low-carbon generators. It therefore set out to agree a CfD, where payments from consumers only begin once generation starts, with no sharing of risk between government and developers during projects' construction phase. This means HPC's developers bear the risks of construction running late or costing more than expected. This is the first time this financing approach has been used for nuclear power anywhere in the world.

10 Committee on Climate Change, *Power sector scenarios for the fifth Carbon Budget*, October 2015; and National Grid, *Future Energy Scenarios*, July 2016.

1.16 Alternative ways of the government providing support for HPC could have resulted in lower costs to consumers over the life of the project. The government contributing to the project's financing could have reduced financing costs because the government's cost of borrowing is lower than for private investors. The investors' required rate of return could also have been lower if consumers or taxpayers had shared some of the construction risks. In recent decades, new electricity generating capacity has been privately financed and built. But the government has taken different approaches in the type and extent of support it provides to large infrastructure projects particularly in more publicly funded sectors, such as transport and defence.[11]

1.17 Our analysis shows that different financing and risk-sharing approaches on the HPC deal could have resulted in significantly lower costs for consumers. We have calculated the sensitivity of the CfD strike price to changes in the required return for investors to illustrate the potential impact on consumers' costs (**Figure 4**). We have not assessed the feasibility of applying these models for HPC, nor whether they would comply with HM Treasury guidance or receive State Aid clearance. We also have not assessed how reducing the investors' return would impact on the deal's structure more widely than reducing the strike price. Appendix Four provides more detail on different financing structures that would result in changes to the required rate of return for investors.

1.18 There are good reasons for the Department not taking an alternative financing approach for HPC, beyond adhering to the prevailing energy policy:

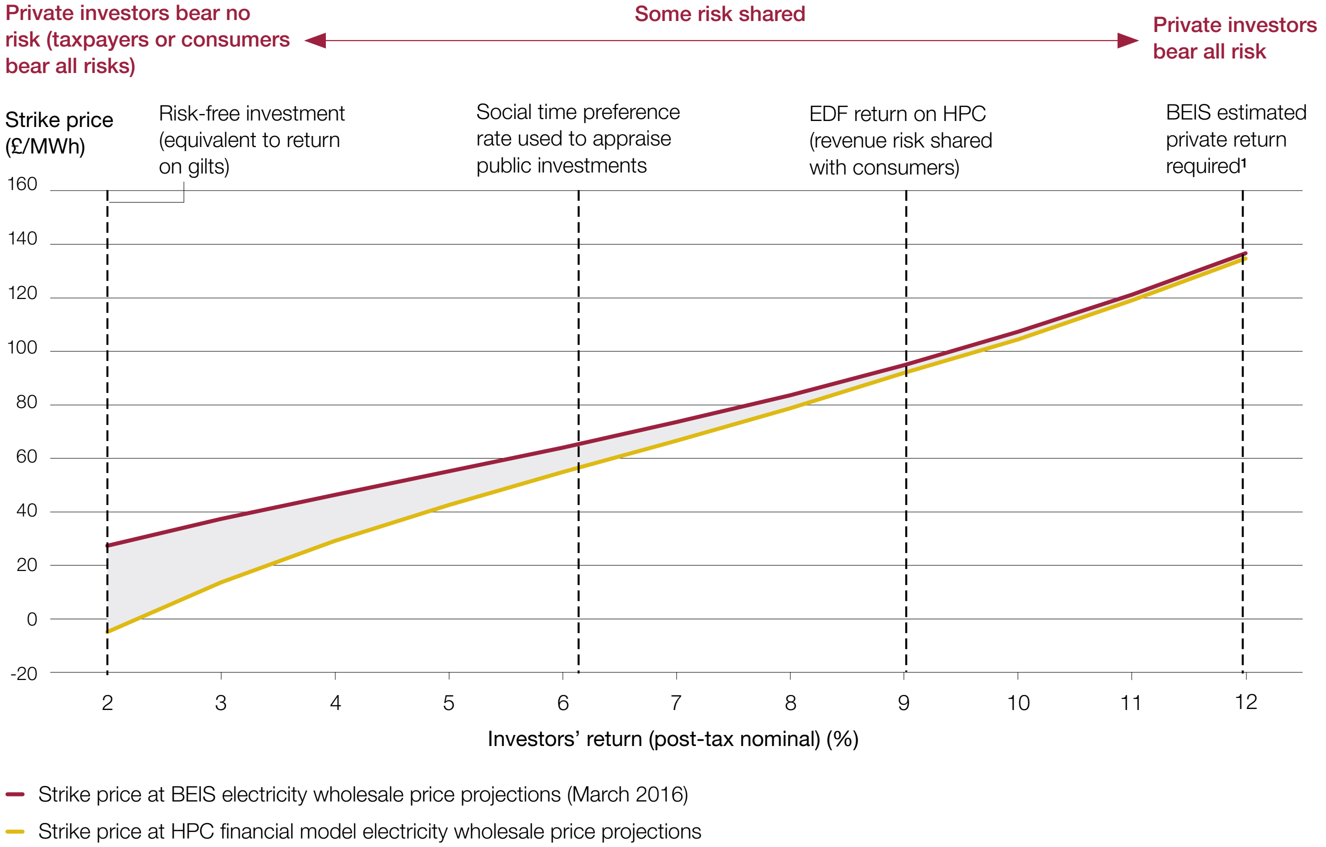
- Alternative financing models would expose taxpayers to additional construction and operational risk and require further investment if the project is delayed or costs overrun. There are many high-profile examples in other sectors where taxpayers have been exposed to government projects overspending. In this case the risks of overspending could be high: the HPC reactor technology has been subject to significant problems, causing costs to overrun in other projects. But our analysis shows that, under most scenarios, the construction cost could overrun significantly before the costs to consumers would equate to the current HPC deal. For example, if we assume the government financed the project and required a 2% return (nominal, equivalent to its borrowing cost), construction costs could overrun by between 400% and 600% to equate to the total cost of the HPC deal. If we assume government needed a 6% return (nominal), costs could overrun by between 75% and 100%.

- Taking a greater stake in the project could have obliged the government to account for HPC as a public asset, bringing it onto the government's balance sheet. This would require trade-offs against other government spending priorities if the government were to stay within its fiscal constraints. If the project was on the government's balance sheet and costs overran, then further rebalancing would be required to prevent additional costs to taxpayers.

11 The Department's chosen approach to financing nuclear power also reduces the feasibility of it taking a 'fleet approach' where it would simultaneously commission building of several large reactors to the same design. Such an approach can result in significantly lower construction costs through economies of scale. The United Arab Emirates, for example, has commissioned four new 1.4 GW nuclear power reactors, totalling 5.6 GW, for $20 billion from a South Korean consortium. All four units are under construction and the first reactor should start generating in 2017.

Figure 4
Strike price sensitivity to investors' return

The strike price is related to the investors' return, which varies according to the risk sharing arrangements



Notes

1 See Appendix Four for methodological notes and assumptions.

2 The return required by investors is proportional to how much risk they bear, and ranges from 2% (investors bear no risk) to above 12% (where investors bear all risks).

3 The strike price awarded to HPC allows NNBG to receive a return of 9% throughout the life of the project. This is lower than 12% because the deal removes revenue risks for 35 years through the CfD and limits waste disposal costs. However, investors still have to bear other significant risks, such as construction and decommissioning risk.

4 We have not assessed the feasibility of different financing and risk allocation for HPC. Our analysis is intended to illustrate the sensitivity of costs to consumers to changes to investors' required rate of return. Alternative approaches to the deal would have had wider impacts to its structure. For example, a CfD may not be required where risks to investors are lower.

Source: National Audit Office analysis of NNB Generation Company (HPC) Limited data

1.19 The Department did not assess the cost implications of standing by the prevailing government policies in its approach to financing the project and allocating risks. Furthermore, the government announced in October 2015 that it was no longer adhering to the 'no subsidy' policy for nuclear power. This could have meant alternative financing options, which may have been better value for money for consumers, were more politically feasible.

Negotiating bilaterally

1.20 The Department's preferred approach is for low-carbon generation projects to compete for government support as it expects this to minimise the costs to consumers. But the Department opted to negotiate the deal bilaterally because HPC was the only viable nuclear power project in 2012, and their modelling showed there would be net costs to society in delaying proceedings until other nuclear power projects were able to compete fairly with HPC.

1.21 The Department viewed reaching a deal for HPC as a means of establishing earlier new nuclear capacity, including subsequent projects. It wanted to mitigate the risk that the UK misses its decarbonisation target if other low-carbon technologies are not available. The Department assumed that there would be significant cost reductions for nuclear power projects after HPC, as the UK's supply chain developed and investors' confidence increased. Developers have proposed to build two further nuclear power stations (equivalent to 6 GW of new nuclear capacity) by 2030. The Department concluded that unnecessary delay to HPC would have a knock-on effect on these projects, risking the achievement of the government's carbon emission reduction target.

1.22 HPC was further advanced than other nuclear power projects partly as a result of earlier government decisions about the allocation of sites suitable for nuclear power stations. EDF purchased British Energy, including the Department's holding, in 2009. As part of the deal, EDF was required to dispose of some potential sites for nuclear generation. But it retained five of the 11 sites nominated by industry as potentially suitable for new nuclear build, including two of the three most suitable sites. The government aimed to attract other developers for the sites which EDF relinquished, as well as other potential generation sites owned by other parties.[12]

Mitigating the risk of negotiating bilaterally

1.23 The Department recognised that negotiating bilaterally created risks that consumers would pay too much for HPC, or would result in insufficient transfer of risks to the developer. For example, in 2014 the Department awarded contracts for renewable energy with administratively set prices rather than through competition. We have previously reported how this meant the contracts may provide higher returns than needed to secure the investment.[13] Since then, strike prices awarded through competitive auctions have been lower than those that the Department set administratively for the early CfDs. The Department put in place mechanisms to mitigate this risk for HPC.

12 Comptroller and Auditor General, *The sale of the government's interest in British Energy*, Session 2009-10, HC 215, National Audit Office, January 2010.

13 Comptroller and Auditor General, *Early contracts for renewable energy*, Session 2014-15, HC 172, National Audit Office, June 2014.

Cost discovery and verification

1.24 The Department commissioned work to check whether EDF's estimate of the costs to construct, run and decommission HPC were reasonable. It appointed LeighFisher in 2012 to scrutinise and review the project costs by benchmarking them against other nuclear projects and reviewing information from the major contracts NNBG has already let with its suppliers. In its final report in 2015, LeighFisher concluded that expected costs were within a reasonable range of expectations, although towards the higher end of the range.

1.25 The report provides some assurance, but there are limitations:

- There is a lack of reliable benchmarks, given that there is no completed EPR reactor anywhere in the world.
- The scope of LeighFisher's work meant it was not required to challenge some key assumptions. In particular, it was not required to assess the efficiency of NNBG's approach to managing the building of an EPR nuclear power station or its proposed project structure, such as work packages and sequencing.
- LeighFisher worked with NNBG to understand how it has learnt lessons from the other projects using EPR technology in France, Finland and China, which have seen significant cost and schedule overruns. But it will only be known during the construction phase of HPC whether NNBG has been able to put in place safeguards to ensure the project does not run into similar problems.

1.26 To mitigate the limits to the assurance of the report, the Department has negotiated a construction gain-share mechanism. This means that consumers will share some of the benefit if the actual construction costs are below what EDF forecasts. Consumers will receive half of any savings against forecast up to £1 billion, and 75% of any savings above £1 billion. We assess the implementation of the construction gain-share mechanism in Part Three.

1.27 LeighFisher had a potential conflict of interest given its parent company, Jacobs Engineering Group, had worked for EDF on the HPC project. Although LeighFisher notified the Department of this in its proposal for the work in July 2012, the Department's monitoring and management of the potential conflict was insufficient. Further details are set out in Appendix Three.

Value-for-money tests

1.28 The Department subjected the deal to four value-for-money tests designed to balance returns to investors with consumers' costs, while considering the value of HPC compared with alternative ways of generating electricity. These were:

- **Fair return:** Whether the CfD package offers a fair return to HPC's investors, without overcompensating them given the project's costs and risks.
- **Cost-competitiveness:** Whether HPC is cost-competitive compared with other options for generating power.
- **Cost–benefit analysis:** Whether HPC brings net societal benefits by reducing the total cost of the British electricity system out to 2050, compared with a range of possible alternative generation mixes if HPC were delayed.
- **Affordability:** Whether HPC is affordable to UK electricity consumers, according to its impact on electricity bills compared with alternative generation scenarios. The Department also, initially, assessed affordability in terms of the total consumer top-up payments through the CfD, relative to forecast wholesale energy prices. This was in line with its Levy Control Framework, the mechanism through which it caps the costs of its consumer-funded policies to support low-carbon generation.

1.29 The Department has subjected its deal to the value-for-money tests four times, at key stages in the negotiations. The Department refined the evidence that underpinned them as more information and analysis became available. We assess the Department's analysis underpinning its value-for-money tests in Part Two.

External challenge

1.30 Because of the deal's high profile there were a number of different parts of government reviewing it. As well as the Department, HM Treasury, the Infrastructure and Projects Authority and the Major Projects Review Group all considered the deal at various points from 2012 onwards. We consider the effectiveness of these reviews in Part Two.

Part Two

Assessing the case for supporting Hinkley Point C

2.1 The Department for Business, Energy & Industrial Strategy (the Department) finalised its deal to support Hinkley Point C (HPC) in September 2016. Although the key commercial terms on the deal were agreed between the Department and EDF in October 2013, it took a further three years to finalise the deal. During this period, the deal went through the European Commission's State Aid process, which it completed in October 2014. EDF also obtained the necessary financing to take its final investment decision, which it took in July 2016. This part of the report:

- assesses the Department's value-for-money case for finalising the deal in September 2016;
- sets out how the Department's case for supporting HPC has changed since it agreed key commercial terms in 2013; and
- considers how the government responded as the case for supporting HPC weakened.

The Department's value-for-money assessment

Fair return

2.2 The Department concluded that the terms of the HPC deal offered a fair return to its investors. The Department based its assessment on projections of future cash flows for the HPC project. These cash flows were calculated in a financial model built by NNB Generation Company (HPC) Limited (NNBG). NNBG gave access to this model to the Department and its advisers so that they could gain assurance about the model's compliance with the contract for difference (CfD) and its outputs.

2.3 The investors expect their return on the project to be 9.04% over the 60-year operating life of HPC.[14] The financial model predicts that NNBG will achieve this return by receiving £79.7 billion (in real terms, 2016 prices) of net project cash flows by the end of HPC's operational life in 2085.[15] The Department conducted a benchmarking exercise, which found that returns on comparable projects in energy and transport infrastructure, regulated utilities and alternative energy range between 8.5% and 13.8%. The European Commission's State Aid ruling also confirmed the expected project returns are within the range of comparable projects.

14 Post-tax nominal Internal Rate of Return.
15 Excludes costs related to the Funded Decommissioning Programme (see paragraphs 3.20 to 3.22).

2.4 The Department has negotiated an equity gain-share mechanism as part of the deal that means consumers will share the benefit if HPC's investors' returns are higher than expected over the lifetime of the project. EDF or China General Nuclear Power Group (CGN) must make a lump-sum payment to the Low Carbon Contracts Company (LCCC, a company the Department established) if the return resulting from a sale of shares or the performance of the project is higher than 11.4% (nominal). LCCC will pass the benefit to consumers.

2.5 The return to NNBG's investors could be higher if they decide to sell part or all of their shareholding to a new investor after construction. This is because there would be a substantial reduction in project risk once HPC is operational. The return to NNBG's investors would be influenced by the required rate of return of the new investor.[16] The Department has negotiated the equity gain-share mechanism as part of the HPC deal to ensure consumers share the benefit if NNBG's investors achieve a return above 11.4%. Our analysis shows that if EDF sells their stake in NNBG after completing construction on time and on budget in 2025, the return to EDF could be higher than the 9% it expects to make over the whole project (**Figure 5**).

