National Audit Office

Report
by the Comptroller
and Auditor General

Cross-government

Infrastructure investment: the impact on consumer bills

Volume II

HC 812-II SESSION 2013-14 13 NOVEMBER 2013

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National Audit Office

Cross-government

Infrastructure investment: the impact on consumer bills

Volume II

Report by the Comptroller and Auditor General

Ordered by the House of Commons
to be printed on 12 November 2013

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

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National Audit Office

7 November 2013

This volume has been published alongside a first volume *Cross-government: Infrastructure investment: the impact on consumer bills* HC 812-I, Session 2013-14

HC 812-II London: The Stationery Office £16.00

This volume includes appendices four and five to our report Infrastructure investment: the impact on consumer bills, volume 1. It also includes our report on the modelling work by the Department of Energy and Climate Change to understand the impact of its policies on energy prices and bills.

Printed in the UK for The Stationery Office Limited on behalf of the Controller of Her Majesty's Stationery Office

2603481 11/13 PRCS

Contents

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This report can be found on the National Audit Office website at www.nao.org.uk/2013-infrastructure-funding

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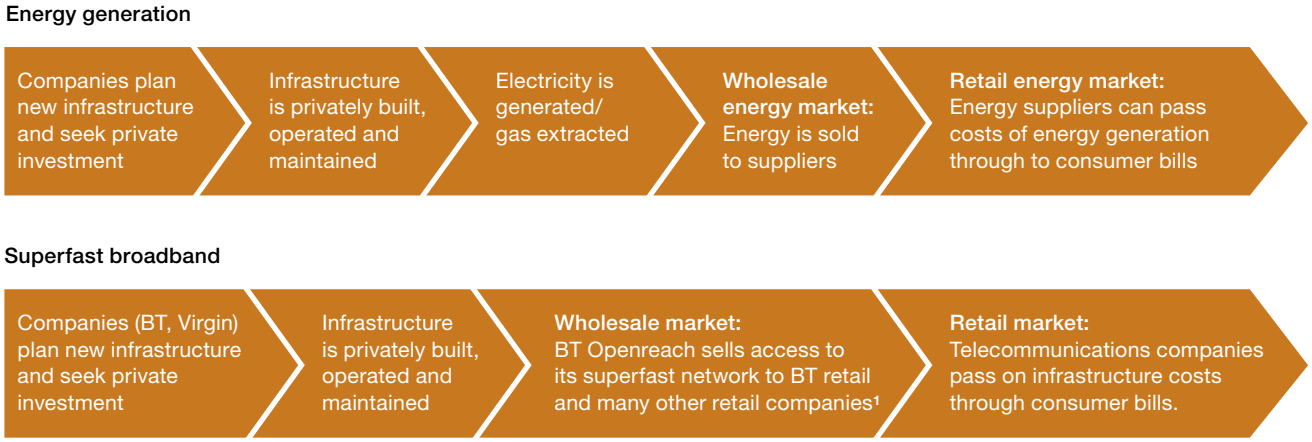
Appendix Four

Competition

1 In the sectors we looked at, competition is government's preferred approach to control infrastructure costs in energy generation and superfast broadband infrastructure (**Figure 9**). It is not only retail competition that matters to consumers, but also wholesale competition where companies buy energy, or access to communication networks, and then sell this on to consumers.

Figure 9
How energy generation and superfast broadband infrastructure costs feed into bills



Note

1 Ofcom does not require Virgin Media to sell wholesale access to its networks to other companies. Current generation broadband is subject to substantial regulatory intervention by Ofcom, which sets the prices BT Openreach may charge. Ofcom believes that this constrains the price BT Openreach may charge for superfast broadband.

Source: National Audit Office

Competition in energy

Wholesale energy market

2 The wholesale energy market continues to evolve rapidly and competition is not yet fully effective. In March 2011, Ofgem reported that smaller companies faced barriers to entering the wholesale energy generation market, and this could reduce competition.[a] Ofgem is now developing plans to force generating companies to sell electricity to other companies to increase the amount of power traded and hence the requirement for suppliers to enter into more purchasing agreements, to help new entrants establish themselves in the market.

Electricity market reform

3 The government's plans to reform the electricity generation market will see government providing a guaranteed electricity price for certain types of energy generation. Contracts for Difference aim to incentivise the investment needed in new, low-carbon electricity generation, including nuclear, renewables and carbon capture and storage. They aim to reduce risks faced by generators by giving them contracts that will provide certainty about long-term revenues.[1] The government plans to introduce competition for the 'strike price' at a later date, but there is no firm timetable.

4 Ofgem generally supports the government's electricity market reform, but has highlighted potential 'distortions' from some of the policies. In 2012, Ofgem expressed concerns that Contracts for Difference may distort operating decisions by incentivising companies to generate electricity, even when it is not efficient. Ofgem told us that while it considers it important to remain watchful of market distortions, it is working with DECC to facilitate implementation of the electricity market reform.

5 Ofgem monitors energy markets, publishing weekly data on market indicators, and reporting on risks to competition periodically. However, it does not produce a summary conclusion on overall market effectiveness.

Licences for offshore wind farms

6 Ofgem used competition to award licences to private companies to transmit electricity from offshore wind farms. Our 2012 report on awarding the first four licences found that giving licensees an inflation-protected income may attract lower cost financing from pension funds but appears generous to licensees whose financing costs do not rise with inflation. Ofgem did not analyse in detail the trade-off between investors' interests and the cost of inflation risk that would be borne by consumers. Inflation-indexation is also Ofgem's policy for onshore wind farms.

1 Generators who have entered into a Contract for Difference will receive revenue from selling their electricity into the market as usual, but will also, under the new contracts, receive a top-up of the difference between a standardised electricity market reference price and a contractually set 'strike price'. Conversely, if the electricity market reference price is higher than the strike price then generators will be obliged under Contracts for Difference to pay the difference to government.

Competition in superfast broadband infrastructure

7 Openreach (a BT Group business) and Virgin Media are both investing in new superfast broadband infrastructure where they have decided this is commercially viable. Superfast broadband is currently available to 73 per cent of UK premises. Following its recent three-yearly review of the market,[b] Ofcom continues to believe that it is not appropriate to set the prices that Openreach charges other companies to access its superfast broadband network (although Ofcom does require Openreach to offer exactly the same products at the same price to other communications providers that it provides to BT's own retail operations). Instead, Ofcom works to promote competition to keep wholesale prices low; this includes measures to improve information available to consumers, and on-going monitoring and review of the market.

8 Like the wholesale energy market, this market is evolving rapidly and competition is not yet fully effective. Ofcom currently considers that Openreach has significant market power through its network coverage, but believes it is inappropriate to fix wholesale prices as there is uncertainty about future demand for superfast broadband. It also believes there is a risk of undermining BT's incentives to expand networks or improve technology (this could result in detriment to consumers). Ofcom is keeping its regulatory decisions under review but argues there are sufficient constraints on the price Openreach can charge for access to its superfast broadband network. (**Figure 10**).

9 One of BT's rivals (Talk Talk) has complained to Ofcom about the difference in price (margin) between BT Group's wholesale superfast products and its retail superfast broadband products. Talk Talk's complaint is that this margin does not allow it to make a sufficient profit and therefore discourages it from wanting to sell superfast broadband products. Ofcom is currently assessing this complaint.

Figure 10

Why Ofcom has not set prices for access to Openreach's superfast broadband network

Ofcom believes the following factors are sufficient to constraint the prices Openreach can charge for access to its superfast broadband network:

- Customers can continue to buy current-generation broadband at fast speeds of up to 24Mbps, and the price Openreach can charge for access to these (non-superfast) broadband networks is regulated by Ofcom.
- Consumers choosing to pay for superfast broadband pay a relatively small premium (typically £5 to £10 per month, but as little as £2 in some cases) compared with normal broadband.
- Many customers have a choice of superfast broadband provider – either BT or Virgin.
- In addition, Ofcom also reviews a range of detailed cost information to understand Openreach's superfast broadband costs and how this market is likely to develop.

Source: National Audit Office analysis of Ofcom market reviews

10 The Department for Culture, Media & Sport has a programme to extend broadband to rural areas (to meet a national target of 90 per cent coverage). We recently reported that at the end of the programme, BT's superfast broadband wholesale infrastructure is likely to have benefited from £1.2 billion of public money. Active involvement from Ofcom and the Department will therefore be required to monitor the impact of the programme on BT's position in the sector in the longer term.[c]

Importance of effective regulatory oversight of competitive markets

11 Since utility markets are rarely fully competitive, regulators must continue to be vigilant in monitoring those markets where competition is relied on to protect consumers. They must be willing to intervene to discourage anti-competitive behaviour where it occurs. In 2010, we noted that regulators were not referring cases to the Competition Commission to the extent they had envisaged.[d] We recommended that the government should adopt a presumption that all regulators actively consider using their powers to refer cases regularly. The government also needs to be aware of the impact its policies might have on competition in these markets. For example, the Department of Energy & Climate Change will need to monitor those markets where it is setting strike prices to establish when it can introduce competition.

Appendix Five

Case studies

Case study selection

1 We examined three infrastructure projects to understand the steps taken by regulators to protect consumers when scrutinising companies' proposals for large new infrastructure schemes. In the energy sector, we reviewed Ofgem's scrutiny of a scheme to replace iron mains forming part of the gas network, and of a proposed undersea high voltage electricity cable. In the water sector, we reviewed Ofwat's scrutiny of a project comprising a bundle of different measures to improve the security of water supply in south-west England.

2 In our review of case studies, we did not attempt to draw wider conclusions about the effectiveness of current regulatory approaches. The three case studies were selected in consultation with the regulators and met the following criteria:

- The project was significant enough in value to merit separate scrutiny by the regulator. Although regulators look at company business plans as a whole as part of a price review, we expected large and one-off projects to receive separate scrutiny.
- Project costs were agreed and construction was under way or had been completed.

