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Trade and Industry Committee

Resilience of the
National Electricity Network

Third Report of Session 2003–04

Volume I

Report, together with formal minutes and an annex

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The Trade and Industry Committee

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Footnotes
In the footnotes of this Report, references to oral evidence are indicated by ‘Q’ followed by the question number. References to written evidence are indicated in the form ‘Appendix x’
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Summary

Following a series of power cuts in the UK and elsewhere in August to September last year, commentators expressed concerns about the resilience of the electricity network in the UK and suggested that there was an imminent and growing danger of blackouts.

Our inquiry into the condition of the national electricity network has led us to the conclusion that, although major power failures like those experienced in North America and Italy are unlikely to happen here, there is a danger that there is currently insufficient investment in the network to replace in a planned and orderly way equipment which is reaching the end of its life.

Coupled with this under-investment has been pressure to minimise operational expenditure, for example on maintenance and repair. While this pressure has doubtless resulted in reducing some inefficiencies, we think that to continue it may be counter-productive for network performance: ageing assets are likely to require more, and more skilled, maintenance. In relation to this, we also raise concerns about a likely shortage of highly skilled staff both to maintain and to reconstruct the network.

We also note the extra investment required to ensure that the network is ready for the anticipated changes to electricity generation over the next ten to twenty years: the expected closure of a number of large nuclear plants and the growth in renewable generation.

We were told that, simply to maintain present performance levels, capital expenditure by the network owners would have to double. Investment to meet environmental objectives (the renewables programme) and for any desired improvements in performance would be extra. Although the total sums involved are high, network costs form a smaller proportion of customer bills than the cost of generating electricity, so a substantial increase in investment need not result in a steep rise in electricity prices.

Network performance, especially by the transmission companies, is good. However, we consider that the Regulator’s concern to reduce costs to consumers should now be tempered by a greater emphasis on ensuring that electricity network owners have the financial resources necessary to secure a viable long-term electricity supply.
1 Introduction

1. During the evening rush hour on 28 August 2003 a power cut affected about 476,000 electricity customers in London, and caused severe disruption to parts of Network Rail and to London Underground. A further power cut affected about 200,000 customers in parts of the West Midlands on the morning of 5 September 2003. During the six weeks between 14 August and 28 September 2003 there were far more serious power failures in the North Eastern USA and Canada, Scandinavia (where the failure affected Southern Sweden and Eastern Denmark) and Italy. People began to ask serious questions about whether the London and West Midlands incidents indicated that very serious black-outs like those experienced in other countries could happen in the UK.

2. Both the Department of Trade and Industry (‘DTI’) and the industry regulator, the Office of Gas and Electricity Markets (‘Ofgem’), initiated studies into the cause of the incidents in England. Rather than replicating these detailed studies, we decided to launch a more general inquiry into the resilience of the electricity network in the UK, taking into account not only the causes of the recent problems but also looking more widely into the condition of the electricity infrastructure, the challenges likely to be faced by the network companies over the next few decades, and the roles of the DTI and Ofgem in ensuring that consumers in the UK have a reliable electricity supply. We also touch briefly on another question that has been troubling commentators recently, which is whether sufficient generating capacity is available; but we do not treat it in detail as we have already discussed this issue in our 2002 Report into the Security of Energy Supply. We were not, in this inquiry, interested in the response of the electricity companies to power cuts: we had already taken evidence on this subject in relation to our investigation into the aftermath of the wind storms of October 2002, and we intend to publish a separate Report on this issue shortly.

3. We started by focussing on the National Grid, the very high voltage electricity transmission system which moves electricity round the country from the large-scale fossil-fuel fired or nuclear generating plants to ‘bulk supply points’ where the electricity is transformed down to a lower voltage for onward movement via the distribution networks. However, the reliability of power supplies to customers depends at least as much on the ‘backbone’ transmission network, and in this Report we consider the electricity supply network as a whole.

4. In the course of our inquiry, we took formal oral evidence from officials from the Department of Trade and Industry, the Energy Networks Association, the Institution of Civil Engineers (‘ICE’), National Grid Transco (‘NGT’), Ofgem (the electricity and gas regulator), Prospect (the trade union), Scottish and Southern Energy plc and Scottish Power. We received nine written memoranda from other companies and individuals, which are listed on page 59 below. We are very grateful to all those who contributed to our

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1 A subsequent power failure in Cheltenham and Gloucester on 22 October 2003 affected 70,000 customers. This took place after we had announced the terms of reference of our inquiry into network resilience. We received no evidence on this power cut, and make no further reference to it in this Report.
3 275kV and 400kV lines
inquiry. We would also like to express our thanks to our two Special Advisers for this inquiry, Professor Richard Green of the University of Hull and Professor Daniel Kirschen of the University of Manchester Institute of Science and Technology.
2 Background

Responsibility for network reliability

5. Responsibility for ensuring reliable electricity supplies lies chiefly with the companies owning and operating the network. The operators’ licences lay down conditions requiring certain standards of security and quality of service. In the case of the transmission network, these standards are essentially the same as those that applied to the Central Electricity Generating Board before privatisation, and the operators argue that they are at least as high as those imposed on grid operators in other countries, and more stringent than most. The role of the regulator, Ofgem, is to monitor the companies to ensure that they meet their licence conditions. In the case of the distribution network operators (‘DNOs’), Ofgem has instituted a system of penalising them if they do not achieve specific standards of reliability; transmission companies are not subject to this regime. Ofgem is firmly of the view that it is the responsibility of the companies to ensure that they have the money and personnel that they require to ensure a high performance by their networks, and that it is not for the Regulator to attempt to manage this.