Figure 5

Potential returns to EDF if it sells its 66.5% stake in NNBG after construction in 2025

The return to EDF could be higher than the 9% it expects to make over the whole project under the likely gain-share scenarios

If the buyer's cost of capital[1] is:	**5.0%**	**6.0%**	**7.0%**	**8.0%**
Implied EDF return before equity gain-share (IRR)[2]	19.5%	16.4%	13.7%	11.2%
EDF will make a project return above the agreed 9.04% fair rate of return. EDF will have to share the difference with LCCC, to be passed on to consumers, according to the equity gain-share mechanism. LCCC would receive a lump sum payment of: (£bn)	9.1	4.3	1.2	0
Amount to EDF for selling their stake after payment of equity gain-share to LCCC: (£bn)	32.6	29.4	26.8	23.8
After having paid the lump sum to LCCC, EDF return on the project (IRR)[2] would be:	15.9%	14.4%	13.0%	11.2%

Notes

1 Buyer's cost of capital shows the level of return it would require to invest in a project. Buyers have different costs of capital depending on their availability of resources, credit rating and risk of the investment.

2 Internal Rate of Return.

3 Figures in 2025 prices.

Source: National Audit Office analysis of NNB Generation Company (HPC) Limited data

16 Comptroller and Auditor General, *Equity investment in privately financed projects*, Session 2010–2012, HC 1792, National Audit Office, February 2012. Paragraphs 3.14, 3.15 and Figure 11, explain changes in returns due to a sale in more detail.

Cost-competitiveness

2.6 In September 2016, the Department concluded HPC is cost-competitive with alternatives. However, its assessment showed that HPC's strike price (£92.50/MWh) is higher than the central case for four out of five comparators (**Figure 6** overleaf).[17] The Department based the costs of the comparators on a series of reports on electricity generation costs that it had commissioned from energy sector consultants and on the results of further analysis it performed on these data.

2.7 The Department emphasised that these cost comparisons do not capture the strategic differences of alternative generating options. For example, nuclear power is a 'firm' source of electricity that can be relied upon to deliver during periods of high demand, in contrast to wind and solar power which are intermittent. The comparison also does not capture the wider unquantified strategic benefits of HPC (paragraph 2.29). In a recent report on carbon capture and storage (CCS), we explained that the strike price is not an appropriate measure for comparing the costs and benefits of technologies at different stages of development and with different characteristics.[18]

2.8 The HPC strike price appears cost-competitive with other technologies in part because of the way it is structured. At the outset of negotiations, the Department set its negotiating team a firm mandate that a fixed strike price should lie in the range £78-£85 MWh (in 2012 prices). This was to ensure broad comparability with onshore wind costs, the cheapest renewable technology at the time, and new gas power stations delivering in 2020. To achieve this strike price, the Department agreed to a CfD longer than the standard 15-year term to spread the costs, and with the strike price indexed to inflation. Our analysis shows to achieve the same investor return a 15-year CfD would have required a headline strike prices of around £113/MWh (in 2012 prices). The Department also considered that having a CfD with a longer duration would have helped EDF secure debt finance for the project, although it subsequently financed HPC using equity along with the investment from CGN.

2.9 The chosen CfD structure could mean consumers' costs over the lifetime of the project are higher than alternative CfD structures. The Department calculated that, using its base case assumptions, lengthening the CfD and linking the strike price to inflation would both increase consumers' total costs over the lifetime of the contract.

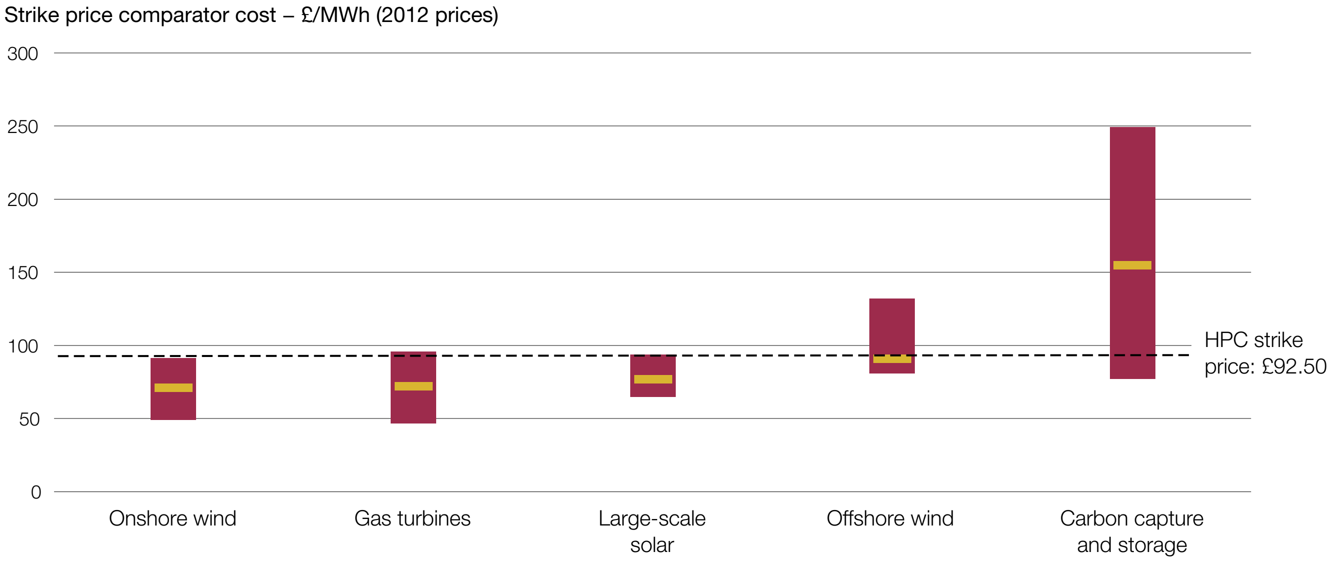
17 The exception is carbon capture and storage (CCS), which at the time of the final decision on HPC the Department considered would be significantly more expensive than nuclear power, and less able to deploy at scale in the 2020s due in part to the government's cancellation of its competition to support CCS projects in 2016.

18 Comptroller and Auditor General, *Carbon capture and storage: The second competition for government support*, Session 2016-17, HC 950, National Audit Office, January 2017.

Figure 6

Expected strike price comparator costs for alternative large-scale power sources in the mid-2020s

The Department's estimates show that the strike price for HPC (£92.50/MWh) is within or just outside the range of costs of alternative large-scale generation technologies



£/MWh	Onshore wind	Gas turbines	Large-scale solar	Offshore wind	Carbon capture and storage
Low case	49	47	65	81	77
Central case	71	72	77	91	155
High case	90	96	92	132	249
Difference (central case)	23% cheaper than HPC strike price	22% cheaper than HPC	17% cheaper than HPC	2% cheaper than HPC	68% more expensive than HPC

Notes

1 The Figure summarises the results of the Department's cost-competitiveness test.

2 To compare like-with-like, the Department calculated a HPC strike price comparator cost. This comprises a central estimate of levelised costs for each technology, with various additions for other costs such as land costs, transmission losses, and other electricity grid and related support charges. These add around £6/MWh to onshore wind, £7/MWh to offshore wind and £14/MWh to large-scale solar. This is not a complete assessment of all the costs associated with these technologies, and excludes certain technology or location-specific costs.

3 To represent the uncertainty surrounding its forecasts, the Department estimates strike price comparator costs as ranges, rather than point estimates. The low case is the lowest cost of each technology in this range, while the high case is the highest cost.

4 The strike price comparator cost estimates are expected costs for plant commissioning in 2025. The estimates are rounded to the nearest £1.

5 Around £17/MWh of the gas comparator cost is made up of the market price of carbon. Removing it would reduce the gas strike price comparator cost to £54-£55/MWh. Under the Department's modelling assumptions, the cost of carbon increases over time.

6 The range of costs for CCS is wider than for other technologies because it is not yet available in the UK. The range represents different deployment options.

7 The Department did not compare the cost of HPC against other nuclear projects because no robust data on the costs of deploying alternative reactor technologies are available.

8 Offshore wind estimates incorporate two sets of strike price comparator cost ranges. The first is consistent with the assumptions and estimates contained in the Department's electricity generation costs report published in November 2016. The second assumes a higher learning rate for cost reduction so that the central estimate aligns with the government's CfD auction strike price cap for offshore wind in 2025 (plus an allowance for extra system costs) as set out in the March 2016 Budget, (HM Treasury, Budget 2016, HC 901, paragraph 1.246).

Source: National Audit Office analysis of Department for Business, Energy & Industrial Strategy data

Cost–benefit analysis

2.10 The Department's latest analysis shows that deferring construction of new nuclear power stations would increase the total costs of the electricity system in scenarios where renewables fill the gap, but not in scenarios where gas generation fills the gap (**Figure 7** overleaf).

2.11 The Department models different combinations of new generating capacity using its 'Dynamic Dispatch Model' (DDM). These scenarios factor in more variables than the cost-competitiveness test, including:

- assumptions about electricity demand and generation, costs, fuel prices and carbon dioxide emissions to 2050;
- current developments in government energy policy, such as coal-fired power stations closing by 2025;
- up-to-date commercial decisions by generators, such as EDF announcing life extensions for its nuclear fleet; and
- wider system costs and impacts, and the effects of curtailing generators in periods of low demand on the power system.

2.12 We have assessed the DDM in the past and consider it to be a reasonable approach to assessing the potential impact of different power sector scenarios given the degree of uncertainty involved.[19]

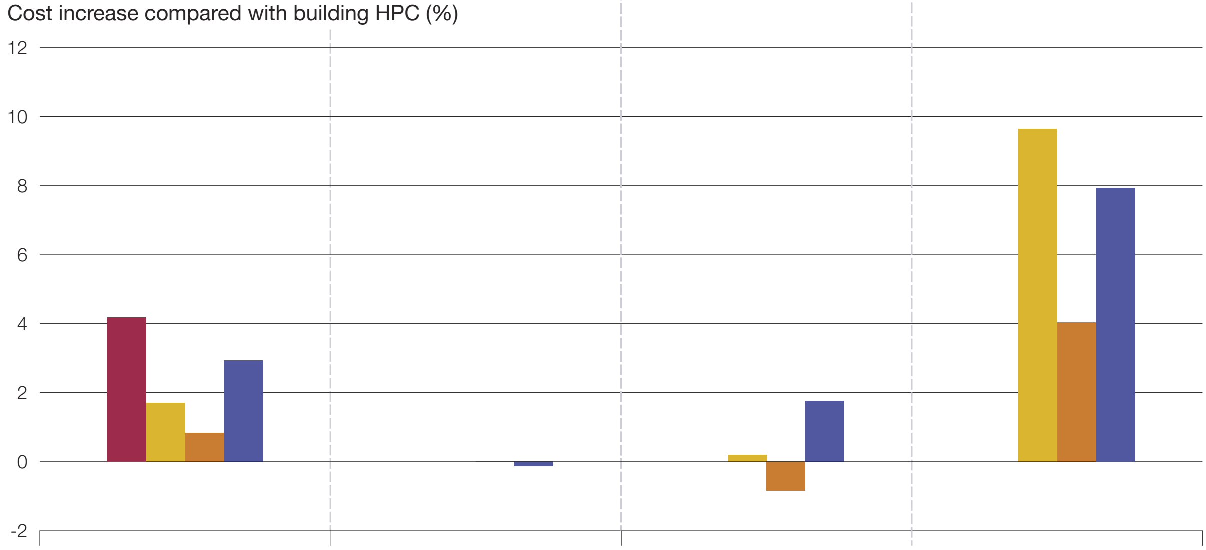
2.13 The estimated impacts of delaying HPC (and a follow-on programme of new nuclear build) are small relative to total estimated cumulative electricity system costs out to 2050 (£660 billion).[20] The Department estimates that delaying the new nuclear programme by three years and replacing it with low-carbon alternatives could increase overall costs by 2.9% (£19.4 billion), whereas filling the gap with gas-fired power would result in a 0.1% (£0.8 billion) saving overall. A 10-year delay to new nuclear, with the resulting generating gap filled by a combination of offshore wind and CCS, would increase cumulative power system costs more significantly (7.9%, £52.3 billion).[21]

19 Comptroller and Auditor General, *Infrastructure Investment: The impact on consumer bills*, Session 2013-14, HC 812, National Audit Office, November 2013.
20 Net present value of total system costs out to 2050 in 2012 prices.
21 All impacts from delay are net present values in 2012 prices.

Figure 7

Estimated cost impacts of delaying HPC and follow-on new nuclear build

The Department's analysis shows that delaying HPC and follow-on new nuclear build and filling the resulting power gap with low-carbon alternatives increases total power system costs, but the results are marginal



Length of the delay	Three-year delay			10-year delay
HPC replaced by	A – offshore wind and carbon capture and storage	B – gas	C – onshore wind and large-scale solar photovoltaic	D – offshore wind and carbon capture and storage
October 2013	4.2%	–	–	–
November 2014	1.7%	–	0.2%	9.6%
October 2015	0.8%	0.0%	-0.8%	4.0%
September 2016	2.9% (£19.4bn)	-0.1% (-£0.8bn)	1.8% (£11.7bn)	7.9% (£52.3bn)

Notes

1. Cost increases (or savings) are shown in percentage terms because total system costs to 2050 vary in each year the Department ran its scenarios. This is because it has updated some of the key assumptions underpinning its modelling over time.
2. Alternative scenarios to replace HPC are not entirely consistent across years.
3. Between 2015 and 2016, the Department updated its assumptions on the balancing and network costs of renewables. This had the effect of increasing the expected costs of renewables.

Source: National Audit Office analysis of Department for Business, Energy & Industrial Strategy data

2.14 The Department has modelled these scenarios on three occasions since it agreed key commercial terms, with some results showing lower societal costs if nuclear deployment is delayed. For example, its October 2015 analysis showed that filling the three-year gap with a combination of onshore wind and solar photovoltaics (PV) would result in lower total costs. The Department discounted this option because the required amount of new onshore wind would be politically unacceptable. The Department's September 2016 analysis, which takes fuller account of the wider system impacts of renewables, showed that the onshore wind and solar PV scenario would be more expensive than proceeding with HPC and follow-on new nuclear. However, a scenario with gas power stations filling the power gap created by a three-year delay to HPC and follow-on new nuclear would be lowest cost. The Department discounted this option on the grounds that gas generation would compromise the achievement of the government's 2050 decarbonisation target.

2.15 While the Department's approach to modelling these scenarios is sensible, the degree of uncertainty is significant. For example:

- The costs of different generating technologies are affected by future fossil fuel prices, which are difficult to predict. When the Department used lower projections of fossil-fuel prices than its central assumption, the savings of deferring nuclear power for three years and filling the gap with gas-fired power *increase* from £0.8 billion to £4.0 billion. But using its higher fossil-fuel price forecast would mean the delay-plus-gas scenario costs £5.2 billion more than the nuclear scenario.
- The cost-benefit case for nuclear power is also affected by the speed with which the cost of low-carbon alternatives reduces. The expected costs of wind and solar power have already fallen faster than the Department expected when it began negotiating the HPC deal.
- The Department's modelling assumes that the costs of nuclear power projects will fall over time as the supply chain develops and learning is shared. But projections of nuclear power costs have doubled since the government's 2008 white paper on nuclear power (see Figure 3).
- The Department assumes that around two nuclear reactors will be built every three years after HPC begins generating. Although it hopes supporting HPC will help develop the UK's nuclear supply chain and increase investors' confidence, the risks inherent in developing new nuclear power stations mean it is far from certain that all the projected schemes will be completed successfully.