Key findings

3 In our two energy case studies, we found that Ofgem scrutinised and challenged costs effectively, reducing the overall cost proposed by companies by 8 per cent in one case and 4 per cent in the other. In the water sector, while Ofwat challenged the specification of this project, leading to a 9 per cent reduction in its costs, it did not scrutinise important aspects of the company's proposal, limiting its ability to assure itself that this project represented value for money for consumers.

4 A summary of our case study findings follows.

Case study 1

Improving the safety of gas mains

What did the company propose?	Northern Gas Networks, the licensed gas transporter for the North of England, submitted its proposal to replace iron gas mains with plastic pipes, in response to requirements from the Health and Safety Executive[1].
What was the outcome?	Ofgem scrutinised the business plan and allowed the company £679 million[2] for the project – an 8 per cent reduction from the original business plan.
How did the regulator protect consumers' interests?	Ofgem protected consumers' interests by: ● comparing Northern Gas Networks' plans for improving the safety of gas mains with the plans of other gas distribution companies; ● challenging the way time of completion to build the infrastructure was treated in the cost benefit analysis; ● scrutinising the company's cost benefit analysis to establish if mains replacement was justified; ● challenging the workload profile and not allowing the company to 'frontload' work in the first eight years; and comparing project costs with historic costs for the same type of work; and ● comparing project costs with historic costs for the same type of work. ● Ofgem meets with the company periodically to review and discuss its cost data. ● The infrastructure is subject to periodic safety inspection by the Health and Safety Executive.
How is the regulator checking on what gets delivered?	Ofgem is consulting on annual reporting requirements for companies and is proposing they report on performance in relation to output measures, including: ● reduction in risk of fatality, injury and property damage as a result of iron mains failure; ● reduction in the number of events which have the potential to lead to an incident, for example mains pipe fractures and corrosion failures, and occurrences of gas in buildings as a result of iron mains failure; and ● network reliability improvements, carbon dioxide emissions reductions, leakage reductions (in terms of its financial and environmental impact).
How were consumer views reflected?	The company consulted stakeholders (during its business planning), including consumers, business groups, local authorities and special interest groups through: ● a web-survey of the general public and telephone surveys of customers on willingness to pay for infrastructure, carried out by an independent survey company; ● customer panel meetings held by the company; and ● one-to-one meetings with different stakeholders. The results of this consultation were published. Ofgem's Consumer Challenge Panel[3] reviewed the overall business plans of all gas distribution companies. This project was a significant component of the Northern Gas Networks business plan.

Notes

1 The Health and Safety Executive initiated an Enforcement Policy in 2002 for the replacement within 30 years of iron gas pipes running within 30 metres of buildings. Ofgem reviewed this policy jointly with the Health and Safety Executive to reduce the scale of the Health and Safety Executive's requirement.

2 2009-2010 prices.

3 The Consumer Challenge Panel acts as a critical friend to Ofgem and consists of experts from a range of backgrounds acting in an individual capacity.

Source: National Audit Office review of Office of Gas and Electricity Markets documentation

Case study 2

Installing an undersea high voltage electricity cable

What did the companies propose?

National Grid Electricity Transmission and SP Transmission are jointly building the Western Link, an undersea electricity cable between Scotland and England to bring electricity from Scotland to homes and businesses in Wales and England.

The need for this type of infrastructure was identified by the Electricity Networks Strategy Group, which is jointly chaired by the Department of Energy & Climate Change and Ofgem.

The companies asked Ofgem for an interim funding decision prior to the next price control review as they believed this infrastructure was an urgent investment, needed to meet the UK's 2020 renewable energy target.

What was the outcome?

Ofgem gave the companies an allowance of £1,051 million[1] for the project, which was 4 per cent lower than what was originally requested.

How did the regulator protect consumers' interests?

Ofgem protected consumers' interests by:

- recognising the unique characteristics of this project, notably the joint venture between two companies, and the high-risk nature of undersea infrastructure, and therefore adopting a bespoke approach to project scrutiny;
- engaging an expert engineering consultant to help assess the companies' funding request in relation to construction works, and the allocation of risk between companies and consumers;
- with consultant support, establishing cost comparisons with similar projects to assure itself the proposed project offered value for money;
- reviewing the levels of contingency built into the budget to cover risks, resulting in reducing the amount of contingency the company had built in; and
- deciding not to delay its decision about project funding until planning permission was granted for all aspects of the project. Ofgem's analysis indicated that if it withheld its decision then this could result in a minimum two-year delay and costs to consumers of up to £144 million.

How is the regulator checking on what gets delivered?

Ofgem does not inspect whether this infrastructure is being delivered to the agreed specification. Instead, Ofgem has required the company to report on progress towards meeting the expected outputs (for the carrying capacity of the cable) and to provide evidence that the output is specified as delivered. Ofgem's future reporting requirements are under consultation as part of the next price control review.

How were consumer views reflected?

Ofgem consulted stakeholders on its initial views on the efficient funding allowances for the project ahead of coming to a decision. The companies consulted with local councils, nature conservation organisations, environmental groups and landowners in the locations affected by the infrastructure, and published the results.

Note

1 2009-2010 prices.

Source: National Audit Office review of Office of Gas and Electricity Markets documentation

Case study 3

Improving the security of water supplies in south-west England

What did the company propose?

Wessex Water proposed an 'Integrated Grid' consisting of a system of new pipes, pumping stations and reservoirs to help ensure continued security of water supply during periods of peak demand.

What was the outcome?

Ofwat's allowance to the company was £13.45 million lower than the £306 million budget originally requested by the company, a 9 per cent reduction.

How did the regulator protect consumers' interests?

Ofwat challenged whether all elements of this scheme were needed. Ofwat:

- removed an £8.2 million scheme designed to protect consumers from the failure of a water treatment plant because it considered the chance of this happening was extremely low, although the Consumer Council for Water considered the expenditure was justified;
- did not accept Wessex Water's rationale for wanting to install larger-diameter pipes, and made a 15 per cent reduction in the £35 million cost of this part of the scheme; and
- scrutinised the company's cost benefit analysis, expressing some concerns over the company's methodology. It commissioned a detailed review of the company's analysis to provide it with assurance that the methodology was reasonable.

However, there are two main areas where we are concerned by aspects of Ofwat's scrutiny of the project:

- The level of financial risk, and amount of contingency the company had included in its cost estimates was not explained by the company or questioned by Ofwat. Ofwat considers that the level of contingency is for companies to manage. In our view, it is not possible for Ofwat to judge value for money without understanding how much contingency is included in companies' proposed costs, given that companies can retain a share of any unspent contingency.
- At the time it took its decision, Ofwat did not yet have full assurance that the scheme was needed. The company's draft Water Resources Management Plan set out the case that there was a growing imbalance between supply and demand for water in the region, requiring new investment. Ofwat relied on this plan in setting company revenues, but had expressed concerns to the Department for Environment, Food & Rural Affairs about the quality of the plan. At the time of Ofwat's decision, the DEFRA Secretary of State had not yet approved the Water Resource Management Plan (although it subsequently did so). This meant that Ofwat was in the position of approving the scheme without full assurance that it met a real need.[1] Ofwat told us that had the scheme gone ahead but been found subsequently not to be needed, then it would have been able to recover the costs from the company on behalf of consumers.[2] We are concerned that this approach would not be best practice for infrastructure projects funded through public spending, where a clear and confirmed business case is a pre-requisite before expenditure can be authorised.

How is the regulator checking on what gets delivered?

- Ofwat specified outputs for this project in terms of the number of properties that are no longer at risk of interruptions to supply. Ofwat also reviews data on the overall level of service provided to consumers, including an index which measures the security of water supply.
- Ofwat does not inspect whether the infrastructure is being delivered to the agreed specification. Instead, Wessex Water is required to assure Ofwat on project progress and costs incurred.

How were consumer views reflected?

- The independent Consumer Council for Water advised Ofwat that this project should go ahead (including all elements proposed by the company).
- Wessex Water surveyed its customers and used information on their willingness to pay for improved services in estimating the benefits of the project, and made the results of this information available to Ofwat.

Notes

1 The 2011 Gray Review had previously identified a concern that Ofwat had sometimes not agreed to fund proposals already in Water Resource Management Plans which had been signed off by the Secretary of State. It recommended that in the event that Ofwat's decisions do not fully reflect the outcomes of processes, such as Water Resource Management Plans, it should explain the rationale for its decision. Available at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/69442/ofwat-review-2011.pdf, page 17 and recommendation 3.

2 Ofwat referred us to a clause in water company licence conditions that allows it to recover monies from water companies where there has been a 'relevant change in circumstances', and it told us that it has used this clause to recover monies in the past. However, in our view, it is not clear that this clause would enable Ofwat to recover monies already spent by a water company in a situation where the company had started a project that Ofwat had made an allowance for, but which was subsequently found not to be needed.

Source: National Audit Office review of Ofwat documentation

Modelling the impacts of infrastructure investment on consumer energy bills

Summary

1 As part of our analysis of how government manages the impact of infrastructure investment on consumer bills, we assessed the models the Department of Energy & Climate Change (the Department) uses to forecast the impacts of its policies.[e] We looked in depth at modelling in the energy sector for three main reasons:

- Expected investment is greatest in the energy sector, representing £158 billion of the £257 billion of investment by 2020 identified in the National Infrastructure Plan.
- The Department has carried out more in-depth modelling of future consumer bills in the energy sector than is the case in other sectors.
- The Department's modelling of energy sector impacts is important to the success of the Levy Control Framework, which we plan to report on later in 2013.[2]

2 In this note, published as an appendix to the main report, we provide more detail of the Department's models and our assessment of them. We make recommendations that aim to improve the Department's modelling of consumer prices and bills in the energy sector.

3 The Department has carried out substantial modelling work to support its decisions about policies to encourage investment in low-carbon technologies. The two most important models for estimating the impacts on consumers are the Dynamic Dispatch Model and the Average Prices and Bills model.

- The Dynamic Dispatch Model (the DDM) is an electricity supply model, which allows users to analyse the effects of different policy decisions on the electricity market. The Department considers this a business critical model, and used it to inform its draft delivery plan for Electricity Market Reform.[3]
- The Average Prices and Bills model (the APB model) is used to estimate the impact of policies to combat climate change, ensure energy security and help the vulnerable on retail gas and electricity prices and on household and business energy bills. The Department publishes the results of this model regularly.