Affordability

Comparing the impact on bills of different options

2.16 The Department calculates that supporting HPC will lead to lower average annual electricity bills until 2030 compared with replacing it with renewables. Using its Prices and Bills model, the Department calculated the impact of different government policies on consumers' electricity bills until 2030. The Department estimates that between £10 and £15 of the average annual household electricity bill (in 2012 prices) will go towards supporting HPC up to 2030.[22] In line with the findings of its cost–benefit analysis, the Department's prices and bills modelling finds that if HPC and subsequent new nuclear build are delayed, and the energy gap is filled by onshore wind and solar PV, the average bill would be £21 higher each year up to 2030. It also calculates bills would be £24 higher each year up to 2030 if the gap was filled with offshore wind and gas power stations with CCS.[23] But if gas power stations without CCS are deployed to fill the gap created by a delay to HPC and subsequent new nuclear, the Department estimates that bills would be £6 lower each year on average.

2.17 The Department's assessment of the impact on bills does not extend beyond 2030 meaning it does not consider the implications of having a CfD with a longer duration than the standard contract. The contract means consumers are locked in to paying a fixed price for power from HPC even if other technologies have become better value. The Department's modelling projects, for example, that offshore wind costs will be lower than the CfD strike price less than halfway through its 35-year term.

Total top-up payments

2.18 When it signed the deal in September 2016, the Department estimated that the present value of future top-up payments was between £11 billion and £21 billion (in 2012 prices and discounted to 2012) over the 35-year term of the CfD. However, it has not concluded whether the total CfD top-up payments are affordable for consumers. In 2011, the Department and HM Treasury established the Levy Control Framework (the Framework) to cap the cost of consumer-funded policies to support low-carbon generation for each year up to 2020-21. The Department calculates the cost to consumers of CfDs in the Framework based on the value of top-up payments.

22 The Department's central estimate is that around £12 from the average annual household electricity bill will go towards supporting HPC up to 2030.

23 Although generating technologies such as wind and solar have lower strike price comparator costs than nuclear power, the Department estimates that overall costs will be higher because of the additional costs of these technologies to the electricity system because of their intermittency.

2.19 Since 2013, the Department has expected HPC to begin generating electricity after the period covered by the Framework. But it used the amount set aside within the Framework for new nuclear projects (£600 million per year) as a measure of affordability:

- When the Department agreed the deal's terms in October 2013, it predicted that annual top-up payments would be within this figure and therefore concluded the deal would be affordable.
- In its last full business case for the deal in October 2015, the Department stated that it expected top-up payments to be broadly in line with the amounts set aside in the previous Framework settlement. The Department acknowledged the risk that having to budget for HPC's top-up payments could be at the expense of other projects included within any cap at the time.
- By September 2016, falling wholesale prices had reduced expected bills overall, but meant that forecast top-up payments for HPC had increased to being clearly above the amount the Department had previously set aside in the Framework for new nuclear. However, the Department did not conclude whether this meant that the deal was now unaffordable for consumers (**Figure 8** overleaf).

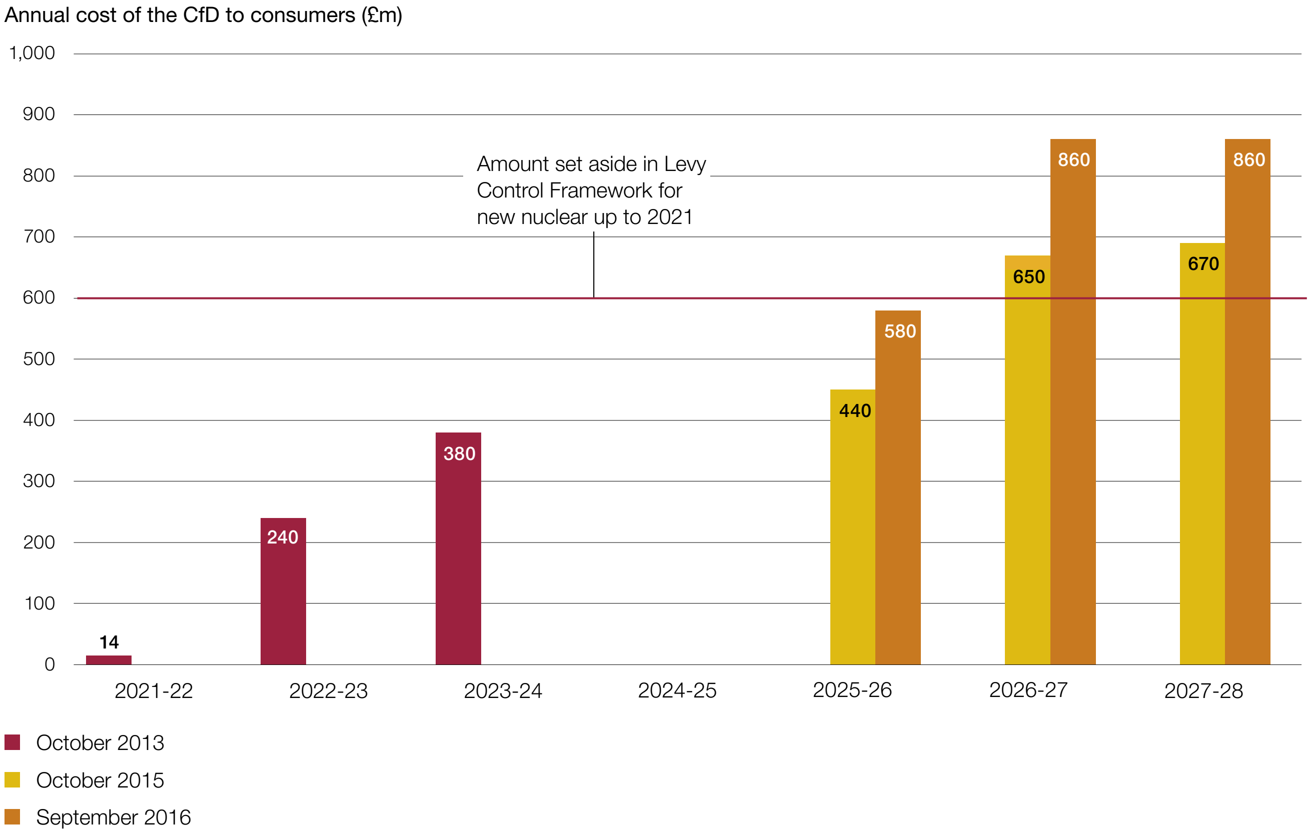
2.20 The Department considers the value of top-up payments to be an inferior measure of value for money as top-up payments are only part of a consumer's electricity bill. The total amount consumers will pay (£92.50/MWh) has not changed and other forms of low-carbon generating capacity will require support through top-up payments. It considers comparing the strike price of alternative sources of low-carbon generation a better way of assessing value for money. We recently reported that, although using top-up payments has the advantage of being simple to measure and explain, the government should consider moving away from capping costs relative to the wholesale price of electricity, as that price fluctuates unpredictably.[24]

24 Comptroller and Auditor General, *Controlling the consumer-funded costs of energy policies: The Levy Control Framework*, Session 2016-17, HC 725, National Audit Office, October 2016.

Figure 8

The Department's forecast of the first three years' top-up payments compared to the Levy Control Framework settlement

The Department's forecasts of top-up payments for HPC have increased between October 2013 and September 2016



Notes

1 All figures in 2012 prices, undiscounted.

2 Top-up payments are less in the first year because it is assumed that only one of HPC's two reactors will be generating power.

3 The October 2013 estimates assume that the strike price for electricity from HPC is £89.50/MWh.

Source: Department for Business, Energy & Industrial Strategy

Changes to the case for HPC since 2013

Cost-competiveness of HPC

2.21 The cost advantage of HPC compared with other large-scale sources of energy has eroded since 2013. This reflects new evidence about the costs and efficiency of alternative generating technologies, and lower forecasts for fossil-fuel prices and the Carbon Price Floor.[25] The Department's estimates of the strike price comparator costs for wind, solar and gas have decreased since its Outline Business Case for HPC in November 2012 (**Figure 9** overleaf). The predicted costs of replacing generation from HPC with solar and onshore wind increased between 2015 and 2016, reflecting the Department's revised assessment of the costs imposed on the system by the intermittency of these sources. But they remained lower cost than HPC. A slump in the projected cost of fossil fuels since 2013 also means that gas-fired power stations are now expected to be more cost-competitive compared with nuclear power, although they would contribute less to achieving decarbonisation.

Increases in forecast top-up payments

2.22 The expected value of top-up payments through the HPC CfD, due to differences between wholesale electricity prices and the strike price, has increased since the Department began negotiating the deal. In July 2016 we reported that the forecast top-up payments had increased from £6 billion in October 2013 to £30 billion in March 2016.[26]

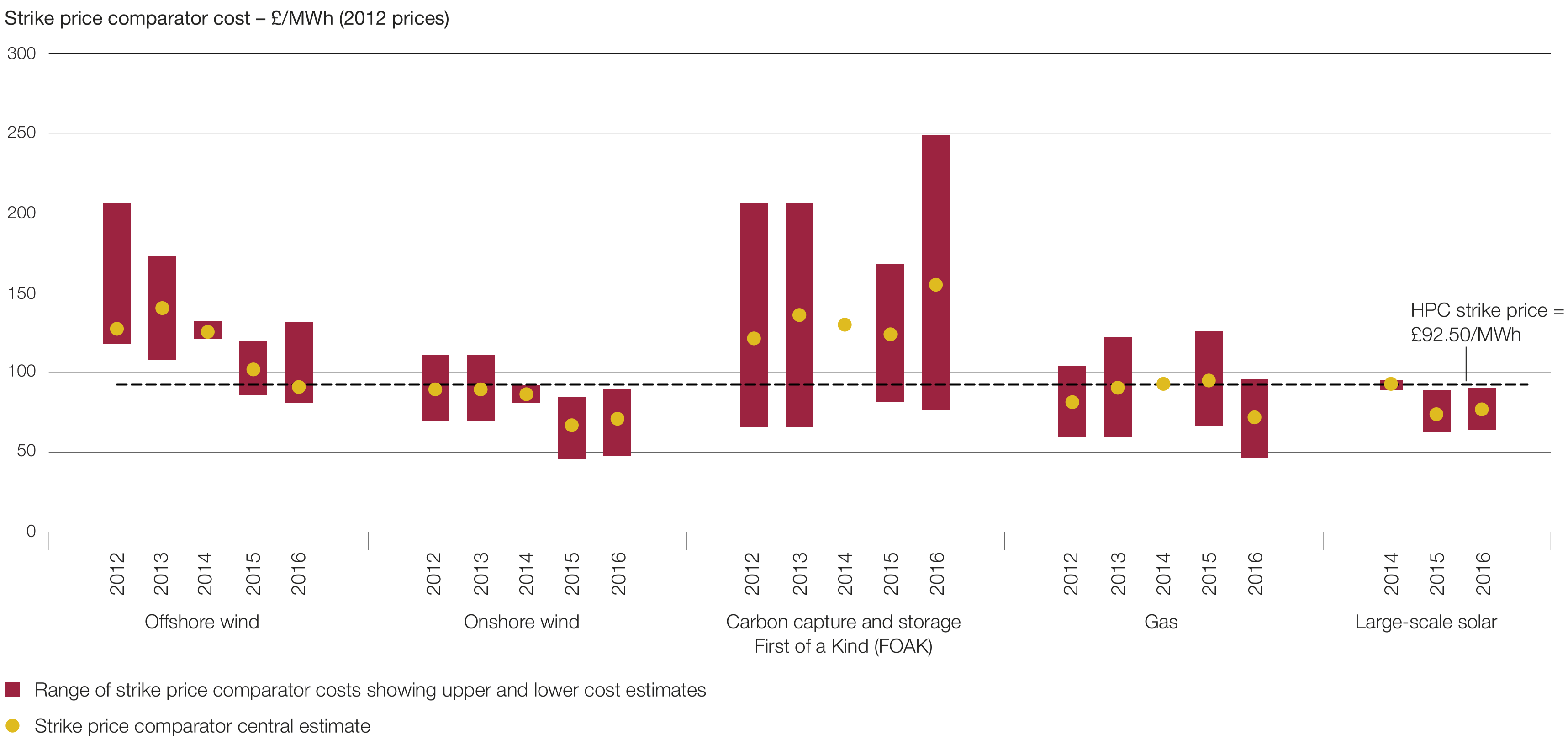
25 The Carbon Price Floor is a government policy that places a price on emitting greenhouse gases by requiring heavy energy users to acquire permits for every unit of greenhouse gases they emit.

26 The £30 billion estimate is a present value discounted to 2015 in 2015-16 prices. This estimate is different from the Department's range of expected top-up payments (£11 billion–£21 billion) mainly because the Department used the HM Treasury's Green Book discount rate (3.5% for the first 30 years) to calculate the present value of future cash flows. Our figure uses the discount rate (0.7%) that HM Treasury requires departments to use when valuing liabilities in their annual accounts.

Figure 9

Expected strike price comparator costs of generating 1 MWh for different large-scale generating technologies in the 2020s: Changes in Department's estimates since 2012

The Department has revised down its strike price comparator cost estimates for generating electricity from wind and solar since its Outline Business Case for HPC in November 2012



Notes

1 The Figure summarises the results of the Department's cost-competitiveness tests since 2012. In 2014 the Department did not publish forecast ranges for some techologies.

2 Strike price comparator costs are shown as ranges to represent the uncertainty surrounding the estimates.

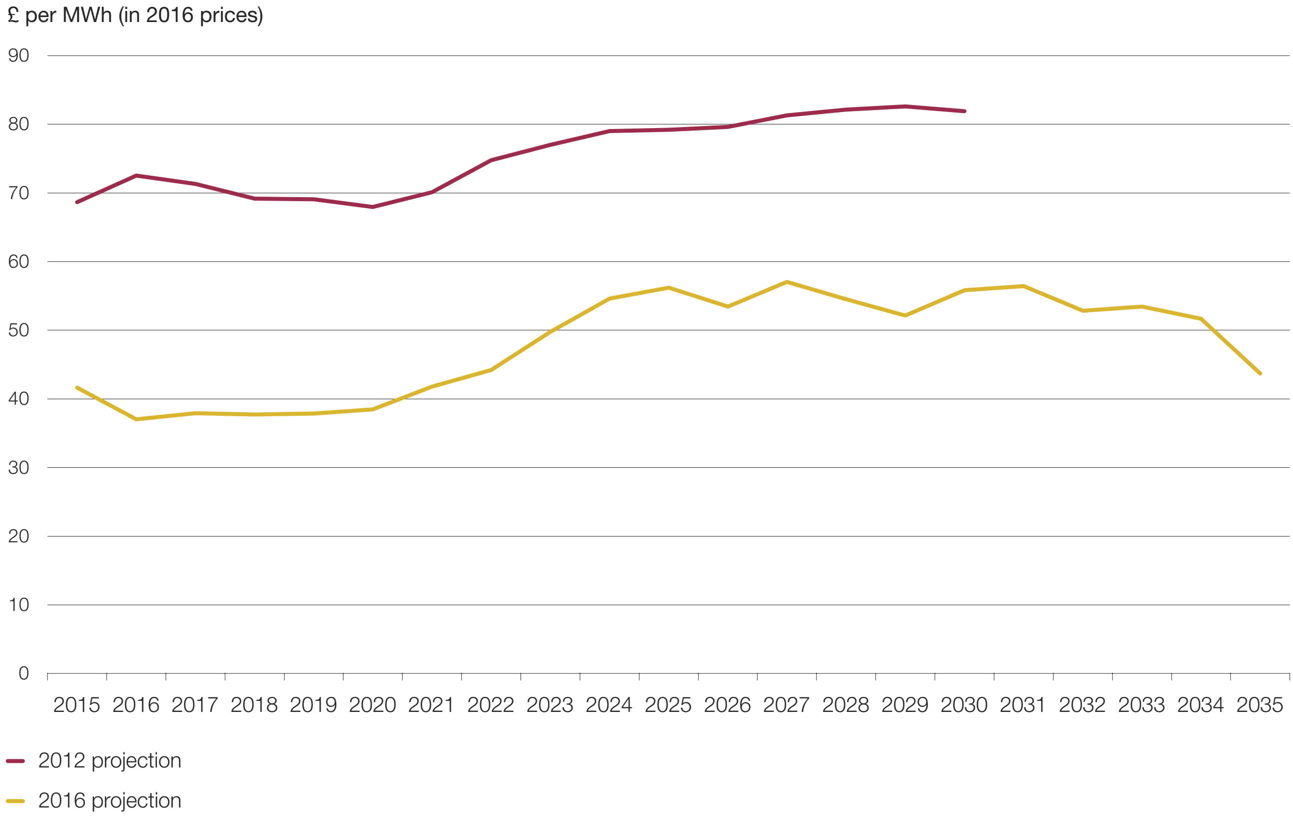
Source: National Audit Office analysis of Department for Business, Energy & Industrial Strategy data

2.23 The increase is due primarily to reductions in the expected wholesale price of electricity. The Department's latest 2016 energy projections show that the expected price of wholesale electricity will be £56/MWh (2016 prices) in 2030, a 32% fall compared with its 2012 projection **(Figure 10)**. The fall is principally attributable to reductions in the expected price of fossil fuels, particularly gas. These fossil-fuel price reductions are driven by developments in the global fossil-fuel market. For example, weaker than anticipated demand in Asia; new evidence about the supply of fossil fuels over the longer term as new sources come on line; and increased availability of relatively cheap gas from the US market.

Figure 10

The Department's projections of wholesale electricity prices, 2015 to 2035

The Department projects lower wholesale electricity prices compared with its 2012 projection



Source: National Audit Office analysis of Department for Business, Energy & Industrial Strategy data

2.24 The increased forecast of top-up payments impacts the case for the HPC deal for three main reasons:

- First, the government has considered top-up payments when making decisions about the affordability to consumers of other schemes. For the Levy Control Framework, the Department calculates the cost to consumers of CfDs based on the value of top-up payments. The government intends to set out its plans for a new set of controls of the costs of low-carbon subsidies later this year.
- Second, the increase reflects a fundamental change in the Department's and other energy analysts' expectations of future wholesale electricity prices. Although the CfD protects consumers from price volatility, it fixes the price at a level that is now more likely to be above the prevailing market price, meaning consumers benefit less from falls in wholesale prices. In 2013, wholesale prices were expected to rise further and faster, largely based on expecting fossil-fuel costs to steadily increase. There is now a consensus that fossil-fuel prices will rise more slowly, which as well as making gas power stations more cost-effective, has a knock-on impact of keeping wholesale electricity prices lower. While this change in outlook impacts all the government's CfDs, the implications are greater for HPC given the longer contract length. There is more flexibility for the government to adjust its support in future for other generating technologies where the standard CfD lasts for 15 years as opposed to the 35-year term of the HPC contract.
- Third, one of the government's aims in the way it has structured the deal is to keep HPC off the government's balance sheet. The project could, however, come onto the government's balance sheet if more than half of its revenues were forecast to be through top-up payments. The fall in expected future wholesale prices means this is more likely to happen. Our analysis shows that top-up payments were expected to be 5% of project revenues when using the Department's 2012 price projections. Latest forecasts show they will be around 25% of revenues.

Timing of HPC relative to other new nuclear projects

2.25 Since the Department began negotiating with EDF on a deal for HPC, delays to the project mean it is no longer as far ahead of the other viable new nuclear power options. In November 2012, the Department stated in its business case for supporting HPC that it expected both HPC reactors to have begun generating electricity by 2020. This start date has been pushed back over subsequent iterations of the business case to 2025.

2.26 There are two other nuclear power projects – Moorside and Wylfa Newydd – that developers currently plan to complete by the mid-2020s. When the Department finalised the deal in September 2016 there was less cause to pay NNBG a premium for building a nuclear power station before any other developers can.

The government's assessment of the weakening case for HPC

2.27 The deal has been reviewed at various times since the Department agreed key commercial terms by the Department and other parts of government.

The Department

2.28 Since agreeing the key commercial terms in 2013, the Department has re-appraised the deal against its value-for-money tests on three occasions (November 2014, October 2015 and September 2016), each time concluding positively. It also contributed to the government's review of the deal over the summer of 2016 after EDF had taken its final investment decision. As well as considering the deal's value for money, the Department assessed the impacts of the project's ownership on national security, the deliverability of HPC's technology and the geopolitical and economic implications if the deal did not go ahead.

2.29 As the overall assessment against the four value-for-money tests has become more marginal, the Department has relied more on HPC's wider, unquantified strategic benefits in deciding to proceed. From the outset of negotiations, the Department wanted the deal for HPC to have additional benefits beyond its quantified value-for-money case, including the following:

- The Department expects HPC to contribute to job creation and economic growth. EDF has stated that HPC will draw investment of £17.5 billion into the UK, creating 25,000 employment opportunities throughout construction for nearly a decade; and 900 permanent posts at the HPC power station for more than 60 years. The Department did not include the jobs and economic growth impacts of HPC in its cost–benefit analysis. Other infrastructure of similar size would also create jobs and growth, and the Department recognised the difficulty of identifying the additional impacts of HPC specifically.

- The Department hopes constructing HPC will help develop the capability of the UK nuclear supply chain and skills. EDF has announced that UK companies comprise around 64% of the value of contracts awarded.

- The Department wants doing a deal for HPC to stimulate a pipeline of investments in other new nuclear power stations, giving the UK the option of having nuclear capacity beyond HPC's 3.2 GW in future decades to support its decarbonisation and energy security objectives. The Department was unable to quantify the value of having this option, but considers it to be significant, given the UK's climate change obligations.

2.30 The achievement of wider strategic benefits is largely outside of the Department's control. For example, it is not legally feasible under EU procurement regulations for the government to impose conditions on the HPC contract to require NNBG to let a certain proportion of EDF's contracts to UK companies. Regardless of the success of HPC, other nuclear power station projects face their own commercial and technical challenges, so a pipeline of follow-on new nuclear build cannot be guaranteed. The Department currently does not have a plan for how to manage and track the realisation of wider benefits, but it is developing one.

HM Treasury

2.31 Because of the scale and risks of HPC, HM Treasury has also reviewed the case for the deal on a number of occasions (**Figure 11**). It noted the limitations to the value-for-money assessment, and the declining case, although emphasised different considerations at various times.

Figure 11
HM Treasury's reviews of the HPC deal

Review date	Findings
January 2013	HM Treasury was concerned that the proposals were expensive compared with the alternative of gas-fired power stations. It also made clear that the government had no required level of decarbonisation for the power sector by 2030, despite this being one of the Department's premises for supporting HPC.
September 2013	HM Treasury noted the proposed strike price of £92.50/MWh along with the debt guarantee which was proposed at the time were pushing towards the limits of what could be considered value for money. It concluded there was a case to pay a premium for HPC, for strategic (but unquantified) reasons, including diversity of supply, recognising the 'first of a kind' costs of HPC and wider economic impacts.
September 2015	HM Treasury highlighted delivery risks around the deal, particularly EDF's problems with obtaining financing to make its final investment decision. It also noted the risk of the project needing to be on the government's balance sheet. It did not consider the value for money of the deal at this point, but recognised the 'strong level of political commitment'.
August 2016	HM Treasury reviewed the deal and concluded that, while the value-for-money case for HPC had weakened, on balance it was worth proceeding with the deal due to the strategic and political implications of withdrawing. It also highlighted how HPC's advantage of being able to commission ahead of alternative nuclear projects had eroded as the project had been delayed, and how the expected costs of alternative generating technologies had fallen.

Source: HM Treasury advice to ministers

Major Projects Authority

2.32 The Major Projects Authority (MPA) reviewed the HPC deal on five occasions between November 2011 and September 2015.[27] The MPA works with HM Treasury and other government departments to provide independent assurance on major projects. Prior to the Department agreeing key commercial terms with EDF, it raised concerns about the Department's skills and capability in the negotiations, which led the Department to bring in additional expertise and appoint a lead negotiator. After October 2013, the MPA mainly considered risks to the Department managing the deal through to completion, such as a lack of resources or clear governance arrangements, and how the Department would manage remaining risks once the deal was completed. The MPA took assurance from the results of the Department's value-for-money tests that it was still worth proceeding with the deal.

Major Projects Review Group

2.33 The Major Projects Review Group (MPRG) reviewed the deal six times between July 2012 and October 2015. The MPRG was established within the Cabinet Office in 2007 to provide independent scrutiny of major projects and to advise HM Treasury ministers on funding decisions. MPRG can challenge projects on deliverability, affordability and value for money at key points in the HM Treasury approvals process. Its earlier reviews of the HPC deal made recommendations on the Department's negotiating approach, such as the need for a 'walk-away' price. After terms were agreed, it focused on deliverability of the deal, similarly to MPA. Its final review in October 2015 led to recommendations for the Department on its oversight arrangements once construction begins and the importance of establishing and maintaining a contingency plan in the event that HPC is delayed. It stated explicitly that it was not assessing the value for money of the deal.

27 On 1 January 2016 the Major Projects Authority merged with Infrastructure UK to form the Infrastructure and Projects Authority.

The implications of changes to the case

2.34 Even if the Department or other government reviewers had concluded after 2013 that the deal was no longer value for money, there were a number of factors that would have made renegotiating terms or abandoning it undesirable:

- NNBG's forecast construction costs have increased since October 2013 by around £1.3 billion. Consequently, its predicted return on the project fell from 9.9% to 9.0%. EDF already faced some internal objections to the terms of the deal as agreed, including from its trade unions. The Department may have found it difficult to negotiate a new deal, which caused NNBG's expected return to fall further.
- The deal was subject to clearance by the European Commission to ensure it complied with State Aid rules. The Commission approved the HPC CfD in October 2014. Changing the deal's terms may have required a new decision and resulted in further delays. The Department was concerned that nuclear deployment had already been delayed for more than a decade and further delays could create risks for energy security in the late 2020s.
- The two other developers planning to complete nuclear power projects in the mid-2020s still need to clear a number of regulatory and other hurdles before reaching final investment decision. The recent deterioration in the financial position of Toshiba, a key investor in the Moorside development, illustrates the uncertainties surrounding all new nuclear projects.
- Agreeing the strike price indicated the strong political commitment to the deal. Trying to change the terms, or threatening to walk away from the deal, could have resulted in reputational damage to the government, or had geopolitical implications, given NNBG is backed by French and Chinese state-owned companies.
- Abandoning or changing the deal at a late stage would have damaged the confidence of investors, in the energy and other sectors, to engage with the government in the future.

2.35 The HPC project demonstrates the difficulties of the government becoming 'locked in' to a deal, reducing the flexibility to renegotiate the terms or pursue alternatives when circumstances change. The Department recognised in 2013 that by agreeing the key commercial terms it may subsequently be tied to the deal even if subsequently it became clear the terms were not optimal. This is because investors need signals from the government that it is committed to any deal in order for them to engage in negotiations and fund early development costs.

Part Three

Remaining risks

3.1 The terms of the government's deal to support the construction of Hinkley Point C (HPC) include a number of mechanisms to mitigate risks to value for money. These include the arrangements to share with consumers any savings on construction costs or 'excessive' returns to investors, as discussed in Part Two. But there are significant residual value-for-money risks that the Department for Business, Energy & Industrial Strategy (the Department) must manage.

3.2 This part of the report explains the main residual value-for-money risks to consumers and taxpayers, and assesses how the Department plans to manage risks:

- during the construction phase;
- during the operational phase; and
- associated with waste and decommissioning.

Risks during the construction phase

3.3 The Office for Nuclear Regulation (ONR) approved the reactor design and granted a site licence for HPC in 2012. However, there are no examples of the European Pressurised Water Reactor (EPR) reactor technology working anywhere in the world. Other nuclear projects using this technology in Finland, France and China have been beset by delays and cost overruns:

- Construction of the first nuclear power station using the EPR design began in Olkiluoto, Finland, in 2005. It was expected to cost €3.2 billion and begin generating power in 2009. Its date of entry into service has been pushed back to 2018 at the earliest and the project is estimated to be €5.3 billion over budget.
- Flamanville, in France, the closest comparator to HPC, has been subject to ongoing delays and costs are escalating. Planned to start service in 2012, it is now running at least six years late and is more than three times over its original budget of €3.3 billion.
- Two more EPR reactors are being built at Taishan, China, and two more are planned. The first Taishan reactor was expected to start operation in 2014, and the second was to be completed in 2015, but both are at least two years behind schedule.

Further details and the reasons for delay and cost escalation are set out in Appendix Five.

3.4 EDF has sought to understand the underlying causes of the cost and time overruns at Flamanville, and has developed adaptions for HPC:

- NNB Generation Company (HPC) Limited (NNBG) will test the HPC design scheme using 4D modelling, which can verify the position and time sequencing of construction against the schedule.
- NNBG has put in place a system to manage and coordinate contractors during construction. EDF is overseeing the development of AREVA NP's (the reactor designer) quality improvement plan to improve reliability of the manufacturing process.
- When quality issues were detected at the AREVA NP forge, it was decided an alternative supplier should manufacture some parts for HPC to avoid delays. A detailed review of processes at the AREVA NP-owned forgings plant at Le Creusot has resulted in reinforced internal quality processes being used for all parts produced for HPC.
- There are programmes for skills development for both contractor and EDF staff to respond to the skills issues encountered at Flamanville.

Whether these adaptions will mean that the problems at these sites will not be repeated at HPC will only become clear during the construction phase of HPC.

3.5 Under the terms of the contract for difference (CfD), the risks that the project is delayed or costs more than expected sit with NNBG, because it only receives payments through the CfD once HPC is operating.[28] But if the project does face problems the government may:

- come under pressure from NNBG or its investors to renegotiate the terms of the deal; and/or
- need to find alternative means of ensuring energy security.

28 There is a small chance that taxpayers will be exposed to some risk if NNBG decides to take up its option of the guarantee (see 1.4). The government has recourse to the shareholders of NNBG in case of a default. NNBG has paid the government an upfront fee of £10 million for the guarantee and is paying an annual commitment fee of 0.25%. Any draw-downs under the guarantee would pay an annual fee of 2.95%.

3.6 There are many examples from previous government projects where risks were originally allocated to private investors, but the government later had to step in and take on more risk or cost (**Figure 12**). As well as exposing consumers and taxpayers to more costs and risks, this increases the likelihood that assets are brought onto the government's balance sheet, which would mean making spending reductions in other areas to stay within fiscal constraints.

Figure 12

Examples of government projects where the government had to take on more risk than it first planned

Project	Intended risk allocation	Outcome
High Speed 1	A private sector contractor would finance, build and operate HS1, with a direct government grant towards construction.	When the demand fell far short of forecasts, the contractor was unable to raise sufficient finance for the project. The government agreed to guarantee the debt required to construct the line, exposing taxpayers to the risk that passenger revenue was lower than expected.
Metronet	Metronet was a public–private partnership established to modernise London Underground's infrastructure. The government aimed to transfer the risks of delivering the network upgrade to the private sector, with contracts that specified the time, cost and required performance.	Poor governance led to Metronet facing financial difficulties, with it eventually going into administration. Transport for London had to step in to repay Metronet's outstanding debt obligations, using a £1.7 billion government grant.
The construction of nuclear submarine facilities at Devonport	Private investors bore all the risks, including the risk of cost overruns.	In August 2002, when the cost increased significantly, the Ministry of Defence (MoD) had to meet the extra cost.
A400M military transport aircraft	The MoD signed a fixed-price contract with the supplier in May 2003.	Suppliers under-priced the A400M and are late with delivery, but the MoD agreed to amend the contract. As a result, it will receive 22 A400M aircraft, rather than the 25 expected originally.