2 Several of the Department's energy and climate change policies are funded through levies on energy bills. The Levy Control Framework caps the amount of money that can be raised through such levies.

3 Electricity Market Reform is a package of measures that aims to attract the investment needed to replace ageing energy infrastructure and to meet projected future increases in electricity demand.

4 We need to caveat our assessment as we had limited access to the DDM. In particular, the Department allowed us to carry out sensitivity tests on the DDM in situ in the Department, but did not allow us to analyse the results of these tests, citing a lack of staff resources to be able to quality-assure the findings.

5 We predominantly report by exception, meaning that we concentrate on those areas where our audit identified weaknesses. We do not report comprehensively on the strengths of the two models. Overall, both models perform well in many areas, but we had several concerns.

Key findings

6 **The two models make an important contribution to understanding the future costs of infrastructure investment to consumers.** Of the three sectors focused on in the main report (energy, water and telecommunications), the best effort to forecast future bills and consider their affordability has been made in the energy sector. For instance, the Department's modelling has enabled it to estimate the impacts of its policies on different income groups, and to identify which groups could be most likely to face higher costs (paragraphs 1.15 and 1.16).

The Dynamic Dispatch Model

7 **The rationale for the DDM is clear and its documentation is comprehensive, including a detailed user guide.** No model can include all possibly relevant factors, but most of the design decisions in the DDM about how to model the electricity supply market appear reasonable (paragraph 2.5).

8 **There have been gaps in the quality assurance of the DDM, but the Department is bringing it into line with its revised internal guidance for quality assurance.** Robust quality assurance is crucial to ensuring the reliability of models, as the problems faced by the franchising of West Coast Main Line demonstrate. The Department has previously been dependent on its contractor for quality assurance of the DDM's coding, and external reviews of the DDM have been carried out under time pressure. The Department has now completed 18 of its 40 planned quality assurance tests on the DDM. Twenty are partially completed and two are outstanding. It has also commissioned an independent professional services firm to review part of the DDM's code (paragraphs 2.7 to 2.10).

9 **The Department's testing and use of the DDM has helped to improve the model and the Department's understanding of it.** For instance, working with the Department, National Grid modelled ten different scenarios in its analytical report for the Department's consultation on the Electricity Market Reform delivery plan. The Department also regularly carries out sense checks to compare the model outputs to its expectations (paragraph 2.15).

10 However, we have found some deficiencies in the Department's approach to testing and use of the DDM. The Department's scenario analysis has not isolated systematically the impact of varying input assumptions. Some key assumptions used in the Department's scenario analysis cover too narrow a range to give a sense of the potential uncertainty involved. For instance, in the period from 2011 to 2021, the Department's most recent high-demand scenario is always within 5 per cent of its central projection. Previous government demand forecasts have been out by more than 10 per cent over a similar time scale, largely due to the recent recession. Furthermore, the Department has not carried out any further detailed comparison of the model outputs to actual outturns since the DDM was commissioned, despite the substantial changes to the model since 2011. Overall, the initial comparison found reasonable agreement between the DDM's wholesale electricity price projections and actual outturns, but there was a large gap between them in 2008. The Department undertook some comparative analysis with another major electricity market model that showed similar wholesale price trends, but this could not explain the discrepancy and it has not yet investigated further (paragraphs 2.14 to 2.16).

11 The Department has recently incorporated electricity transmission investment into the DDM. National Grid has developed a high-level Excel model of investment in electricity transmission infrastructure, which the Department has brought into the DDM. The focus on transmission network costs is appropriate, since these represent the bulk of the expected increase in future network investment. But the Department recognises that there is further to go to reflect fully the increased demands that new power plants are likely to place on the network (paragraph 2.5).

12 There is an inconsistency between the amount of investment identified in the National Infrastructure Plan and the amount that the Department's models predict is needed to meet government objectives. The Department's models currently predict that only around three-quarters of the level of energy investment identified in the National Infrastructure Plan is required to meet government objectives. This is because the DDM calculates the level of investment required based on assumptions such as future energy demand and the amount of investment in renewables required to meet targets. In contrast, the National Infrastructure Plan shows investment planned by companies, adjusted down to reflect that not all proposed investment is likely to go ahead (paragraph 2.5).

13 Like other large-scale models of the electricity market, the DDM does not currently allow the Department to model strategic behaviour by investors and generators. For example, it does not model the possibility that large electricity generators or investors could act to reduce supply in order to increase prices. Previous experience of periods of high wholesale prices suggests this could sometimes be an important factor in determining customer bills. At present, the DDM recognises this possibility by assuming that generator profit margins and prices rise when spare capacity is low, but it does not model generator behaviour in detail, or allow for strategic investment decisions (paragraph 2.5).

The Average Prices and Bills model

14 The APB model is documented to a high standard, and it is relatively easy to use and understand. Inputs, analysis and outputs are separated, allowing users to see clearly the structure and elements of the model. Overall, the design approach for the APB model was reasonable (paragraphs 2.19 and 2.20).

15 We found some weaknesses in the Department's quality assurance and sensitivity testing processes for the APB model. For instance, we found no evidence that the Department tested systematically the formulas in the Excel model. Its quality assurance currently focuses on inputs and outputs to the model. We recognise that the APB model might require less detailed quality assurance than the DDM as it is not considered business critical, but the high-profile nature of its outputs means that robust quality assurance remains important. The Department said that it is working to improve the quality assurance of the APB model (paragraph 2.21).

16 The APB model lacks detail on how the Department's policies could affect supplier costs and margins and network costs. The Department estimates that these factors currently make up 39 per cent of a typical household energy bill. While the model includes estimates of the amount of investment expected in energy networks, it does not separate out how much is a result of policies. Also, the Department has not considered how supplier costs and margins may change in the future either as a result of its policies or otherwise (paragraphs 2.23 and 2.24).

Recommendations

a **The Department should act to increase the transparency and public profile of its modelling of energy markets.** This could include publishing version logs showing how the models have developed and producing simplified versions of the models that would help the public to explore the trade-offs involved.

On the Dynamic Dispatch Model

b **The Department should carry out thorough quality assurance of the Dynamic Dispatch Model**, in line with its own requirements. This should include:

- Gaining more assurance on those elements of the model coding that are not covered by ongoing work, for instance through a code review by the Department or by another body which is independent from the consultancy firm that initially built the DDM.
- A detailed review of the outputs from the most recent version of the model to gauge its accuracy against known outcomes and explain any discrepancies.
- Keeping a detailed log of any future changes to the model so that it is clear how the model is developing.

c **The Department should ensure that its sensitivity analysis includes sufficient variability in input variables.** It should develop the stochastic capability of the DDM to allow more sophisticated analysis of uncertainty.

d **The Department should develop its understanding of the consequences of strategic behaviour by investors and of multi-plant ownership.** This may be better achieved by carrying out separate small-scale analyses of potential implications, rather than by adding to the complexity of the DDM itself.

e **The Department should ensure that the DDM is developed to reflect more detailed understanding of network costs.**

On the Average Prices and Bills model

f **The Department should carry out thorough quality assurance of the APB model.** This should include:

- a full review of the Excel formulas in the model to ensure it has no underlying flaws;
- more systematic sensitivity testing; and
- a regular programme of historical reviews to gauge the accuracy of the model against known outcomes.

g **The Department should develop its modelling of supplier costs and behaviour and network costs within the APB model.** This will require closer consultation with stakeholders such as electricity suppliers and National Grid.

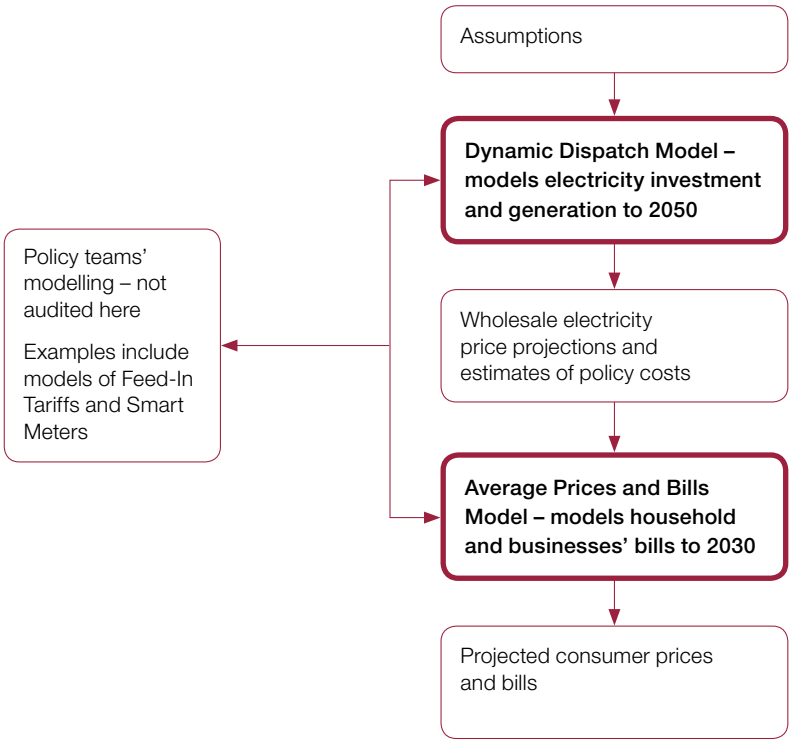
h **The Department should present the uncertainty around its estimates of price and bill impacts more explicitly.**

Part One

The Department's modelling

1.1 The Department of Energy & Climate Change (the Department) has carried out substantial modelling work to support its decisions about policies to encourage investment in low-carbon technologies. The two most important models for estimating the impacts of energy and climate change policies on consumers are the Dynamic Dispatch Model (DDM) and the Average Prices and Bills (APB) model. The links between the Department's models are shown in **Figure 1**.

Figure 1
The Department's modelling of impacts on consumer energy bills



Note
1 Assumptions include wholesale fuel prices, level of demand, costs of new technologies, rates of new building and investor hurdle rates.