Sources: 1. Comptroller and Auditor General, *The completion and sale of High Speed 1*, Session 2010–12, HC 1834, National Audit Office, March 2012; 2. Comptroller and Auditor General, *The failure of Metronet*, Session 2008-09, HC 512, National Audit Office, June 2009; 3. Comptroller and Auditor General, *Ministry of Defence: The Construction of Nuclear Submarine Facilities at Devonport*, Session 2002-03, HC 90, National Audit Office, December 2002; 4. Comptroller and Auditor General, *Major Projects Report 2015 and the Equipment Plan 2015 to 2025*, Session 2015-16, HC 488, National Audit Office, October 2015; 5. Comptroller and Auditor General, *Major Project Report 2014 of the Equipment Plan 2014 to 2024*, Appendices and Project Summary Sheets, Session 2014-15, HC 941-II, National Audit Office, January 2015

3.7 NNBG may request a renegotiation of the deal's terms if the project runs into difficulties and its investors are unable to provide additional support for the project. EDF's financial position has weakened in recent years, resulting in reductions to its credit rating. EDF has posted persistent negative cash flows with higher levels of capital expenditure than expected and earnings below financial analysts' expectations. In April 2016 the company announced a detailed strategy to address this financial stress. This included a reduction in investments and operating expenditure, a large asset disposal plan, dividends to the French State being paid in shares until 2017, and a €4 billion capital injection, of which €3 billion will come from the French State. EDF also announced a plan through to 2030 for upgrading and operating its fleet of nuclear reactors in France. This may cost as much as €100 billion and overlaps with the planned construction of HPC. Any substantial further deterioration of EDF's financial profile could escalate to a discussion about its ability to fund construction of HPC.

3.8 Delays and cost escalation could also happen for reasons outside the project itself. The Austrian government is challenging the European Commission's ruling that the deal complies with State Aid rules. If this challenge is upheld, which the Department considers is unlikely, the project could be subject to delays while new terms are agreed. The project could also be delayed and/or cost significantly more if there is a major nuclear incident anywhere in the world, like Fukushima in 2011, which may require additional safety measures to be built into HPC's design.

3.9 The government will hold a stronger negotiating position if it maintains alternative ways of ensuring energy security if HPC runs late or is not completed. The Department's contingency plan to ensure there is enough grid capacity to compensate for delays to HPC is to incentivise the construction of new power generators through the Capacity Market and/or to extend the lives of existing fossil fuel and nuclear power stations.[29] Some of these alternatives require significant advance notice to be put into operation – for instance it takes around four years to build a gas-fired power station. Furthermore, such short-term actions may prove to be costly in the long run if they result in unnecessary excess capacity once HPC is built. On the other hand, some options would not lock in unnecessary excess capacity, such as a life extension to a gas-fired plant.

29 The Capacity Market provides an insurance policy against the possibility of power shortfalls. It is designed to ensure capacity is available by offering payments to all capacity providers. In return, providers must be able to deliver power when needed or face penalties.

The Department's oversight plans

3.10 The Department has put in place oversight plans for the construction phase to ensure that consumers benefit from the construction gain-share mechanism. The Department also plans to use its oversight arrangements to ensure it is aware early of any problems that could mean it needs to deploy alternative ways of maintaining energy security.

3.11 The Low Carbon Contracts Company (LCCC), the counterparty body to the CfD, is a government company wholly owned by the Secretary of State for Business, Energy & Industrial Strategy with primary responsibility for monitoring the project's progress. The CfD provides LCCC with rights to certain information, so it can manage the contract:

- LCCC has the right to inspect the books and records of NNBG and request any information related to CfD and milestone requirements. This includes board meeting packs, papers and documents to shareholders and information about financial, business or operating conditions.
- NNBG is in the process of preparing its systems to be able to report on physical progress and actual costs against the baseline schedule and budget. Once this is done, NNBG will provide monthly information packs showing the project's progress. Additionally, there are a series of planned one-off reporting requirements around major milestones.

3.12 A series of quarterly and annual governance meetings will take place involving the Department, other government parties and NNBG (**Figure 13** overleaf).

3.13 It is too early to reach conclusions on the effectiveness of the government's oversight arrangements. We have, however, assessed the planned arrangements against good practice principles, highlighting the main remaining risks, which are likely to change over time as the project progresses (**Figure 14** on page 51).

Figure 13
Programme review meetings

	Cross-government review meeting	Review meeting with NNBG	Secretary of State review meeting
Purpose	To review and analyse information collated on HPC to inform other review meetings; to escalate issues on milestones not met	To review progress and address issues directly with NNBG[1]	To review progress on HPC as well as on broader issues including progress on Taishan and Flamanville
Frequency	Quarterly	Quarterly	Annual
Attendees			
Department for Business, Energy & Industrial Strategy (BEIS)	✔	✔	✔
Secretary of State for BEIS			✔
HM Treasury	✔	✔	
Infrastructure and Projects Authority	✔	✔	
UK Government Investments Limited	✔	✔	
Civil Nuclear and Resilience Directorate (part of the Department)	✔	✔	
Low Carbon Contracts Company (LCCC)	✔	✔[2]	✔
NNB Generation Company (HPC) Limited (NNBG)		✔	
EDF			✔
China General Nuclear Power Group (CGN)			✔

Note

1 There will also be an annual meeting between government representatives and NNBG's non-executive directors to review progress

2 LCCC will only attend the Secretary of State review meetings at BEIS's request.

Source: National Audit Office

Figure 14

Assessing the government's oversight plans

Good practice principle	The plan for HPC	Remaining risks
Clear roles and responsibilities	LCCC is the first line of oversight, but will escalate any problems with the project to the Department and Secretary of State.	If the project runs into problems there may be conflicting interests in government about who is responsible for representing consumers' and taxpayers' interests.
A clear separation between sponsor and delivery body	The Department, as the government sponsor for the project, is clearly separate from NNBG as the developer. The Department is reliant on the LCCC for overseeing the project. LCCC will have a dedicated team to oversee the HPC project.	LCCC must be able to challenge NNBG's compliance with its obligations under the CfD and the Secretary of State Investor Agreement (SoSIA), particularly if it considers that financial reporting of costs are overstated. LCCC will have access to the services of technical and financial advisers.
A critical path on involving governance arrangements	There is currently no critical path map for the transition between construction and operational phases. Most governance arrangements focus on monitoring the construction phase.	LCCC has a right to request further monitoring information from NNBG. However, there is currently no plan for how these reporting arrangements will evolve as the project passes through the various stages of construction and operation.
Sufficient skills and knowledge base	LCCC aims to recruit a skilled team with skills in managing complex contracts.	LCCC is able to draw on the support of experienced technical and financial advisers with track records in infrastructure projects. However, it will have to sustain skills and knowledge for many decades to maximise consumers' value. The technical professional advisers will need to have the necessary access and detailed knowledge to understand fully NNBG's construction costs.
A swift response mechanism to escalate issues	LCCC intends to escalate indications of problems on the project to the Department, which will then consider how to address the situation.	The Department does not have a plan showing how it would respond to problems on the project of different levels of severity. Limiting government and consumer losses requires maintenance of a clear 'Plan B', with triggers for activating it.
A 'project representative' to sit in the delivery body (LCCC) to provide the Department and Secretary of State with assurance about the project's progress[1]	The Department does not have a project representative in LCCC. It has set up LCCC in response to investors' requirement for CfDs to be managed by an independent counterparty, separated from government. It considers that having a project representative would compromise LCCC's independence from government.	The Department is reliant on LCCC gathering and interpreting information to enable timely escalation of problems. A project representative within the team managing the HPC contract is one option that could provide the Department with additional assurance that LCCC is receiving the right information from NNBG and is escalating evidence of any issues with the project.

Note

1 We have reported on the role of project representatives in previous reports on major transport projects, including HS2 and Crossrail.

Source: National Audit Office

Risks during the operational phase

3.14 There are risks beyond the construction phase of HPC that the Department must manage. The contractual arrangements for HPC contain clauses to maximise its value for electricity consumers, while simultaneously ensuring NNBG's rate of return remains fair. These arrangements make the HPC contracts far more complex than other low-carbon generation CfDs (**Figure 15** and **Figure 16** on page 54). It also lasts longer, with a 35-year term compared with the 15 years typical for other CfDs, and is far larger. The expected cost of top-up payments is broadly equivalent to the forecast cumulative cost of top-up payments for all of the other CfDs the government has signed to date for other low-carbon generating technologies.[30]

3.15 Many government infrastructure contracts include a compensation clause to protect investors and lenders from political shutdown events. But the HPC SoSIA covers a wider range of possible circumstances throughout the term of the CfD. The compensation liabilities could be very substantial because the project is being financed entirely by NNBG's shareholders and not, like most other infrastructure projects with a government contract, by external debt. The required returns on equity are normally higher than on debt, and the amount paid in compensation would need to reflect the higher return expected on a 100% equity investment. The Department has calculated that the compensation the government would need to pay NNBG in the event of a shutdown event could be up to £22 billion (in 2012 prices).

3.16 The SoSIA also makes HPC distinct from other low-carbon power projects with a CfD in that it means taxpayers could potentially be liable to compensate the developer in some circumstances, rather than electricity consumers. Taxpayers would also have to meet the costs over and above the first €1,200 million that resulted from a nuclear accident at HPC as this is the amount that international and UK law requires nuclear operators to insure.

3.17 As part of the UK's decision to leave the European Union, the UK government announced in January 2017 its intention to withdraw from the European Atomic Energy Community (Euratom), a pan-European atomic energy regulator. Exit from Euratom will have wide-ranging implications for the UK nuclear industry, the deal for HPC and future deals to support new nuclear build. In particular, withdrawal from Euratom might be interpreted as a change of law that could result in an adjustment to the terms of the HPC CfD, or an event that could trigger the compensation clause in the SoSIA. At the time of the decision to withdraw from Euratom, the Department had not performed any assessments of the effects of withdrawal or the risks arising from the decision.

30 HPC will generate broadly the same amount of power as these 40 CfDs: the annual generation output from HPC will be around 26 terawatt hours (TWh), while the first 40 CfDs are expected to generate around 30 TWh a year.

Figure 15

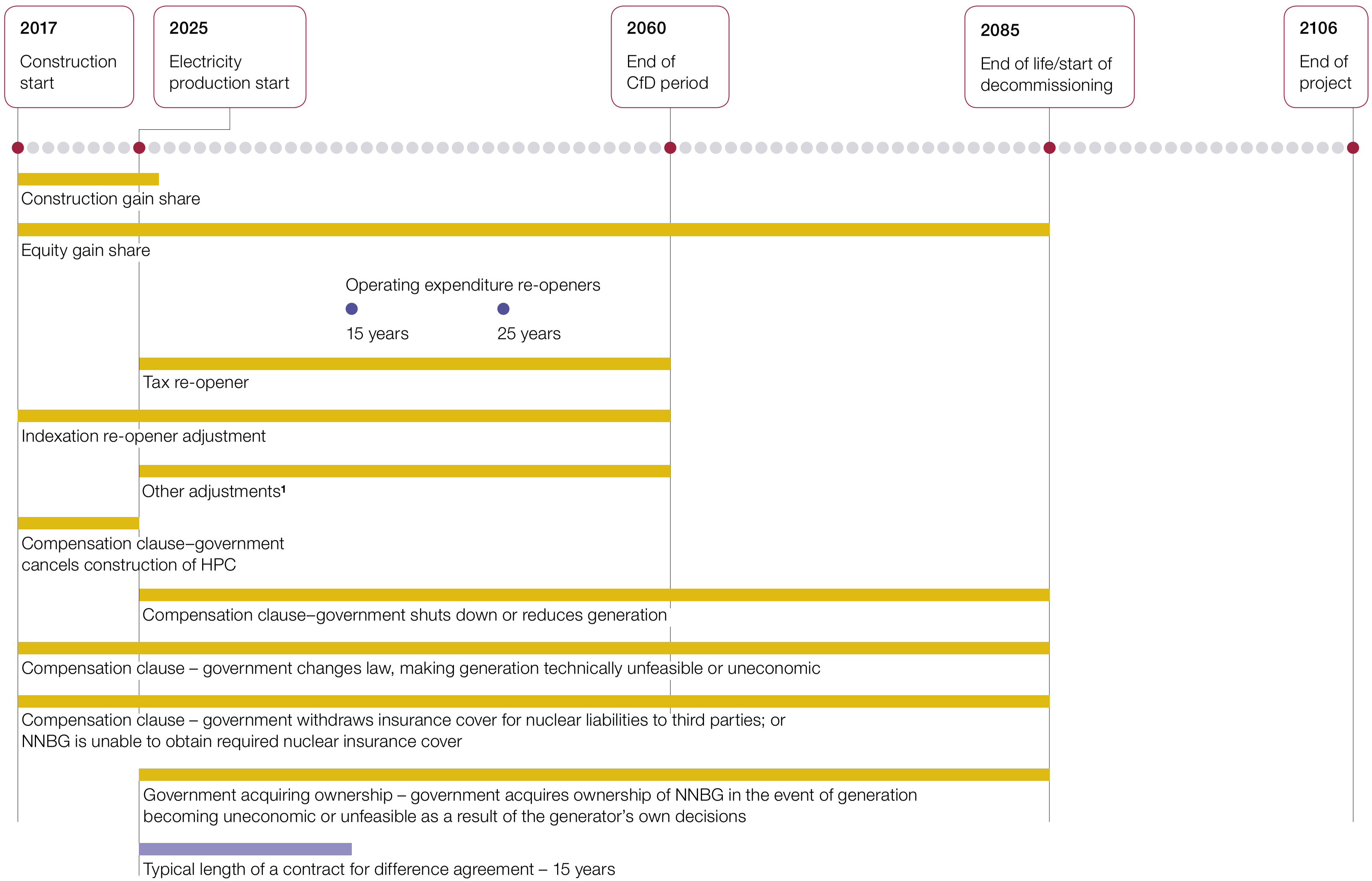
Main clauses in the HPC contracts that could impact consumers and taxpayers

Contract	Clause	Description
CfD – between NNBG and the Low Carbon Contracts Company (LCCC)	Construction gain share	The first £1 billion of construction gain (nominal value) will be shared between the LCCC and NNBG on a 50:50 basis. Any construction gain in excess of £1 billion (nominal value) will be shared with 75% going to the LCCC and 25% going to NNBG.
	Operating expenditure re-opener	Mitigates long-term cost risks for both parties due to the uncertainty of operating expenditure at HPC. Adjustments occur 15 and 25 years after the first reactor begins generating. Risks and benefits of under/over costing in the forecasts is taken by NNBG until the reopening date.
	Tax re-opener	Protects LCCC if actual tax paid by NNBG is lower than expected, in circumstances relating to shareholder funding and tax structuring of NNBG.
	Indexation re-opener	The CfD strike price may be readjusted on a revenue-neutral basis should the capital structure of NNBG change.
	Other	There are additional mechanisms that allow for adjustments of the strike price to keep NNBG's finances in a positon where it is no worse nor no better off than its position on the agreement date, for example, to counteract changes to network charges and changes in business rates. The contract terms also mean that NNBG continues to receive revenues even where HPC's power is not needed on the grid, for example at times of excess supply.
Secretary of State Investor Agreement (SoSIA) – between all parties in the deal, including the Secretary of State, the LCCC, NNBG and its shareholders (EDF and CGN)	Equity gain share	Consumers share in the proceeds if the investors' returns over the operating life of the project are higher than expected. If the return is above 11.4%, (in nominal terms), the gain is shared in the proportion 30:70 between consumers and NNBG respectively. If the return is above both 13.5% (in nominal terms) and 11.5% (in real terms), the gain is shared 60:40 between consumers and NNBG respectively.
	Compensation clause	The government will pay compensation to the investors should future governments or regulators seek to: • cancel the construction of HPC; • subsequently shut down or reduce generation; • introduce changes in law which would make continued generation technologically unfeasible or uneconomic; and • withdraw insurance cover for nuclear liabilities to third parties, or NNBG is unable to obtain required nuclear insurance cover, for reasons other than its own claims record or default on its insurance arrangements. The investors would receive their future expected returns on the project. Under the SoSIA, the government underwrites payment of compensation by LCCC. The clauses operate throughout the term of the CfD or SoSIA, essentially 35 years after the start date for the relevant reactor. The clause would not apply if any of the above events were on grounds of protecting health, nuclear safety, security, environmental, nuclear transport or nuclear safeguards related matters.
	Government acquiring ownership	The government would acquire ownership of NNBG in the event of generation becoming uneconomic or unfeasible as a result of the generator's own decisions, meaning it would also take on the liabilities for decommissioning the plant. If NNBG's shareholders cease funding the project, the government could take ownership of HPC and the power it produces, although it would be challenged to build and operate the plant without input from EDF and AREVA NP.

Source: National Audit Office

Figure 16

Period of applicability of different contract clauses



Note

1 There are additional mechanisms that allow for adjustments of the strike price, such as to counteract changes in electricity grid and other related support charges, and business rates.

Source: National Audit Office

Waste and decommissioning risks

3.18 The Department is responsible for managing, decommissioning and treating radioactive waste from the UK's fleet of retired nuclear power stations, reprocessing of spent fuel, and military and research activities. This currently costs taxpayers around £3 billion a year and is expected to cost some £120 billion over the next 100 years (undiscounted and in 2016 prices).[31] The Department wants to avoid exposing taxpayers to the costs of dealing with waste and decommissioning at new nuclear power stations and requires developers to pay for these costs.

3.19 NNBG expects decommissioning and waste management and disposal operations to cost £7.3 billion (in 2016 prices) and end by 2151 (**Figure 17** overleaf). The Nuclear Decommissioning Authority (NDA) has reviewed this estimate in its capacity as adviser to the Department. The NDA concluded that the estimate provided an appropriate conservative provision.

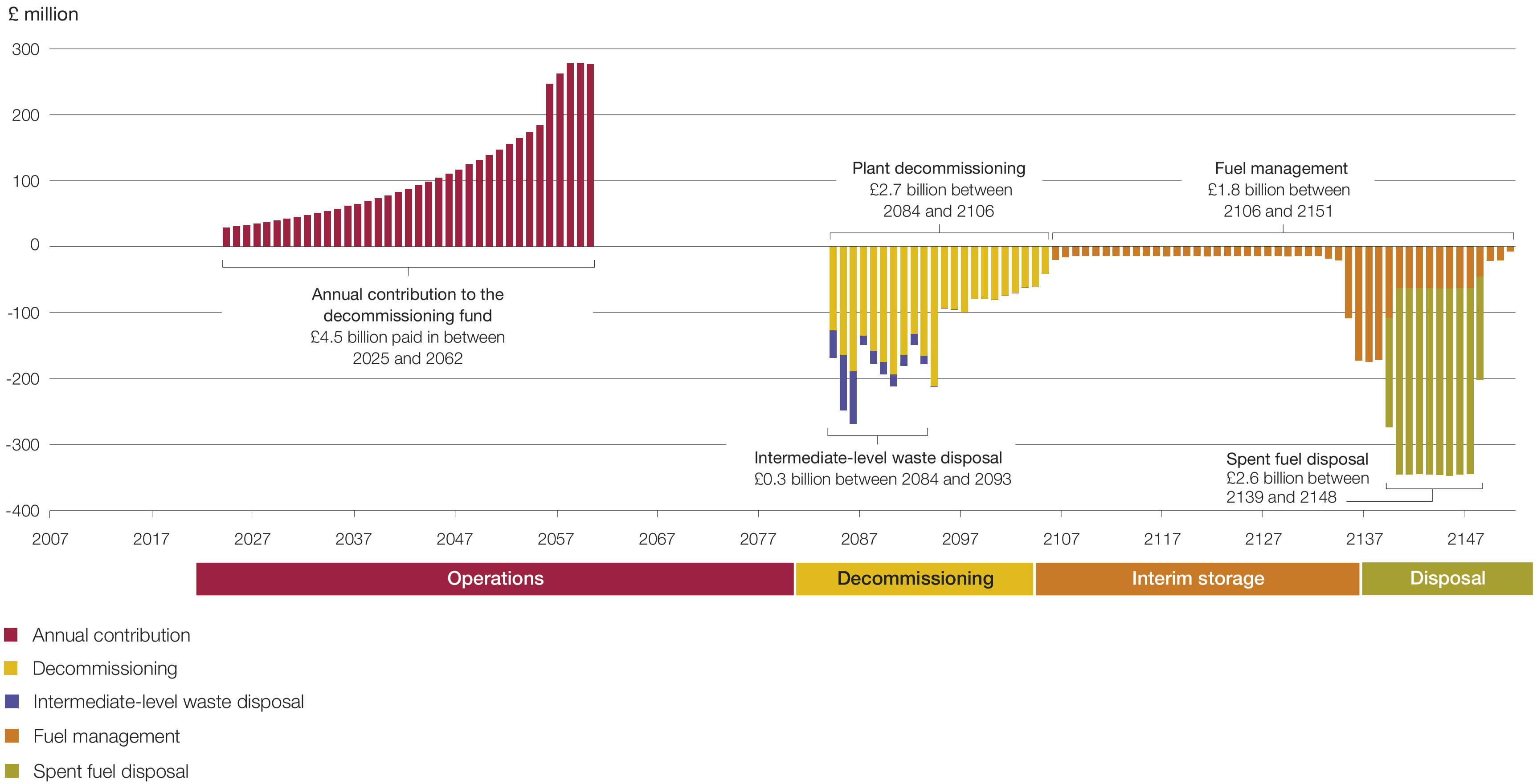
3.20 The HPC deal includes arrangements aimed at ensuring NNBG meets the costs of dealing with its nuclear waste and of decommissioning the facility. The Department requires NNBG to set up a Funded Decommissioning Programme that will ensure it has the funds in place to pay the full costs. NNBG plans to build the fund by setting £4.5 billion (in 2016 prices) of revenues aside during operations, which will be reinvested to generate a return that will cover the entire cost. NNBG and the Department will keep the fund under review, leading to NNBG adjusting its contributions to keep the fund on track if, for example, decommissioning costs increase or the fund underperforms.

31 Department of Energy and Climate Change, *Annual Report & Accounts 2015-16*, Session 2016-17, HC 327, July 2016.

Figure 17

NNBG estimates of decommissioning and waste management costs and timeline (2016 prices)

The majority of decommissioning costs will be incurred decades after NNBG completes payments into the fund



Notes

1 Cost estimated using the P80 method, which means there is an 80% chance that actual costs will be below these figures.

2 The decommissioning fund should be fully committed by the end of the CfD in 2060. It will then be managed for 20 years to ensure it will be large enough to cover all decommissioning costs when they start arising (in 2084).

Source: National Audit Office analysis of NNB Generation Company (HPC) Limited data

3.21 There are some risks associated with the decommissioning and disposal operations:

- **Uncertainty over waste disposal costs**. The Department agreed to dispose of radioactive waste from HPC. According to current estimates, this will cost £2.9 billion (in 2016 prices).[32] The Department will set the final price in 2050 but, to avoid an unquantifiable liability on NNBG's balance sheet, it has capped the price at £5.9 billion (in 2016 prices). The actual costs are highly uncertain because the Department does not know where it will site a Geological Disposal Facility to store the waste, or how much it will cost. If actual costs are above the price cap taxpayers may be liable, although the Department set the cap substantially higher than the central estimate of its costs to mitigate this risk.
- **Insufficient funds**. NNBG currently estimates that its fund will be sufficient to meet the waste and decommissioning liabilities 37 years after HPC starts generating electricity. There are two circumstances where HPC may stop generating before the fund is sufficient to meet liabilities. First, if a change in government policy forces NNBG to close HPC, taxpayers would pay for liabilities unmet by the fund. Second, technical problems may force NNBG to shut down the plant if the costs to resolve the issues are high, although this risk is lower during the CfD period, when revenues are guaranteed. The fund is expected to cover all liabilities by the end of the CfD period, and NNBG's investors are liable to pay for any liabilities unmet by the fund in this scenario. But the liability would transfer to taxpayers if the investors are unable to contribute to the fund.
- **Early transfer**. NNBG can transfer the responsibility for managing spent fuel waste to the government prior to its disposal, but will need to pay a lump sum from its fund to do so. This could lead to the Department managing the waste and the fund for several decades. There is a risk that the government opts to invest the fund in other areas, meaning it needs to find new funding sources when it comes to disposing of the waste.

3.22 The Department's arrangements for ensuring developers cover the costs of dealing with waste and decommissioning could contribute to limiting future nuclear projects to a small number of state-owned companies. Payments to the Funded Decommissioning Programme must be made before debt repayments and dividends. NNBG found that this made it more difficult to obtain project finance for HPC, meaning it had to fund the project through equity. There are likely to be very few other entities with sufficient financial capacity to meet the large upfront costs of building a nuclear power station without outside investment, and those that can are mainly state-owned. Even if there are other parties willing to invest equity, the required returns are likely to be higher than for debt, increasing the overall project cost.

32 This includes both spent fuel and intermediate-level waste.

Appendix One

Our audit approach

1 In September 2016, the Department for Business, Energy & Industrial Strategy (the Department) reached a deal with EDF and China General Nuclear Power Group (CGN) to support investment in Hinkley Point C (HPC). We examined the rationale for the project and the risks to value for money from this deal. We reviewed:

- the government's case for supporting HPC and nuclear power;
- the implications of policy choices to the costs of the deal, electricity bills and taxpayers;
- the value-for-money tests applied to the changing business cases;
- the Department's negotiating position and approach; and
- the residual value-for-money risks and how the Department intends to manage them.

2 The report follows up our report *Nuclear power in the UK*, which set out the electricity system challenges that the UK faces in the coming decades and the background to the HPC deal.[33]

3 Our evaluative criteria addressed the Department's rationale for supporting HPC, and the strength of the evidence informing its decision; the costs of the project and its affordability to consumers; and the adequacy of the measures that the Department is taking to protect consumers and taxpayers from residual risks of the deal over the lifetime of HPC.

4 Our audit approach is summarised in **Figure 18**. Our evidence base is described in Appendix Two.

33 Comptroller and Auditor General, *Nuclear power in the UK*, Session 2016-17, HC 511, National Audit Office, July 2016.

Figure 18
Our audit approach

The objective of government

The government aims to maintain a secure and resilient supply of electricity to power the UK while, at the same time, keeping energy bills as low as possible for households and businesses, and supporting ambitious greenhouse-gas emission reduction targets.

How this will be achieved

The government's Electricity Market Reform (EMR) programme is aimed at delivering the expansion of secure, low-carbon and affordable sources of electricity. HPC and a follow-on programme of new nuclear build form an important part of the government's strategy to establish a 'balanced mix' of generating technologies over the longer term.

Our study

Our study examines the strength of the Department's case for supporting HPC, the costs of the project and the adequacy of the measures that the Department has taken to help ensure it is affordable to consumers and taxpayers; and residual value-for-money risks that need to be managed.

Our evaluative criteria

There is a compelling case for supporting new nuclear build that aligns with the government's decarbonisation objectives; and is at least cost to consumers and taxpayers.

The decision to proceed with HPC is informed by a balanced assessment of strategic, economic, affordability and deliverability considerations.

The government has identified residual risks to value for money, and has robust arrangements to mitigate those risks.

Our evidence

(see Appendix Two for details)

- Financial analysis of the Department's and NNB Generation Company (HPC) Limited's (NNBG's) financial model for HPC.
- Review of the Department's affordability modelling.
- In July 2016, our report, *Nuclear power in the UK*, described the background of the government's nuclear strategy.
- Review of the Funded Decommissioning Programme for HPC, and supporting analysis and modelling.
- Interviews with officials from the Department and HM Treasury.
- Interviews with energy sector stakeholders.

- Review of the Department's business cases, and supporting analysis and modelling.
- Review of the Department's strike price setting methodology and calculation models.
- Document review.
- Interviews with officials from the Department.
- Interviews with energy sector stakeholders and academics.

- Review of final contracts.
- Review of Major Projects Authority and Major Projects Review Group reports.
- Review of the Funded Decommissioning Programme for HPC, and supporting analysis and modelling.
- Document review.
- Interviews with government officials from the Department, HM Treasury and the Low Carbon Contracts Company.
- Interviews with energy sector stakeholders.

Our conclusions

See paragraphs 25 and 26.

Appendix Two

Our evidence base

1 We reached our independent conclusions on the Department for Business, Energy & Industrial Strategy's (the Department's) deal to support construction of the Hinkley Point C (HPC) nuclear power station and whether the project represents value for money following our analysis of evidence collected between October 2016 and March 2017.

2 Our audit approach is outlined in Appendix One.

3 We outlined the government's deal to offer a contract for difference (CfD) and a debt guarantee to NNB Generation Company (HPC) Limited (NNBG) (Part One):

- We interviewed officials from the Department, HM Treasury and energy sector stakeholders, including industry representatives and academics, to assess the UK's electricity system challenge and the strategic importance of nuclear energy in helping to meet that challenge.
- We interviewed officials from the Department and HM Treasury to understand the terms of the deal that it reached to support the construction of HPC.
- We reviewed contracts and other supporting information to understand the terms of the deal and expectations with respect to costs and performance.
- We obtained information from the Department and EDF to calculate the costs of the deal to the project's developer, consumers and taxpayers.

4 We reviewed the government's case for proceeding with a deal for HPC (Part Two):

- We interviewed officials from the Department to understand the business case for proceeding with a deal to support the construction of HPC.
- We reviewed the Department's business cases, and accompanying analysis and modelling, to assess the strength of the evidence base supporting the case to proceed with a deal for HPC.
- We analysed the Department's and NNBG's financial model for HPC to assess the returns offered by the deal and how that impacts the strike price required.
- We calculated the top-up payments that will be paid under the HPC CfD across a range of wholesale electricity price scenarios.
- We obtained information from HM Treasury about its assessments of the deal.

5 We considered the remaining risks of the deal to value for money and how the Department plans to manage them (Part Three):

- We interviewed officials from the Department, the Low Carbon Contracts Company and HM Treasury to assess the remaining risks that the deal poses for electricity bill-payers and taxpayers; and the government's plans to mitigate those risks.
- We examined previous National Audit Office reports to identify projects where the government had to take on more risk than it first planned and best practice in departments' oversight of major projects.
- We interviewed officials from the Department and reviewed design and implementation documents to assess the plans to fund waste treatment and the decommissioning of HPC; and protect consumers and taxpayers from any exposure to funding shortfalls that may occur in the future.

Appendix Three

LeighFisher potential conflict of interest

LeighFisher's role

The Department paid LeighFisher £1.2 million to provide advice on the deal. This largely involved providing technical services to verify whether EDF's construction cost estimates were reasonable. This exercise helped to inform the Department's negotiations with EDF on an appropriate strike price for the contract for difference (CfD) that would enable NNB Generation Company (HPC) Limited (NNBG) to achieve a fair return on those costs.

Two separate tender exercises were held in 2012 and 2015. The Department used the Ministry of Defence (MoD) Framework Agreement for Technical Support (FATS) to identify potential contractors to invite to tender from the framework and MoD's expertise to identify competent technical nuclear advisers.

Potential conflict of interest

Jacobs Engineering Group, the owner of LeighFisher, had provided engineering and project management services, including seconded staff, to EDF in relation to the HPC deal.

The Department's initial assessment of the potential conflict of interest (2012)

LeighFisher notified the Department of a potential conflict of interest in its proposal for the work in 2012, which meant the Department was aware of the potential conflict from the outset of the engagement. The Department placed the onus on LeighFisher to manage the potential conflict of interest. LeighFisher assured the Department that the proposed team for the cost discovery exercise was independent from the work with EDF.

The Department's revised assessment of the potential conflict of interest (2015)

The Department reappointed LeighFisher in 2015 following a competitive tendering process. In August 2015, it wrote to LeighFisher setting out a draft agreement for 'ethical wall arrangements' and asking for assurance that LeighFisher was setting up such arrangements. This includes all the necessary safeguards to manage the potential conflict of interest, such as:

- 'organisational separation' between LeighFisher's HPC team and the rest of Jacobs Engineering Group's subsidiaries;
- all HPC team sign confidentiality agreements;
- only add further team members with the Department's agreement; and
- provide monthly evidence of the paper and electronic information barriers in place and that the HPC team was kept separate from the Jacobs team.