Source: National Audit Office analysis of Department of Energy & Climate Change documents

1.2 The Department's primary uses for these models are to assess the impacts of policies, to forecast future developments and to inform public debate. The models can also help to identify the Department's projections of the impacts of infrastructure investment, although this is not their main purpose. In its return to the Macpherson review of quality assurance of government models, the Department identified the DDM as one of its 'business-critical' models, because of its role in informing decisions on Electricity Market Reform and in spending negotiations with the Treasury.[4] For instance, the Department used the DDM to inform its thinking on the cap on levy-funded spending under the Levy Control Framework.

The Dynamic Dispatch Model

1.3 The DDM is an electricity supply model that allows users to analyse the effects of different policy decisions on the electricity market. The Department uses the DDM to forecast electricity dispatch from power generators and investment in generating capacity from 2010 to 2050, under many different assumptions.

1.4 The Department commissioned the consultancy firm Lane Clarke & Peacock (LCP) to build the DDM after tendering for bids in November 2010.[5] LCP developed the model to incorporate a 'stochastic' mode that would enable users to assess the range of uncertainty associated with the results. However, the Department does not currently use this feature as the range of variables that can be specified as stochastic is limited, and policy settings cannot be included. The model also takes a long time to run in stochastic mode. The Department has since commissioned LCP to carry out further developments. For instance, in 2013 it asked LCP to update the model in advance of using it to inform the delivery plan for Electricity Market Reform, including the incorporation of more types of wind generation.

1.5 The DDM aims to simulate the behaviour of individual investors and generators. Investors are assumed to invest in new power plants if they expect to make a profit from doing so, based upon factors such as their cost of financing, expected future electricity supply and demand, and the policy environment. Similarly, owners of power plants supply electricity to the grid if the price is sufficiently high to make this beneficial to them. Investors and generators are assumed to act broadly competitively, with no coordination among them.

1.6 The DDM is very flexible, allowing users to examine the impact of different detailed assumptions about, for instance, fossil fuel prices, the costs of new technology and the extent of government support for low-carbon generation. It produces a wide range of outputs, including the simulated future path of electricity generation and investment, wholesale electricity price projections, the level of carbon emissions and the extent of spare generating capacity.

4 The Macpherson review required all departments to identify their business-critical models, and made recommendations for how best to assure their quality. The Department of Energy & Climate Change identified a total of 12 business-critical models. See HM Treasury, *Review of quality assurance of government analytical models*, March 2013.

5 LCP programmed the DDM's core simulation engine in the programming language C#, allowing simulations to be run more quickly than in an equivalent Excel-based model.

1.7 The Department uses the DDM's outputs as inputs to several other models, including the APB model. It also used the DDM to inform its development of the July 2013 draft delivery plan for Electricity Market Reform. This helped it to understand the likely cost to consumers of support for low-carbon generation under different possible scenarios.[f]

The Average Prices and Bills model

1.8 The Department developed the APB model to estimate the impact of policies to combat climate change on gas and electricity prices and household and business energy bills. The Department initially developed the APB model to inform The UK Low Carbon Transition Plan in July 2009.[g] It has subsequently refined it to incorporate additional factors and to allow it to project policy impacts up to 2030, although it is inevitably less confident in its estimates for later years. It was developed in-house using Excel.

1.9 The APB model incorporates inputs from several other departmental models, including the DDM. It does not simulate consumer or firm behaviour in detail, but instead assumes that changes in wholesale prices are passed through to households with a one-year lag and other costs are passed through fully in the year they are incurred. So, for instance, if a policy change causes wholesale prices to rise, there will be a corresponding increase in the price paid by households one year later. Changes to electricity supply costs (for example, due to changes in policy costs) are assumed to be spread evenly across all relevant electricity consumers, meaning that simulated electricity suppliers do not decide to concentrate price rises on households rather than businesses.[6]

1.10 Users of the APB model can specify in detail the policies they wish to focus on and the level of key input variables. Different policies can be turned on or off, enabling isolation of the impact of individual policy changes. Three broad categories of policy impact are included, with some policies having more than one impact:

- Impacts on the wholesale price of energy, through policies such as Electricity Market Reform, a package of measures designed to stimulate investment in low-carbon electricity generation.
- Direct impacts on supplier costs, through policies such as the Renewables Obligation, which requires electricity suppliers to buy certificates from generators of renewable electricity, and Electricity Market Reform.
- Direct impacts on the amount of energy consumed, through policies such as the European Union's products policy, designed to increase the energy efficiency of appliances.

6 For example, if a policy relates to households only (such as the Energy Companies Obligation), then costs are only spread over households.

1.11 The APB model incorporates estimates of increases in future electricity network costs based on Ofgem's RIIO price control proposals.[7] Future gas network costs are based on average costs over the last decade. However, given the difficulties with identifying network cost requirements in the absence of policies, the modelling does not currently separate out the proportion of network costs that are a result of policies. Supplier costs and profit margins are based on historical data published by Ofgem and the model does not assess how policies could affect these in the future (see paragraph 2.23 and 2.24).

1.12 The main outputs of the APB model are estimates of the future impact of policies on electricity (and gas) prices and bills, up to 2030. The Department has published three reports estimating the impact of its policies on household and business energy bills, in 2010, 2011 and 2013.[h] It plans to continue publishing regular updates to its estimates. It also publishes estimates of the impacts on particular groups, such as those with low incomes, using the APB model along with the Distributional Impacts Model for Policy Scenario Analysis, originally developed by the Centre for Sustainable Energy. The Department also includes estimates of prices and bills impacts in individual policy Impact Assessments where relevant.

The Department's estimates of price and bill impacts

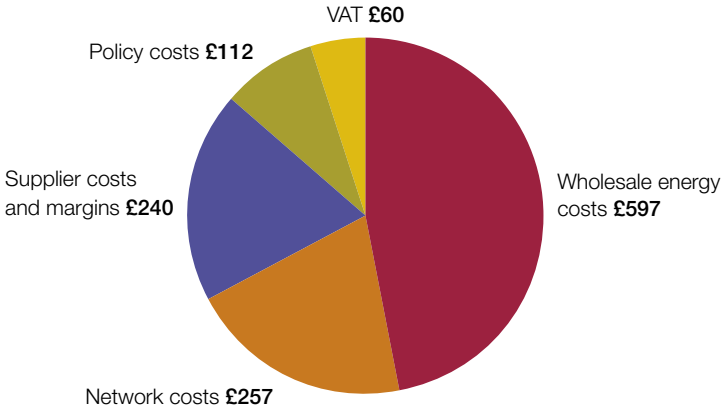
1.13 For context, we describe here some of the results of the Department's modelling. In its 2013 report on price and bill impacts, the Department estimated that, in 2013, the energy bill for a typical UK household that uses both gas and electricity will be £1,255, in 2012 prices.[8] **Figure 2** shows the Department's estimated breakdown of this bill.

7 RIIO stands for Revenue = Incentives + Innovation + Outputs. It is Ofgem's performance-based framework for setting network companies' price controls for the next eight years.

8 Average household bill after Warm Home Discount rebate netted-off. A typical household is assumed to consume 16.6 MWh of gas and 4.5 MWh of electricity each year, before the impact of policies to reduce consumption. Consumption levels in 2013 after reductions in consumption are 14.8 MWh of gas and 3.8 MWh of electricity.

Figure 2

The Department's estimate of the composition of a typical 2013 household energy bill



Notes

1 Average household energy bill in 2013 is £1,267 before the Warm Home Discount rebate and £1,255 after.

2 Figures are in 2012 prices.

3 In constructing this estimate, the Department assumes that the impact of policies on prices or consumption is spread evenly across all affected consumers (both domestic and business) on the basis of the amount of electricity they consume.

4 'Policy costs' include carbon costs and 'Wholesale energy costs' exclude carbon costs.

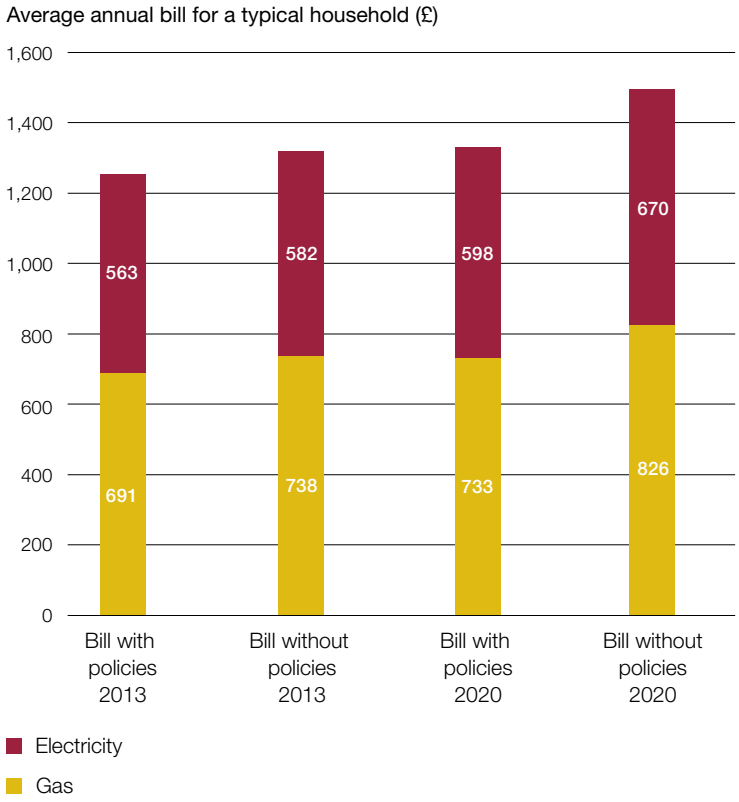
Source: *Estimated impacts of energy and climate change policies on energy prices and bills*, Department of Energy & Climate Change, 2013

1.14 Under its central fossil fuel price assumptions, the Department expects energy bills to increase up to 2020, but expects the rise to be smaller than it otherwise would be as a result of its policies (**Figure 3** overleaf). This is because the Department expects the cost of policies to encourage investment, such as support for low-carbon generation, to be outweighed by the benefits of policies in increasing energy efficiency, such as the EU's products policy and Smart Meters.

Figure 3

The Department's expectation of energy bills, with and without policies in 2013 and 2020

The Department expects the rise in energy bills between 2013 and 2020 to be smaller than it otherwise would have been, as a result of its policies



Notes

1 Figures are in 2012 prices.

2 The Department also carries out sensitivity analysis based on changing fossil fuel prices. This analysis finds that the likely range of the bill in 2020 with policies is between £1,103 and £1,542, while the range of the bill without policies is between £1,174 and £1,794.

Source: *Estimated impacts of energy and climate change policies on energy prices and bills*, Department of Energy & Climate Change, 2013

Estimated effects on different households

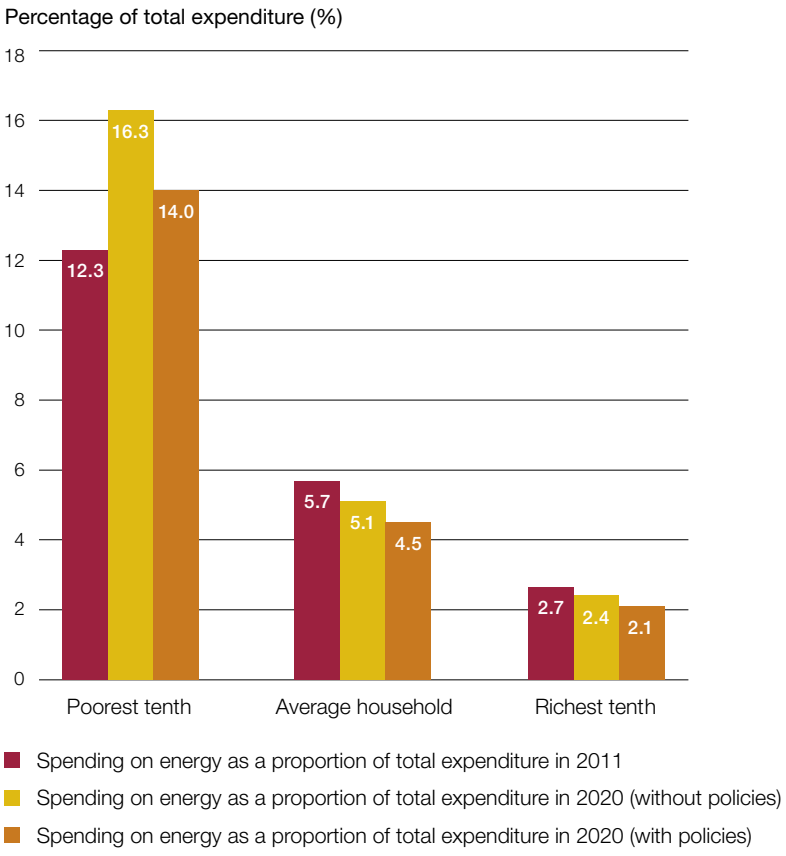
1.15 The Department's main focus is the average impact of its policies on households, but it also estimates the impact of its policies on households with differing:

- expenditure level;
- composition (for example, number of children, pensioners);
- heating fuel (for example, solid fuel, gas, electricity);
- tenure type (owner-occupied, privately rented or socially rented); and
- location (urban, town, village or hamlet).

1.16 The Department expects that, in 2020, on average households at all expenditure levels will be made better off by its policies than if the policies had not been put in place, in terms of the proportion of their spending that goes on energy. For the poorest tenth of households, it expects energy costs to represent 14.0 per cent of spending in 2020, compared with 16.3 per cent if energy and climate change policies did not exist (**Figure 4**).

Figure 4

The Department expects spending on energy as a proportion of total spending to remain high, for the poorest households, but expects its policies to mitigate the impact



Notes

1 The 'poorest tenth' refers to the lowest equivalised expenditure decile.

2 The 'average household' here is defined as the average of the fifth and sixth equivalised expenditure decile.

3 The 'richest tenth' refers to the highest equivalised expenditure decile.

4 Using its distributional impacts model, which we did not audit, the Department found that the modelled numbers for 2011 were different than those based on the Living Costs and Food Survey, at 16.2 per cent for the poorest tenth, 5.2 per cent for the average household and 2.5 per cent for the richest tenth. It explains the discrepancy as reflecting differences in assumed levels of household energy consumption.

Source: *Estimated impacts of energy and climate change policies on energy prices and bills*, Department of Energy & Climate Change, 2013 and the *Living Costs and Food Survey*, Office for National Statistics, 2012

The Committee on Climate Change's estimates

1.17 The independent Committee on Climate Change has also estimated household energy bills to 2020.[i] It expects bills to increase from £1,035 in 2011 to £1,195 in 2020, or 15 per cent, after taking into account the impact of energy efficiency measures. Of the £160 increase, it expects support for low-carbon investment to add about £100 to average bills in 2020. These estimates are similar to those of the Department, but the figures are not directly comparable because the Department:

- assesses impacts of policies that have already been delivered as well as future policies;
- includes a wider range of policies such as Smart Meters; and
- measures the average impact across all households, including those which only consume electricity. Since 'electricity-only' households typically consume more energy in total, this means that the Department's estimates of average bills are higher.[j]

Part Two

Model assessment

2.1 We assessed both the Dynamic Dispatch Model (DDM) and the Average Prices and Bills (APB) model against our framework for model audit, which we describe in the Annex. We have used this framework during several previous studies including those covering the Work Programme[k] and the franchising of West Coast Main Line.[l] The framework considers:

- model concept and design, including the rationale and scope;
- model build and development, including the Department's process for quality assurance;
- model input data;
- model assumptions, including the range of assumptions considered;
- testing of model sensitivity; and
- making use of the outputs.

2.2 We expect models to be fit for the purposes for which they are used, meaning different standards are appropriate in different situations. Since the DDM is a business-critical model, we would expect it to score highly against all aspects of our framework. We assessed the APB model against a slightly lower standard, since the Department of Energy & Climate Change (the Department) does not identify it as business-critical, but its high profile means that we would still expect it to score highly overall.

2.3 We need to caveat our assessment as we had limited access to the DDM. In particular, the Department allowed us to carry out sensitivity tests on the DDM and APB model in situ in the Department, but did not allow us to analyse the results of our tests on the DDM, citing a lack of staff resources to be able to quality-assure the findings. We also did not assess in detail how the Department makes use of the model outputs.

2.4 We predominantly report by exception below, meaning that we concentrate on those areas where our audit identified weaknesses. We do not report comprehensively on the strengths of the two models. Overall, we found that both models perform well in many areas, but we had several concerns.

The Dynamic Dispatch Model

Model concept and design

2.5 The rationale for the DDM is clear and its documentation is comprehensive, including a detailed user guide produced by Lane Clarke & Peacock (LCP). No model can include all possibly relevant factors, but most of the design decisions in the DDM about how to model investor and generator behaviour appear reasonable. However, external experts[m] and our own assessment raised four potentially important issues:

- **Strategic behaviour**. Previous experience of periods of high wholesale prices suggests that strategic behaviour could sometimes be an important factor in determining customer bills. The DDM assumes that generator mark-ups above the system short-run marginal cost increase as capacity becomes scarce, due to the exercise of market power.[9] However, like other large-scale models of the electricity market, the DDM does not model strategic behaviour by generators in detail. It also does not currently allow for strategic behaviour by investors, such as the possibility that investors could decide to reduce investment in order to create tight capacity margins in future.

- **Multiple power plants**. The DDM treats each investment decision independently. In reality, many companies will own more than one power plant, or will operate in both the wholesale and retail markets. This is particularly likely where construction costs are high and uncertain, such as for nuclear and offshore wind power plants. Multiple plant ownership allows greater hedging of risk, and could make firms more willing to accept lower rates of return on individual investments. It could also make collusion between firms and strategic behaviour more likely.

- **Network costs**. Generation assets are often far from electricity consumption markets, meaning that new transmission networks could represent a substantial extra cost. The DDM initially omitted this effect, but National Grid has recently developed a high-level Excel model to understand better the costs associated with electricity transmission. The Department has now incorporated this model into the DDM, and used the results of this modelling to inform its draft delivery plan for Electricity Market Reform. The Department's focus on transmission network costs is appropriate, since these represent the bulk of future increases in network investment. But the Department recognises that there is further to go in fully incorporating network costs in the model.

- **Consistency with National Infrastructure Plan**. The DDM currently predicts that only around three-quarters of the level of energy investment identified in the National Infrastructure Plan is required to meet government objectives. This is because the DDM calculates the level of investment required based on assumptions such as future energy demand and the amount of investment in renewables required to meet carbon reduction targets. In contrast, the National Infrastructure Plan shows investment planned by companies, adjusted down to reflect that not all proposed investment is likely to go ahead.

9 This assumption is based on research commissioned from Redpoint Energy by the Department.

Model build and development

2.6 The Department commissioned LCP to build the DDM following an initial competitive tender process, and has commissioned it to carry out subsequent developments to the model. We found weaknesses in the Department's engagement with the model development. For instance, although the DDM has been modified multiple times since its inception, the Department's documentation of these changes is unsystematic. Unlike with the 2050 Calculator, one of the Department's other business-critical models, the Department does not maintain a detailed log of changes to the DDM.

2.7 More significantly, the Department's quality assurance of the DDM during the build and development process has been dependent on LCP. The Department has recently revised its internal guidance for quality assurance of models, which sets out a list of required procedures, depending on the time available. For a model of the importance and complexity of the DDM, it requires a full code review by somebody not directly involved with the project, a full analytical review, thorough data quality checks and a specification test. It also requires a quality assurance plan from early in the model-building process, and a Model Quality Assurance Log as changes to the model occur. These processes are sensible, and would provide thorough assurance of the model. The model is scheduled for a formal review by the Department's Modelling Quality Assurance Team to ensure it is compliant with the updated guidance.