LeighFisher only signed the agreement for 'ethical wall arrangements' in October 2015.

Conclusions

The arrangements the Department put in place to manage the potential conflict of interest were insufficient:

- The Department did not stipulate to LeighFisher the arrangements required to manage the potential conflict from the outset of the engagement in 2012. This means there was no active consideration or assurance that the conflict of interest did not have an impact on LeighFisher's work. The Department has told us that LeighFisher had input from Jacobs' employees during its cost verification exercise. Placing the onus on LeighFisher to manage the potential conflict is not in line with good practice, particularly given the significance of its advice for guiding negotiations of the HPC deal.
- By the time LeighFisher did confirm it was complying with arrangements stipulated by the Department, it had already completed the majority of its work. The Department did not receive any monthly updates on the arrangements in place, as it had requested. LeighFisher subsequently provided confirmation that there were no breaches of the ethical wall measures agreed in October 2015.
- Even when the Department did stipulate ethical wall arrangements, they were below the standard we would expect in this sort of engagement. For example, it is common to demand physical segregation of the paper and electronic information related to a project from the rest of the office, a demand not made by the Department. There was also no requirement for the return or destruction of information at the end of the project.

Appendix Four

Alternative financing options and implications

1 This appendix reviews possible alternative financing options for Hinkley Point C (HPC) and the impact on the strike price. This analysis is indicative and should only be used to give a high level picture across the different options. We have not assessed the feasibility of applying these models for HPC nor whether they would comply with HM Treasury guidance or receive State Aid clearance. We recognise that some of the models have not been used before for nuclear power projects. Our analysis does not account for all the potential additional costs to taxpayers of these models. Our intention is to demonstrate that different models could have had significant cost implications and therefore could have achieved better value for money for consumers. Any potential cost reductions would need to be balanced against the possible downsides, particularly taxpayers and/or consumers being exposed to some or all of the risk that the project goes over budget.

2 **Figure 19** presents a summary of our analysis and **Figure 20** on page 68, **Figure 21** on page 69, **Figure 22** on pages 70 to 71 and **Figure 23** on page 72 provide more details on each alternative and the underlying assumptions. The strike price calculations for each scenario assume the government does not achieve a profit from the investment (its project return is equal to its cost of capital). For the calculation of the strike price this means that it is set such that the government achieves a zero net present value on its investment and breaks even. The strike prices are shown as a range depending on the wholesale electricity price forecasts used. The analysis maintains the agreed 35-year contract for difference (CfD) structure to make the strike price between the scenarios more comparable. In reality, alternative financing options could result in wider changes to the contractual agreements.

3 The scenarios are based on the financial model the Department used to assess the investors’ returns from HPC. As a result, the scenarios do not reflect any changes to the cost or revenue an alternative financing scenario may entail, such as changes to construction, operational, or decommissioning costs or tax.

Figure 19

Summary table: alternative financing options and implications

Deal Type	Description	Case	Investors' return (post-tax nominal)	Cost to taxpayers during construction[3]	Risk sharing: Construction	Risk sharing: Operational	Risk sharing: Financial	Strike price (£/MWh): Low[4]	Strike price (£/MWh): High[4]
HPC deal-type structure	Private investors finance, build and operate the project for its entire duration	100% private risk	12%	£0	No	No	No	135.00[5]	137.00[5]
		HPC	9%	£0	No	Shared	No	91.00	95.00
		100% public risk	2%	£18 billion	Yes	Yes	Yes	-6.00	27.50
		Partnership return (WACC)	**Government equity share**	**Cost to taxpayers during construction**	**Construction**	**Operational**	**Financial**	**Low**	**High**
Public-private partnership	A partnership between government and private investors where the government participates with equity capital in the project. We assume the government can borrow at 2% (nominal) to finance the project, while private investors would earn the same return as the HPC project (9%). Example government projects: Thameslink; Eurostar.	7.25%	25%	£4.3 billion	Shared	Shared	Shared	69.50	76.00
		5.50%	50%	£8.8 billion	Shared	Shared	Shared	48.50	59.50
		3.75%	75%	£13.1 billion	Shared	Shared	Shared	25.00	44.00

Deal Type	Description	Government return	Private investor return	Cost to consumers during construction	Risk sharing			Strike price (£/MWh)	
					Construction	Operational	Financial	Low	High
Hybrid regulated asset base model	The government agrees to provide investors with a return during construction. Consumers' energy bills would increase during the construction period. Two scenarios:								
	• Consumers are reimbursed if the project is not completed. Investors bear similar construction and operational risk as the current HPC deal. We assume a 9% return.	–	9%	£9.3 billion, an average of £5.50 per household per year during construction	No	Shared	No	63.50	67.50
	• Consumers share the construction risk with investors and do not get compensated for failure to complete or costs overrun. We assume a 7% return.	–	7%	£7.3 billion, an average of £4.50 per household per year during construction	Shared	Shared	Shared	51.00	58.00
	Example government project: Thames Tideway Tunnel								

Deal Type	Description	Government return	Developer return	Cost to government in 2025	Risk sharing: Construction	Risk sharing: Operational	Risk sharing: Financial	Strike price (£/MWh): Low	Strike price (£/MWh): High
Engineer, Procure & Construct ('EPC' or 'turnkey')	The government contracts a private company to finance and build HPC, agreeing to buy the plant at the end of construction at a pre-agreed price. The government would then become the owner and operator for the operating life of the plant. The developer would bear construction risks. We assume investors would require a return between 14% and 17%. We assume the government can borrow at 2% to finance the project. Example government project: purchase of F-35 Joint Strike Fighter aircraft; HS2.	2%	14%	£34.7 billion (2016 prices)	No	Yes	Yes	11.50	45.00
		2%	17%	£42.0 billion (2016 prices)	No	Yes	Yes	19.50	52.00

Notes

1 The options presented in the table assume government's return is 2%, which is a proxy for the government's long-term borrowing rate. Figures 21, 22 and 23 show the strike price if the return required by government is 6%, which is the social time preference rate (3.5%) increased by inflation during the project's life (2.5%).

2 In the real world, some alternative financing options would not require a contract for difference. The cases presented are theoretical and we estimated a strike price equivalent to allow a comparison with the HPC deal.

3 Payments during construction are expressed in nominal (current) prices.

4 Strike price is the price for the electricity for the CfD period (2025 to 2060). In order to compare the cost of electricity between the scenarios we kept this 35-year fixed price period constant including scenarios when the strike price is below the market price. A strike price below market price would mean that investors would need to pay the difference back to consumers. The range depends on different electricity market forecasts. The low end reflects wholesale price projections in the HPC financial model and the high end is the Department's projections as per March 2016. The strike prices of scenarios where the government participates in the financing of the project assume the current long-term cost of borrowing (2%).

5 In the case where 100% of project risks are borne by private investors there would not be a strike price, and the range presented shows a 'strike price equivalent'. This is the market price investors will need for the first 35 years of generation to achieve the 12% return on the project.

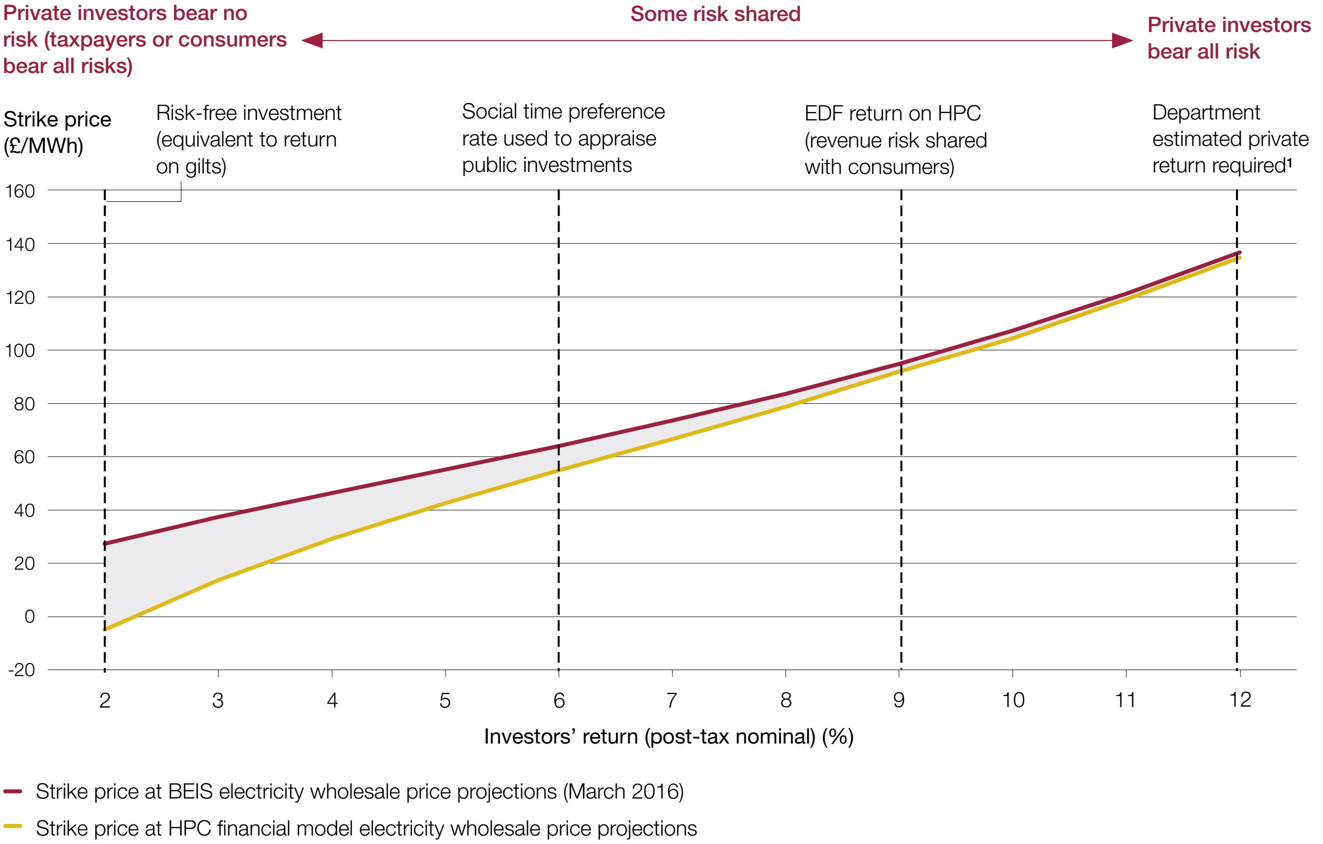
6 Detailed assumptions for each scenario can be found in Figures 21 to 23.

7 All return rates shown are nominal.

Source: National Audit Office analysis of NNB Generation Company (HPC) Limited data

Figure 20
HPC deal-type structure

Sensitivity of strike price to investors' return



The chart presents the strike price necessary for investors to achieve different levels of return based on two sets of electricity wholesale price projections. The higher the level of risk private investors bear, the higher the strike price. In the summary table (Figure 19), we show three different scenarios:

- '100% private risk' assumes private investors carry all risks. The Department has estimated that the hurdle rate for nuclear projects is about 12% (post-tax nominal).[1] To achieve this return, the price they receive would need to be between £135 and £137 per MWh during the first 35 years of generation;
- 'HPC' scenario replicates the current deal. By removing the electricity price risk for 35 years as well as other risks, it reduces the investors' required return to 9% which results in a strike price between £91 and £95 depending on the forecasts for market prices after the CfD period; and
- '100% public risk' assumes all risks are transferred to the public sector and the taxpayer would have to pay the full project cost (£19 billion). In this case the strike price for 35 years would range from -£6 to £28 depending on the electricity price forecasts. The combination of low discount rate and high future electricity prices makes the present value of the cash flows post CfD so high that it compensates for the negative strike price during the CfD period to achieve an overall investor return of 2%. Such a strike price is a theoretical price based on a comparison with the 35-year CfD structure used in HPC.

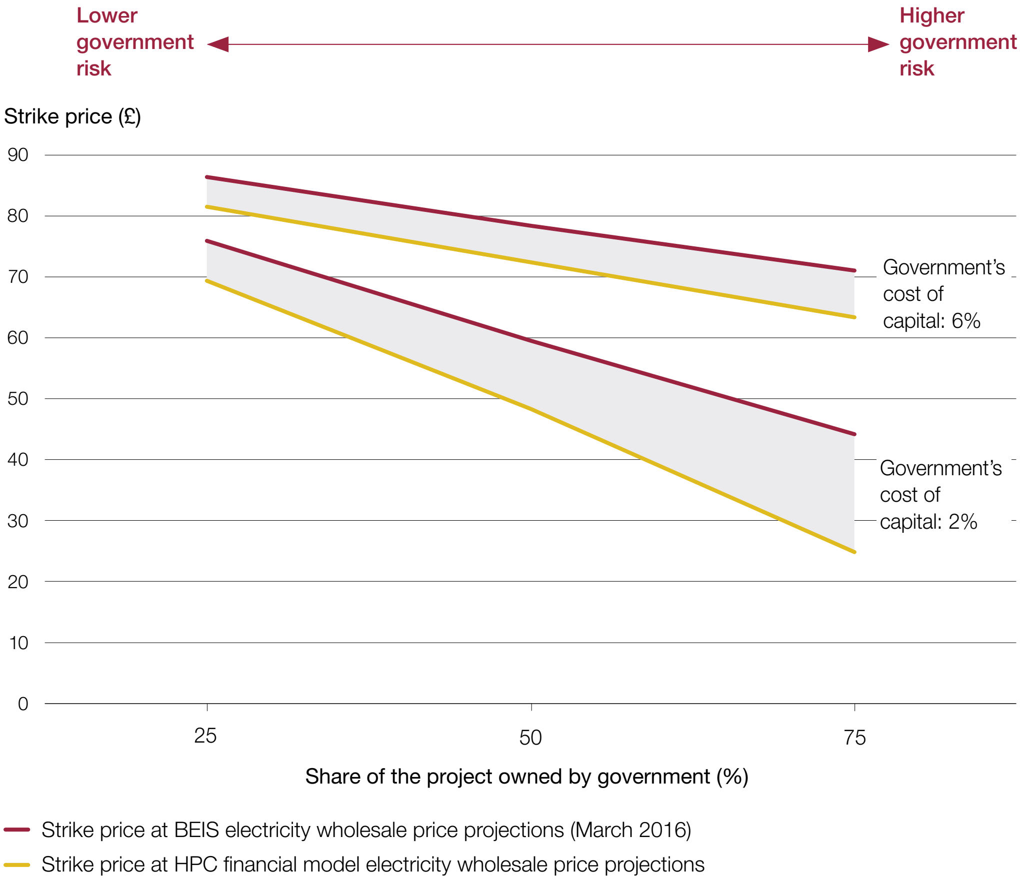
Note

1 The hurdle rate is the minimum return that a company expects to earn when investing in a project, and it varies with the specific project risk. The Department estimates the pre-tax real hurdle rate for nuclear to be 8.9% (Department for Business, Energy & Industrial Strategy, *Electricity generation costs*, November 2016), which we estimate to be equivalent to more than 12% when expressed as post-tax nominal.