2.8 We found that the Department has carried out some of the required processes, but gaps remain:

- LCP carried out a review of its code as part of its contract for building the model initially. Given the potential for conflicts of interest, we would expect the Department to gain assurance on the extent of this review, but we have no evidence of it having done so.

- Two external panels have reviewed the model. LCP commissioned two academic experts to review it when it was first built.[n] In July 2013, an expert panel reviewed it as part of the consultation on the draft delivery plan for Electricity Market Reform.[o] These reviews are valuable, and both panels found that the model functioned broadly as expected. The functional testing carried out in the first review encompassed a range of sensitivities and scenarios, including changes to capital costs, fuel prices, carbon prices and constraints on key technologies. However, both panels noted that their reviews were conducted under time pressure, and had not had the opportunity to examine the model coding.

- The Department's Model Quality Assurance log lists 40 tests required of the DDM, of which 36 are considered 'high' priority, and the remaining 4 'medium' priority. To date, the Department assesses that it has completed 18 of these tests. Twenty tests are partially completed and two remain outstanding.

2.9 The DDM is not in the public domain, meaning that there is little opportunity to benefit from external quality assurance, or 'armchair auditors'. The Department publishes outputs from the DDM regularly, such as in the annual Updated Energy and Emissions Projections and the draft Electricity Market Reform Delivery Plan. But it has only published a 900-word description of the model,and does not allow external commentators to use the model or investigate its coding.[p] In contrast, users of the 2050 Calculator are able to explore the impact of changing assumptions, see a complete log of changes to the calculator and download the model code directly to their computers.[q] While such full transparency might not be appropriate for the DDM, greater transparency could help to improve the model and to increase public confidence in its results.

2.10 We believe that the weaknesses in the Department's quality assurance and model testing (see paragraphs 2.14 to 2.16) give rise to risks that the DDM has flaws that have been overlooked. This is particularly concerning, since the problems faced by the franchising of West Coast Main Line, and the subsequent Macpherson review of government modelling, demonstrate the need for robust quality assurance.[r] It is therefore vital that the Department ensures that the DDM is brought into line with its quality assurance processes.

Model data

2.11 As a projection model the DDM's results are predominantly driven by assumptions about future developments. The most important input data concern current electricity generating capacity and the terms under which current generators operate, since current capacity is a key determinant of future capacity. We did not identify any errors in these data.

Model assumptions

2.12 The DDM incorporates assumptions in many different fields; the Excel reference case input file contains 63 different assumption worksheets, allowing users to input assumptions on factors including costs of different technologies and fuels, the path of future demand and investor costs of financing. Users are typically able to vary these assumptions over time. Many of the inputs to the DDM are inherently uncertain, and the Department has commissioned several studies to inform its choice of assumptions.

2.13 The Department assesses different ranges of assumptions for different analyses. In our review, we focused on the range of assumptions that the Department considered as part of the draft delivery plan for Electricity Market Reform. The Department told us that it uses a wider range of assumptions in some circumstances; for instance, it said that it used a wider range of technology cost assumptions in its analysis to support the Levy Control Framework.

2.14 In general, we found that the range of assumptions considered in the Electricity Market Reform draft delivery plan analysis was appropriate given the uncertainty involved. However, there are some key areas where the range of assumptions may be too narrow.

- **Technology costs.** The Department has used several sources to inform the technology cost assumptions in the DDM.[s] There remains, however, a high level of uncertainty around these assumptions. For instance, the Department's expert panel felt that there was a risk that construction costs for innovative technologies could remain higher than the Department supposes.[t] The uncertainty around construction costs is reflected in the range of variation between expert estimates. For example, in three reports commissioned by the Department, Parsons Brinckerhoff's central estimate of the cost of a new nuclear power station increased from £3,613 per kW of generating capacity in 2011 to £3,824 in 2012 and £4,206 in 2013, an increase of 16.4 per cent in two years.[10, u] However, the Department only considered scenarios in which construction costs vary by plus or minus 10 per cent from the central case.

- **Hurdle rates.**[11] In the consultancy firm Oxera's report for the Committee on Climate Change, high and low estimates of current hurdle rates for capital investments differed by as much as 5 percentage points, with even wider ranges in future years.[12] Also, the Department's expert panel suggested that hurdle rates could decline more quickly than the Department expects. The Department did not explicitly model variations in hurdle rate assumptions in its draft delivery plan analysis. It argues that its high and low technology cost scenarios are equivalent to variations in hurdle rates of between 1.5 and 2.9 percentage points.

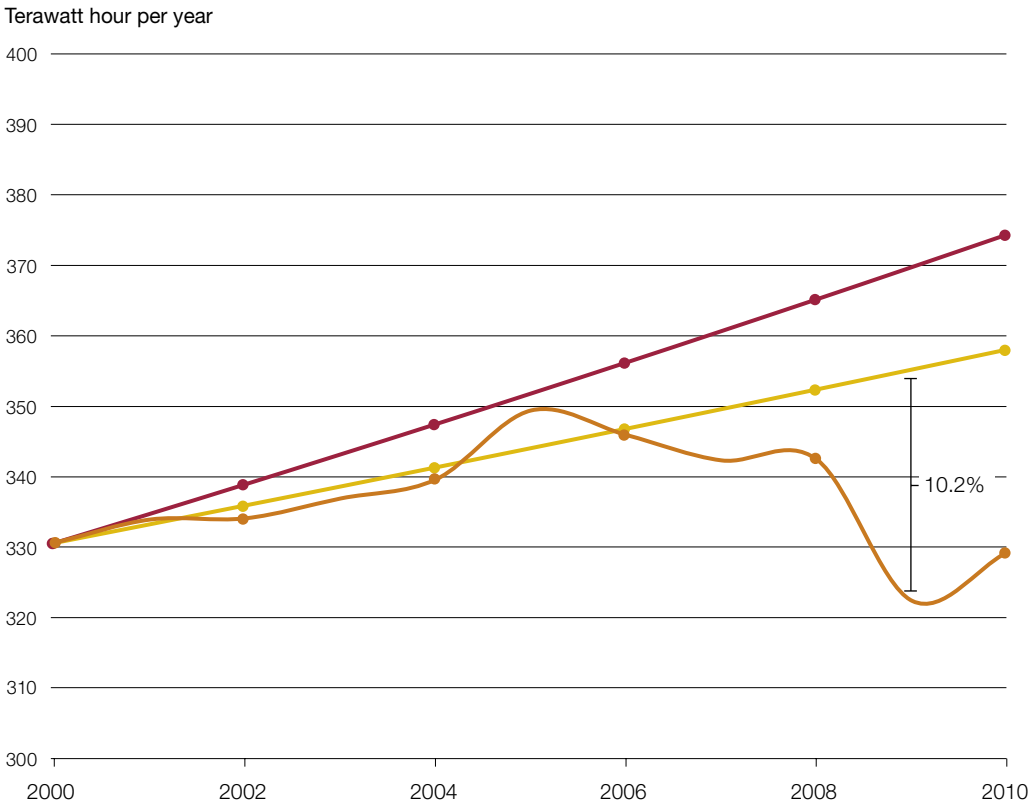
- **Demand.** The Department considered a narrow range of demand projections. In the period from 2011 to 2021, its high-demand scenario is always within 5 per cent of its central projection. Previous government demand forecasts have been out by more than 10 per cent over a similar time scale, largely due to the recent recession (**Figure 5** overleaf). This gives rise to the concern that policy is being informed by an incomplete assessment of plausible future scenarios. Were demand to be substantially higher than the Department expects, the DDM suggests that there would be risks of blackouts and increased energy prices.

10 Figures are adjusted to 2012 prices using HM Treasury's GDP deflator
11 An investor's "hurdle rate" is the minimum rate of return they require to invest.
12 For instance, Oxera estimated that the range of current discount rates for carbon capture and storage plants was between 12 and 17 per cent. Oxera, *Discount rates for low-carbon and renewable technologies*, 2011.

Figure 5

Forecasts of electricity demand from the year 2000 compared with actual demand

Previous forecasts of electricity demand have differed significantly from outcomes



	2000	2002	2004	2006	2008	2010
2000 DTI high prediction	331	339	347	356	365	374
2000 DTI low prediction	331	336	341	347	352	358
Actual outcome	331	334	340	346	342	329

Source: Department of Trade and Industry, *Energy Paper 68*, 2000, and Department of Energy & Climate Change, *Historical electricity data: 1920 to 2012*, July 2012

Model testing

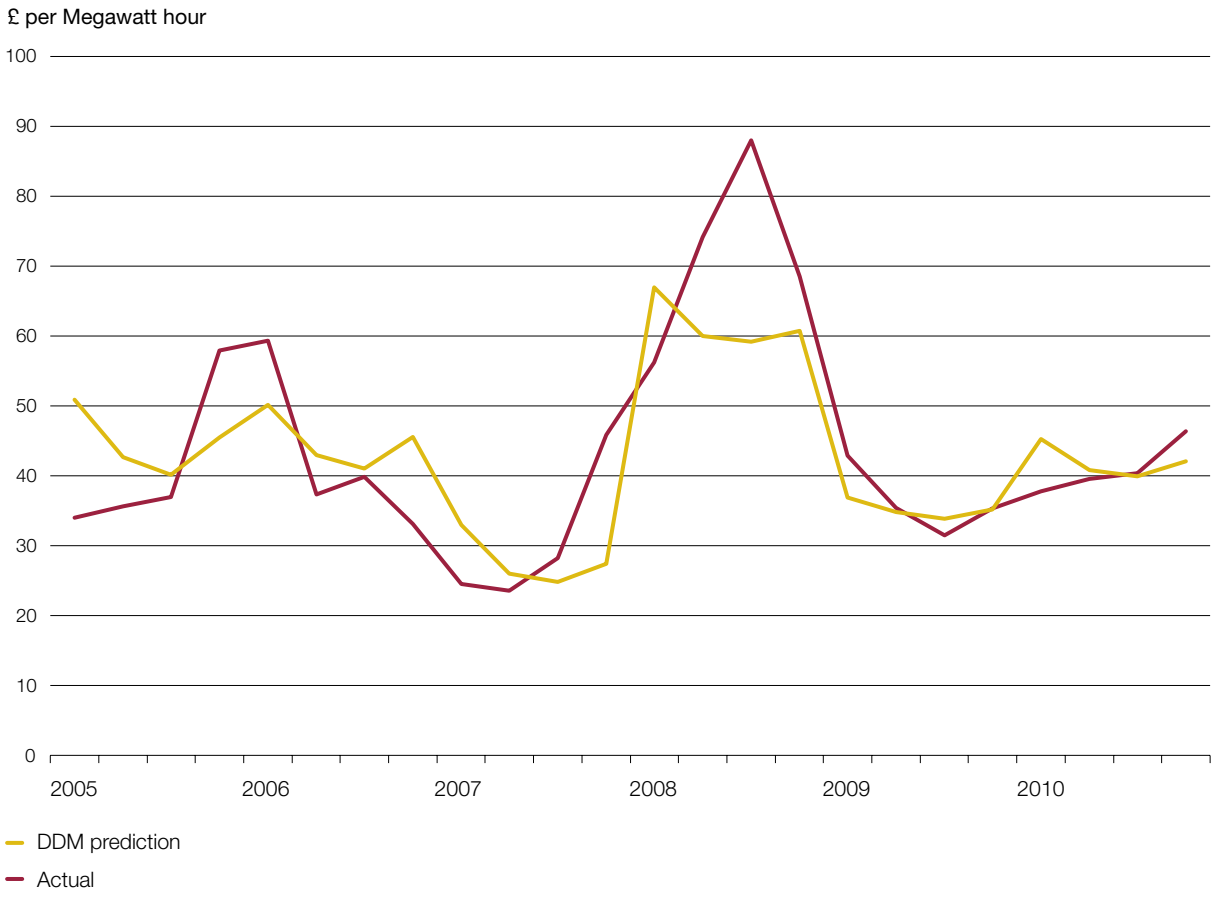
2.15 Rigorous testing of models is essential to ensure their reliability and to check whether model results are robust to reasonable changes in input assumptions. The Department has tested the DDM in three principal ways:

- **Scenario modelling**. For instance, in conjunction with the Department, National Grid modelled ten different scenarios in its analytical report for the Department's consultation on the Electricity Market Reform delivery plan.[v] These include a low fossil fuel price scenario, and scenarios in which technology costs are either higher or lower than the baseline case.

- **Sense checks of output files**. The Department compares the outputs from the model to its expectations. For instance, it checks whether an increase in fossil fuel prices leads to an increase in wholesale electricity prices, as would be expected.
- **Comparison of model projections to outturns**. During the commissioning phase of the original model, LCP carried out an exercise to compare price projections and generation mixes to historical data (**Figure 6**). Overall, there is a reasonably good agreement between the model output and outturn. However, there is a sustained period in 2008 where the actual wholesale price was up to 50 per cent higher than the model would have predicted. LCP and the Department noted that generator mark-ups were higher than expected during this period, but were not able to explain the discrepancy.[13]

Figure 6

LCP's comparison of model forecasts of the wholesale electricity price against outturns



Note

1 Figures are in 2010 prices.

Source: LCP comparison of forecasts to actual outturns

13 The Department provided us with its analysis showing that another large-scale dispatch model also struggled to explain wholesale price developments in 2008.

2.16 This testing has been valuable in improving the DDM and the Department's understanding of it. Members of the DDM team have run many scenarios beyond the published ones, providing them with a good knowledge of the factors that drive the model results. After developments to the DDM, the Department also carries out functional testing to assess whether the changes produce the expected results. However, we have identified two deficiencies which cause us concern:

- The Department's scenario analysis has not isolated systematically the impact of varying individual input assumptions. The Department told us that it looks at the impact of changing individual assumptions as the scenarios are developed, but the final scenarios involve many other changes to assumptions, particularly to the strike prices of Contracts for Difference to ensure that the modelled outcomes fall within budgetary and other constraints.[14] Furthermore, the range of variation in assumptions is sometimes relatively narrow compared to historical experience (see paragraph 2.13), although the Department has considered a wider range of scenarios in its internal work.

- The Department has not carried out any further detailed comparison of the model outputs to reality since the model was commissioned, despite the substantial changes to the model since 2011. The Department told us that it has not repeated the earlier exercise with more recent versions of the DDM, because doing so would be too resource-intensive. However, each time the DDM is run, the model starts projecting from the beginning of 2010, allowing a comparison of results from 2010 to 2012 with outturns. The Department told us that this comparison shows good agreement between the model's output and the average outturn for the year, with predicted wholesale electricity prices being within £3 (or 7 per cent) of actual prices in each year from 2010 to 2012. The Department also provided us with evidence showing that recent DDM projections are broadly in line with those of other major electricity market models.

2.17 In response to our concerns about the level of sensitivity testing, the Department allowed us to carry out sensitivity tests on the DDM in situ in the Department, but did not allow us to analyse the results of our tests, citing a lack of staff resources to be able to quality-assure the findings.

Making use of model outputs

2.18 We did not review the Department's use of DDM outputs except insofar as they enter into the APB model, as our focus was on the operation of the DDM itself. We will assess the use of DDM outputs for informing the Levy Control Framework in future work.

14 Under Contracts for Difference, electricity generators will receive the market price plus a 'top up' to an agreed level, called the 'strike price'. If the market price exceeds the strike price, the generator will have to pay back the difference.

The Average Prices and Bills model

Model concept and design

2.19 We found that the APB model is documented to a high standard, and it is relatively easy to use and understand. Inputs, analysis and outputs are separated, allowing users to see clearly the structure and elements of the model.

2.20 Overall, the design approach for the APB model was reasonable. Many of the model's important design choices cover energy supplier behaviour and consumer take-up of energy efficiency measures.[15] We noted two issues for the Department to consider:

- The APB model assumes that energy suppliers pass through completely wholesale price changes to household bills, after a one-year lag due to supplier hedging.[16] This is a reasonable approach, but it may not fully reflect supplier behaviour, such as the possibility that they will pass through price increases more quickly than price falls.
- For its distributional analysis, the Department assumes that only those consumers who will benefit financially might choose to take up energy-saving measures. It then supposes that a proportion of these consumers will actually take up such measures, based on its analysis of previous energy-efficiency policies. This is a reasonable approach, which should be updated as further information emerges on take-up rates.

Model build and development

2.21 The Department built the APB model in-house, and has continually refined it as issues arise. We found no issues with the way in which the Department built the model, but again found that quality assurance of its build and development has been limited. For instance, we found no evidence of the Department having tested the formulas systematically. Its quality assurance currently focuses on inputs and outputs to the model, with less focus on the model coding. This creates risks that the APB model could contain errors that have not yet been identified. The Department told us that it is working to improve the quality assurance of the APB model.

Model data

2.22 Most of the data used in the APB model come from policy modelling teams within the Department, the central modelling team or from the DDM. This includes data on the expected impact of policies on energy consumption, wholesale prices of gas and electricity, supplier costs and network costs. The APB model team sense-checks these data as they arrive. We did not identify any major issues with the use of data within the APB model.

15 We did not audit the Department's assumptions around the effectiveness of energy-efficiency policies.
16 Suppliers often agree to purchase the inputs they require in advance at a set price, helping to insulate them against changes in the wholesale price.

Model assumptions

2.23 The APB model brings together:

- **Impacts of policies on consumption**. The estimated impact of the Department's policies on levels of energy consumption comes from policy teams' analysis of the effects of their policies. For instance, the Department expects Smart Meters to decrease household electricity consumption by 2.8 per cent annually and household gas consumption by 2 per cent annually.[w]
- **Wholesale prices**. Estimates of future wholesale electricity prices come from the DDM, which can be run both with and without individual policies to estimate their effects. Estimates of future wholesale gas prices come from forward market prices and the Department's estimates of the long-term costs of gas supply.
- **Policy costs**. Estimates of policy costs come from individual policy teams. For instance, the Energy Company Obligation is projected to cost energy suppliers an average total of £1.3 billion per year until 2022, in 2012 prices.[x]
- **Supplier operating costs and margins.** Estimates of supplier operating costs and margins are based on Ofgem data. The model assumes that supplier operating costs stay fixed over time and that supplier margins are a fixed percentage of wholesale costs.
- **Network costs** (transmission, distribution and metering costs and balancing costs). The model bases future electricity transmission and distribution charges on allowed revenue under Ofgem's RIIO price control proposals. Gas transmission and distribution costs are projected forward using the trend over the last ten years. Metering costs are assumed to stay flat in real terms. Balancing costs are projected forward based on a five-year historical average.

2.24 The Department has devoted substantial resources to understanding how the first three factors above will develop over time. The Department bases its estimates of total future electricity network costs on the latest Ofgem estimates, but it is less informed about the proportion of these costs that are driven by its policies and how its policies could affect supplier costs and margins. The APB model currently does not allow for possible strategic behaviour by suppliers, such as coordinated price increases. The Department estimates that network costs and supplier costs and margins currently make up 39 per cent of a typical household energy bill (see Figure 2).

Model testing

2.25 Although the Department does not consider the APB model to be business-critical, it regularly publishes outputs from it, most recently in March 2013.[9] We would therefore expect the APB model to be thoroughly tested. However, we found some weaknesses in the Department's testing:

- The Department had only tested the sensitivity of its outputs to changing fossil fuel prices. It had not investigated other sensitivities.
- The Department had not systematically assessed the performance of its projections against actual outcomes during the period since its development.

2.26 At our request, the Department carried out further testing of the model by assessing the impact of the 14 scenarios it developed as part of the Electricity Market Reform delivery plan. **Figure 7** overleaf shows the results of this testing. Most of the scenarios have a relatively small impact on projections of consumer bills, with fossil fuel price developments being most important. However, as described in paragraph 2.15, other key variables have been changed in each scenario, so it is not possible to isolate the impacts of individual variables. Also, the range of variation differs across the scenarios, and in some cases is relatively small.