Source: National Audit Office analysis of NNB Generation Company (HPC) Limited data

Figure 21
Public-private partnership

Sensitivity of strike price to share of government ownership



The chart represents the strike price depending on different levels of equity participation by the government and differentiates between the government's current long-term cost of funding and nominal social time preference rate. The strike price would decrease when the government's share increases, but risks for the taxpayer would increase with the government's investment. We assumed the following discount rates:

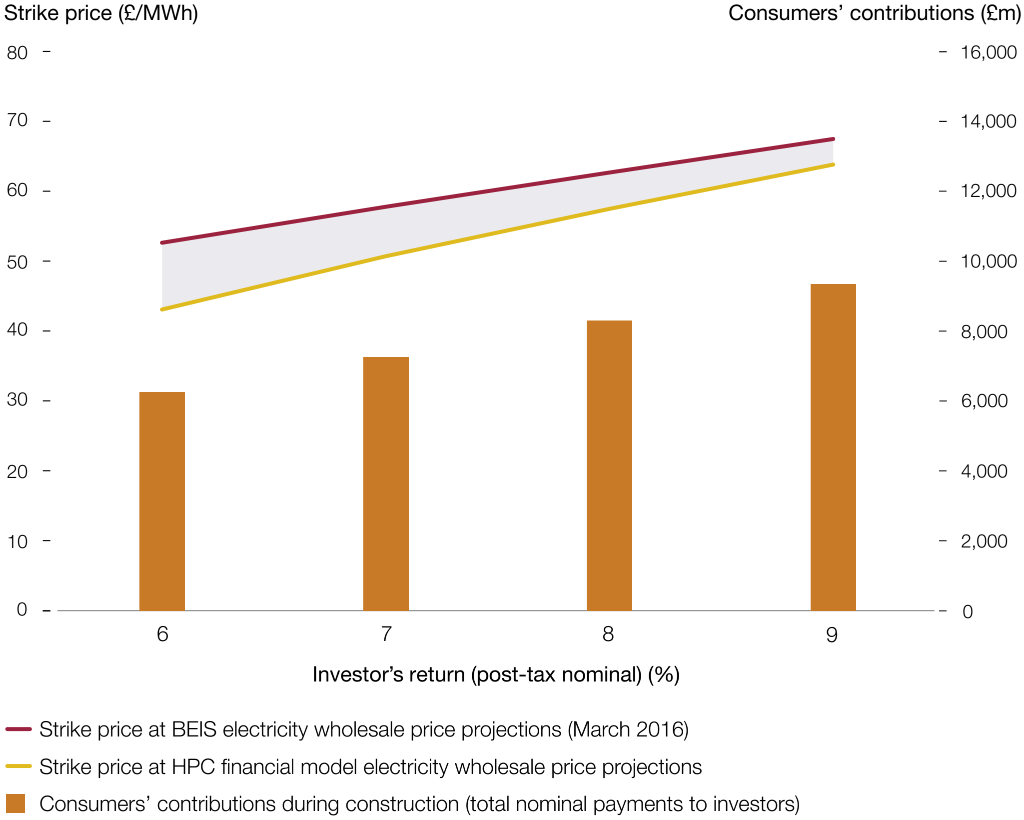
- private investors would require a 9% return; and
- government's cost of capital is 2% and 6%. We use 2% for the current long-term government borrowing rate and 6% is the social time preference rate. These are nominal rates. The 3.5% social time preference rate in real terms is increased by 2.5% inflation as per the assumptions in the HPC financial model.

Source: National Audit Office analysis of NNB Generation Company (HPC) Limited data

Figure 22
Hybrid regulated asset base model

Strike price sensitivity to investors' return and total consumers' contributions during construction

Providing investors with a return during the construction phase would decrease the strike price by at least £20/MWh



In this scenario, private investors benefit from a 35-year CfD agreement similar to HPC, and in addition they are provided with a return during the construction period. The return during the construction period is based on a regulated asset base methodology used in the utility industry, and in particular for the Thames Tideway Tunnel. Consumers contribute to costs during construction through an increase in their electricity bills. We assume sharing the construction risk reduces the overall project risk, and therefore the investors' return requirement. The range of potential investor returns is indicative only and for illustrative purposes. The impact of investors receiving a return during the construction period, and the reduction in the return requirement reduce the strike price during the CfD period.

In the summary table (Figure 19), we show two different scenarios:

- in the high cost of capital scenario we assume developers would bear all risks and would require a return of 9%. Consumers contribute to the construction cost, but are reimbursed if the project is not completed. Annual payments to the developer during construction (until 2025) amount to 9% of the cumulative net cash flow generated up to the previous year. Under this scenario, developers will receive a total of £9.3 billion (nominal), equivalent to 52% of their total cash flow during construction (£17.8 billion). The average household contribution will be at most £20 in 2025 (see chart opposite). The strike price during the CfD period is between £63.5 and £67.5; and

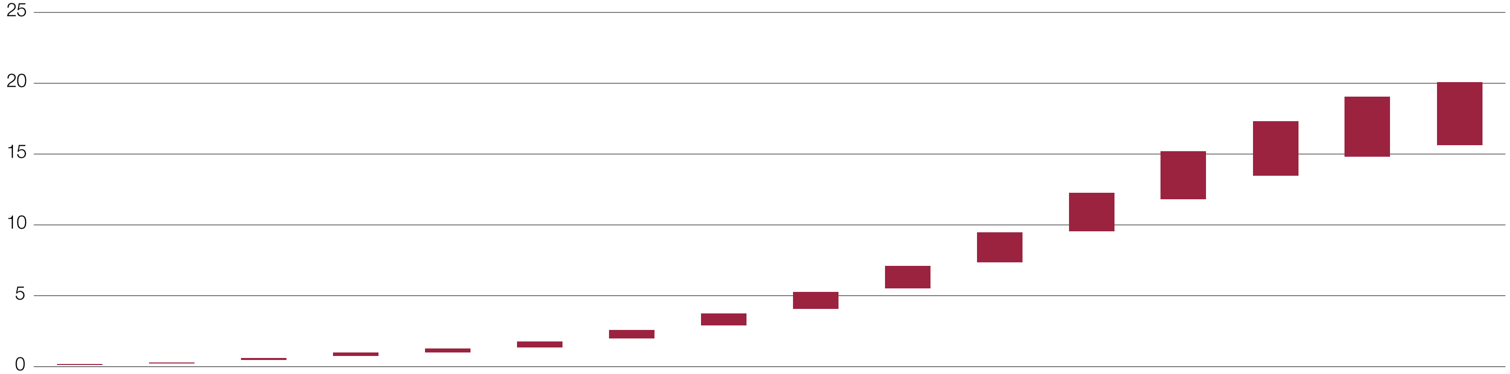
- in the low cost of capital scenario, we assume consumers would share the risk and would not be compensated if the project is not completed. We therefore reduced investor's return requirements to 7%. In this case, developers would receive a total of £7.3 billion (41% of total cash flow during construction). This would equate to £15.6 at most added to the average annual bill during construction and the project would be viable for a strike price between £51 and £58.

Figure 22 *continued*

Hybrid regulated asset base model

Impact on the average UK domestic electricity bill during construction

Under the regulated asset base model, consumers would pay at most £20 in 2025 and then would carry on paying for the CfD top-up payments. The amount they would pay during construction could be lower if consumers share some risks on these payments, enabling investors to lower their return.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Investor return 7%	£0.13	£0.23	£0.48	£0.76	£1.00	£1.38	£2.00	£2.90	£4.08	£5.52	£7.35	£9.54	£11.83	£13.47	£14.82	£15.61
Investor return 9%	£0.16	£0.30	£0.62	£0.98	£1.28	£1.78	£2.57	£3.73	£5.25	£7.10	£9.46	£12.27	£15.21	£17.31	£19.06	£20.07

Note

1 Impacts on the energy bill is estimated by sharing the cost equally across domestic and non-domestic consumers proportionally to their consumption. We assumed an annual consumption of 3,800 kWh per household.

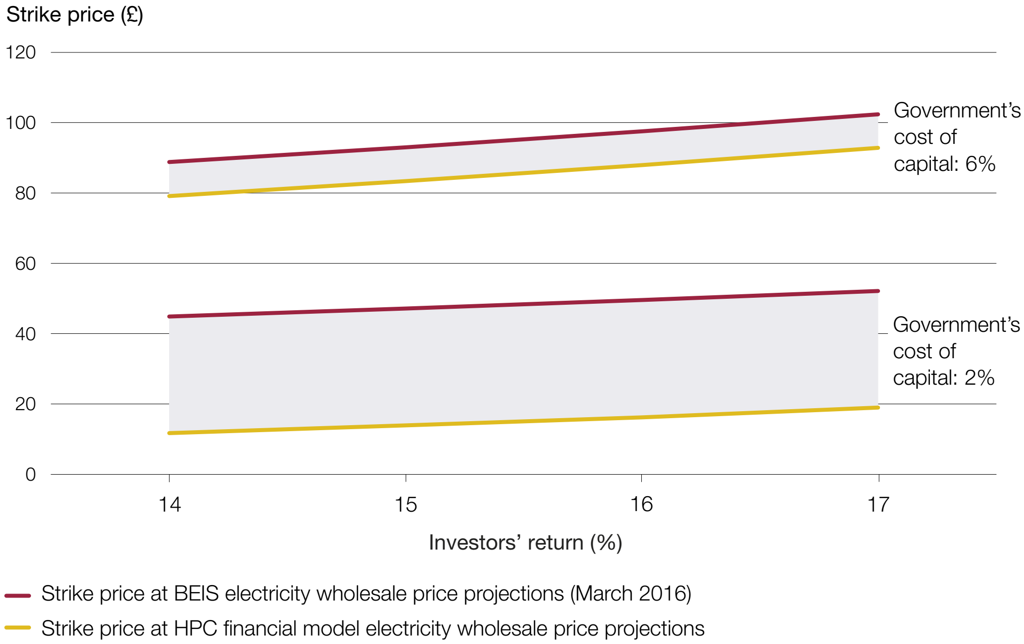
Source: National Audit Office analysis of NNB Generation Company (HPC) Limited data

Figure 23

Engineer, Procure & Construct (turnkey)

Strike price sensitivity to investors' return for an Engineer, Procure & Construct project

In an Engineer, Procure & Construct project, investors' return has a limited impact on the strike price



In this scenario, the government contracts a developer to finance and build the plant and then takes ownership once it is operational (assumed in 2025). Construction is the riskiest stage of the project, and to reflect the increase in risk we assume investors require a return on their investment ranging between 14% and 17%. The chart shows how the strike price would vary according to the investors' cost of capital and whether government's cost of capital is assumed to be 2% or 6%. The high and low range of the forecasts depends on the wholesale electricity market price forecasts.

If we assume an investor return of 15% and a single lump-sum payment at completion (2025), the government would need to pay £36.5 billion (2016 prices) to the developer. In this case, the strike price would need to be between £15 and £47 per MWh during the first 35 years of generation. This assumes government's cost of capital to be 2%.

Source: National Audit Office analysis of NNB Generation Company (HPC) Limited data

Appendix Five

European Pressurised Water Reactor (EPR) technology issues

1 The EPR reactor technology has been used for three projects prior to Hinkley Point C. Each one has faced delays and cost overruns.

Figure 24

EPR technology issues

The reactor design for HPC is unproven and other projects that incorporate it are experiencing difficulties

	Hinkley Point C	**Flamanville 3**
Location	Somerset, UK On site of existing nuclear plant with two reactors	Normandy, France On site of existing nuclear plant with two reactors
Nuclear generation in country	The UK has 15 nuclear power reactors operating at seven plants. These reactors represent around 9 GW of capacity and generate around 20% of the UK's electricity Most of the UK's reactors will be retired by 2030 Developers, including EDF, propose to build 9 GW of new nuclear capacity by 2030	France generates approximately 75% of its electricity from 58 nuclear power plants This supply share is expected to reduce to 50% by 2050 following a policy decision in 2014 to increase supply from renewables
Generating capacity	Twin reactors Combined output of 3.2 GW (1.6 GW each)	Single reactor 1.6 GW
Construction start date	Site works started 2011 First permanent concrete for the power station poured in March 2017	Site works – 2006 Construction start – 2007
Original and revised forecast commissioning date	Original – 2023 Revised – 2025	Original – 2012 Revised – 2018
Expected operating lifetime	60 years	60 years
Original and revised forecast project costs	Original – £16 billion (2012 prices) Revised – £18.2 billion (2016 prices)	Original – €3.3 billion (2005 prices) Revised – €10.5 billion (2015 estimate, price base unknown)

Olkiluoto	Taishan 1&2	
West Finland On site of existing nuclear plant with two reactors	Guangdong province, China	
Finland generates nearly 30% of its electricity from its existing four reactors	China has more than 30 operating nuclear power stations, which provided some 4% of the national generation in 2016 A further 20 nuclear power stations are under construction to meet rapid growth in electricity demand and address air pollution and carbon emissions concerns	
Single reactor 1.6 GW	Twin reactors Combined output of 3.4 GW (1.7 GW each)	
Site works – 2003 Construction start – 2005	Construction start – 2009 (unit 1)	Construction start – 2010 (unit 2)
Original – 2009 Revised – 2018	Original – 2014 (unit 1) Revised – second half of 2017 (unit 1)	Original – 2015 (unit 2) Revised – 2018 (unit 2)
60 years	60 years	
Original – €3.2 billion (2003 prices) Revised – €8.5 billion (estimated, price base unknown)	Original – 50 billion Yuan (estimated, price base unknown) Revised – Unknown	

Figure 24 *continued*
EPR technology issues

	Hinkley Point C	Flamanville 3
Project delivery arrangements	Client: NNB Generation Company (HPC) Limited (NNBG), a joint venture between EDF and China General Nuclear Power Group (CGN) NNBG owns the site and EDF will be the architect-engineer (role includes project and contract management, and safety licensing)	Client: EDF EDF owns the site and is the architect-engineer (role includes project and contract management, and safety licensing)
Delivery issues	N/A	Ineffective liaison between engineering teams Communication issues which led to Flamanville design problems Ineffective handling of specific regulatory design needs leading to construction delays (for example, French regulator changed requirements for some elements after manufacture) Design was incomplete when construction started, leading to significant delays Inadequate project management (for example, problems with coordination of multiple contractors on site) Inadequate scheduling of component supply leading to unscheduled wait times Component manufacturing quality faults (for example, cracks in the parts forged and manufactured by AREVA for the Flamanville 3 reactor pressure vessel) Lack of skills to swiftly respond to technical faults

Sources: National Audit Office analysis of European Pressurised Water Reactor technical viability assessment prepared by Department for Business, Energy & Industrial Strategy Chief Scientific Adviser and World Nuclear Association

Olkiluoto	**Taishan 1&2**
Client: Teollisuuden Voima Oyj (TVO), an electricity generation company TVO owns the site. It contracted with Framatome ANP (now AREVA NP) and Siemens AG for a 1.6 GW EPR pressurised water reactor in a turnkey contract. Site works were excluded from the contract	Client: Guangdong Taishan Nuclear Power Joint Venture Company Limited (TNPC) A joint venture 70% owned by China General Nuclear Power Group (CGN) and 30% by EDF
Lack of skills in client/licensee and inadequate sub-contractor network due to lapsed time since last nuclear project Lack of understanding of safety requirements and regulatory practices Lack of readiness of project implementation by key parties Detailed design completed too late, delaying regulatory review and resulting in time-consuming inspection, and lack of communication of design changes within vendor consortium Inadequate quality of design and engineering work, resulting in time-consuming re-work Ensuring sub-contractors understand and meet nuclear-specific quality and safety requirements, including in off-site manufacturing Original construction schedule was overly ambitious	The Taishan reactors are set to be delivered with less of a delay and at a lower budget than Flamanville and Olkiluoto, which implies that lessons have been learned The reactor design for Taishan is the same as the one used for Flamanville and lessons learned from Taishan are taken into account for HPC design and construction To date, the concrete pour was successful and the nuclear supply system engineering is as scheduled Chinese nuclear safety authorities have made commencement of Taishan 1 conditional on the French nuclear safety authorities approving the reactor vessel at Flamanville 3. The French authorities are due to reach conclusions on this by June 2017 Taishan 1 started hot functional testing – the last performance test before first loading of nuclear fuel – during the first quarter of 2017

This report has been printed on Evolution Digital Satin and contains material sourced from responsibly managed and sustainable forests certified in accordance with the FSC (Forest Stewardship Council).

The wood pulp is totally recyclable and acid-free. Our printers also have full ISO 14001 environmental accreditation, which ensures that they have effective procedures in place to manage waste and practices that may affect the environment.

National Audit Office

£10.00

ISBN 978-1-78604-122-7

Design and Production by NAO External Relations
DP Ref: 11471-001