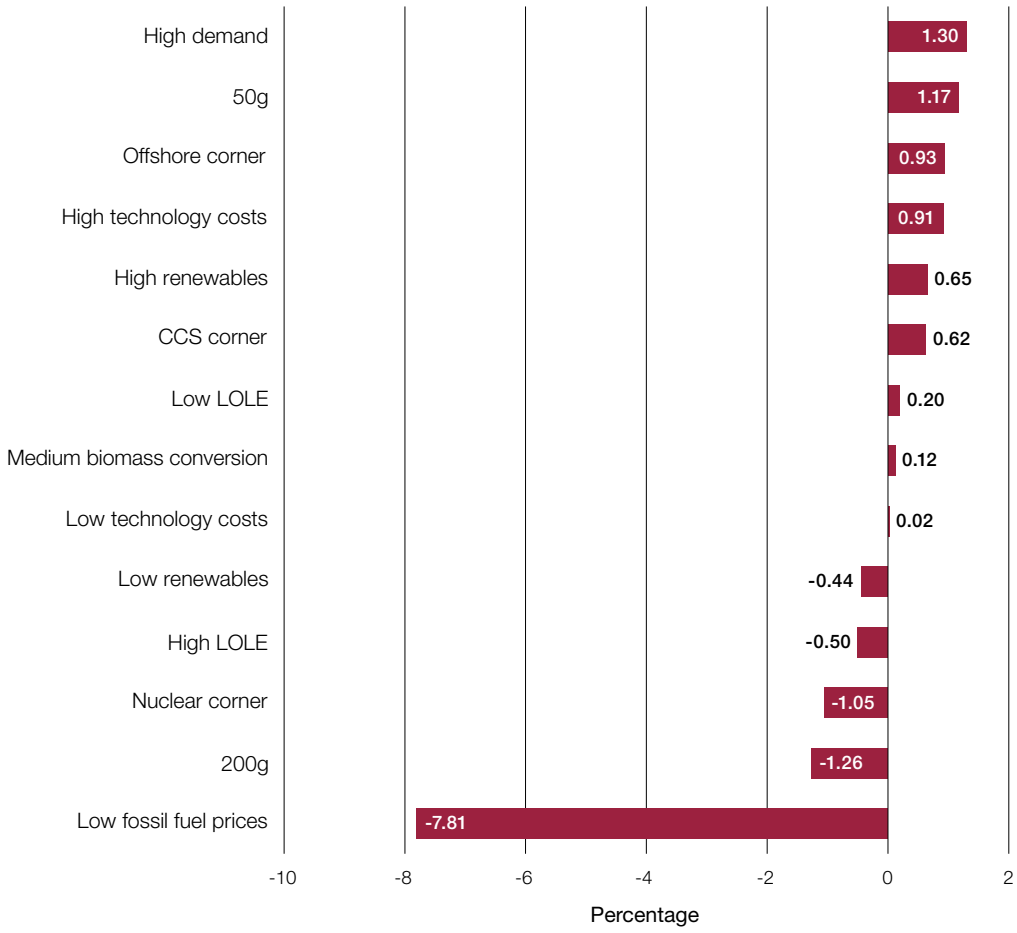
2.27 Also at our request, the Department carried out an exercise to compare estimates from the model with outturn data for the years 2010 to 2012. It found that estimates of domestic retail gas prices were within 5 per cent of outturns and estimates of domestic retail electricity prices were within 16 per cent of outturns.

- On retail gas prices, the Department underestimated actual prices in 2012 by 5 per cent in its July 2010 projections, and overestimated them by 5 per cent in its November 2011 projections. The Department thinks that this is due to previous inaccuracies in its projections of supplier costs and variations in wholesale gas prices. The methodology used to estimate supplier margins has changed between the three reports. In the 2010 report, the Department assumed a fixed £/MWh supplier margin. In 2011, it assumed a fixed percentage gross margin. In 2013, it assumed that supplier costs are split into a fixed level of operating costs per MWh and a percentage margin, reflecting updated information.
- On retail electricity prices, the Department underestimated actual prices in 2012 by 1.4 per cent in its July 2010 projections, and overestimated them by 15.2 per cent in its November 2011 projections. It explains this as resulting from changing estimates in the size of supplier costs and margins and variations in the wholesale electricity price. In 2013, the Department updated its assumptions and methodology for projecting supplier costs and margins.

Figure 7

Impact of a range of scenarios on expected household electricity bills between 2016 and 2030

The percentage difference from the reference case



Notes

1 The reference case is the 100g case from the Electricity Market Reform Impact Assessment.

2 100g, 50g and 200g refer to the carbon intensity of the electricity generation mix in 2030.

3 LOLE stands for Loss of Load Expectation. It refers to the amount of time when there is lost load.

4 Nuclear corner, Offshore corner and CCS corner refer to the cases where relatively more nuclear, offshore wind turbines, or carbon capture and storage plants are built.

5 The impacts given here are the average impact from 2016 to 2030.

Source: Department of Energy & Climate Change

Making use of model outputs

2.28 We did not review in detail how the Department uses the outputs of the APB model. The presentation of results in its prices and bills reports is clear and comprehensive, including discussion of the drivers of uncertainty. However, it does not note explicitly the range of variability around its central estimates. This could leave the reader with a misleading impression of precision in estimates that are intrinsically highly uncertain.

Annex

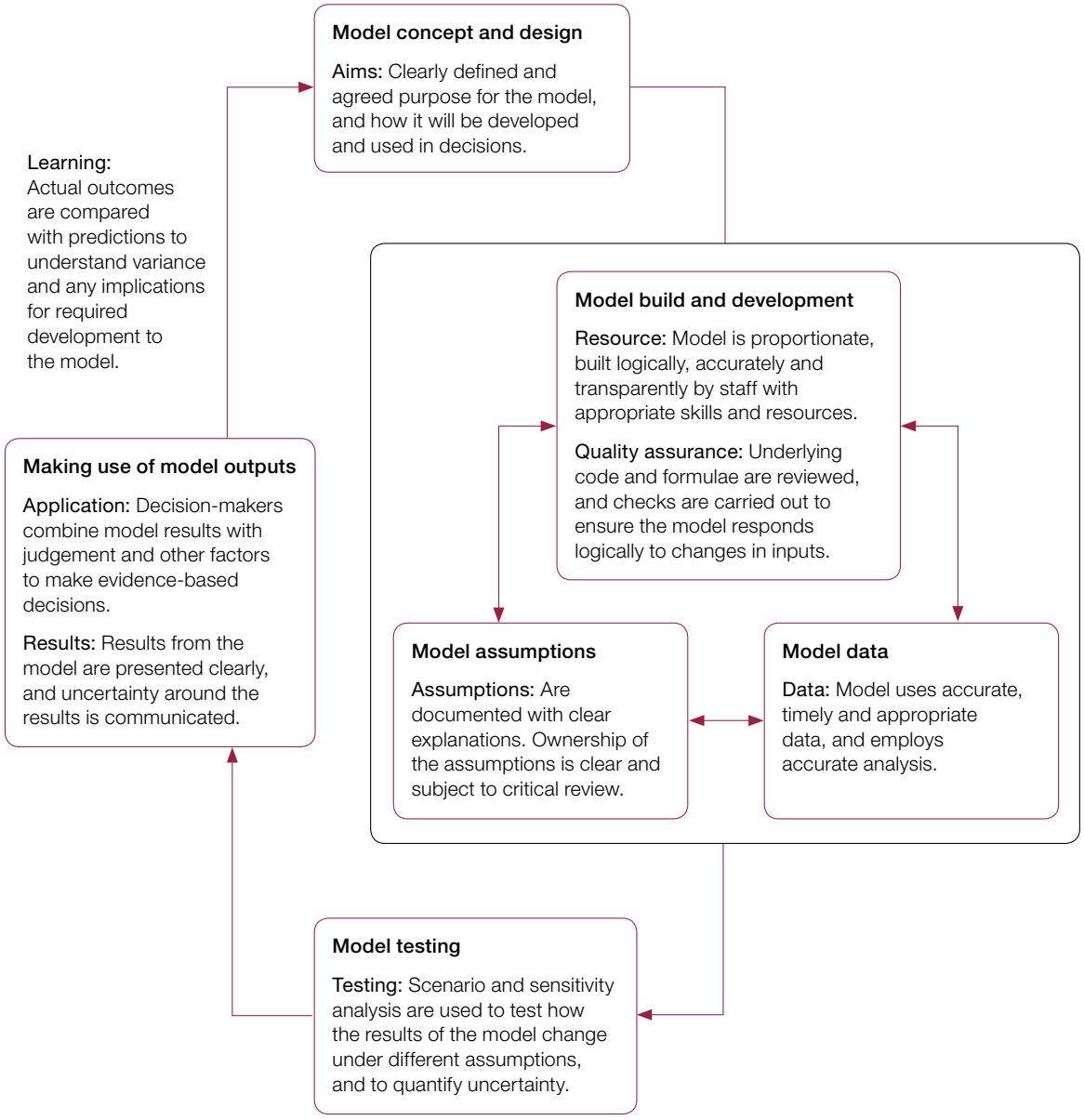
Our framework for auditing the Department's models

1 **Figure 8** gives an overview of our model audit framework, under which we assessed both the DDM and the APB model. Due to the cost involved and our limited access, we did not review the coding of the DDM, but instead reviewed the Department's own assessment of the code. Our audit questions included:

- **Model concept and design.** Is there convincing evidence of the rationale and the scoping of the model concept?
- **Model build and development.** Was the model subject to sufficient review during and after development? Does the model respond logically to basic changes being made to the model inputs?
- **Model data.** Are the input data of good quality?
- **Model assumptions.** Are the model assumptions appropriate? Are the details of these assumptions recorded and rationalised?
- **Model testing.** Has sensitivity analysis been performed around projections in the model? Do changes to uncertain inputs have a significant impact on outputs?

2 We did not assess the use of the model outputs in detail. We did, however, consider how outputs from the DDM enter into the APB model, and how results from the APB model are presented to the public.

Figure 8
An overview of our model audit framework



Source: National Audit Office analysis

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Design and Production by
NAO Communications
DP Ref: 10286-002

National Audit Office

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ISBN 978-0-10-298705-8

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