6. The DTI distances itself even further, pointing out that its responsibility is to set up a framework that enables Ofgem to do its work properly, and it is not for the Government to second guess the regulator. However, the DTI has some responsibility for strategic planning—together with Ofgem, it has set up the Joint Energy Security of Supply (‘JESS’) working group to consider long-term trends and issues relating to the security of energy supply—and the DTI’s Engineering Inspectorate is charged with the examination of technical issues relating to the safety and quality of energy supply. Moreover, the DTI’s role extends into areas in which Ofgem is not involved, such as the offshore oil and gas supply industries, and trade in energy supplies with other countries.

7. We discuss Ofgem’s role in ensuring network reliability in more detail later in this Report, but it may be helpful if we describe here the work of the part of the DTI specifically concerned with network performance, the Engineering Inspectorate. First, the Inspectorate monitors the performance of electricity companies using two sources of data: the reports which companies are required by statute to make to the Secretary of State on major supply interruptions; and the performance data that the companies provide to Ofgem. It also investigates specific problems, and where necessary makes recommendations on any action required under the Electricity Safety, Quality and Continuity Regulations 2002. An example of such action is the review undertaken by the Inspectorate into the London and West Midlands incidents. The Engineering Inspectorate has a total staff of eight, of whom

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4 Q 2 (NGT)
5 For more on this, see Paragraph 45 below.
6 Qq 71–72 (NGT)
7 Appendix 9, para 48 (Ofgem)
8 Qq 270 and 280 (DTI)
9 Ibid.
10 Q 265 (DTI)
11 See footnote 38 below.
five are “active” inspectors; the Chief Engineering Inspector told us that the staffing level was adequate. Given the limited staffing, we asked whether the Inspectorate contracted work out to consultants, and how much information it shared with Ofgem. We were told that the Inspectorate was constrained by the statutory requirement on it to be impartial in the conduct of its duties, which was normally interpreted as requiring the inspectors to form their own views independently. Only a limited amount of information was shared even with Ofgem (for example, if the Inspectorate had to investigate whether an electricity company was complying with the 2002 Regulations, only its final report would be shared with Ofgem). The consultants’ investigation into the facts of the London and West Midlands incidents, which the Inspectorate had commissioned jointly with Ofgem, had been exceptional.

8. We agree that neither the relevant government department nor the regulator should seek to micro-manage the private companies engaged in an industry. However, the energy industry is not quite like any other sector: all other industries, the public sector and every person depend on its efficient operation. While not wanting Government or regulator to manage the industry, we thought it right to question whether either has enough resources to enable it to make an independent assessment of the performance of the network companies and to determine what more, if anything, needs to be done to ensure a reliable electricity supply. We accept that the Engineering Inspectorate of the DTI has sufficient staff for the work it currently carries out. However, as we describe later in this Report, the electricity network will change significantly over the next decade or so, in terms both of new construction and of the pace at which infrastructure has to be replaced. At the same time, public tolerance of interruptions to electricity supply appears to be decreasing. We believe that over the next few years the Inspectorate is likely to experience both an increase in its workload and growing public interest in the Government’s role in maintaining electricity supplies. If our predictions are correct, the Inspectorate will need more resources; we expect the Government to provide them.

Reliability of the electricity networks

9. There are various ways of measuring the reliability of electricity networks: apart from the overall comparison of actual circuit hours available with planned circuit hours available, there are more detailed indicators such as the total number of incidents, average unsupplied energy per incident, and average duration of incident. On all these, the GB electricity networks perform well, both in absolute terms and in comparison with other developed countries. For the transmission system in England and Wales, over the five years to March 2003, the overall circuit availability measure averaged 99.7 percent; there have been on average fewer than nine loss of supply incidents per year since 1990; and the average amount of energy unsupplied due to transmission failure has been less than 0.0001 percent between 1991 and 2003. Although the transmission systems in Scotland are less reliable, mainly because of the harsher weather conditions, they too have a record of high performance, sustained over time: the DTI has reviewed the incidence of unplanned

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12 Q 266 (DTI)
13 Qq 267–69
14 Appendix 7, paras 5–8 and figures 2–4 (NGT)
outages on the GB transmission networks for the 15 years to 2002/03 and concluded that the indicators “point to a generally stable level of network reliability” over the period for all three transmission networks. Both the transmission and the distribution companies also suggested that network performance had improved since electricity privatisation. The DTI reported that since 1991–92, for the distribution companies the number of power cuts had decreased by 11 percent and the duration of power cuts by 30 percent; over the same period, there had been no deterioration in the number of power cuts experienced on NGT’s network. The DTI concluded there was no evidence that the overall performance of the electricity network was deteriorating.

10. NGT summed up the situation by saying that its transmission network was reliable 99.9999 percent of the time, which meant that on average transmission problems would cause one power cut of five minutes duration once every ten years per customer. It claimed, moreover, “the risk of loss of supply due to a fault on National Grid’s transmission system is about four times lower than the nearest [international] comparator … and nearly twenty times lower than the European average.”

11. However, the distribution networks are significantly less reliable than the transmission system. Ofgem’s report for 2001–02 showed that the average annual Customer Interruptions for the 14 distribution companies in Britain was 87.40 per 100 customers, and the average annual Customer Minutes Lost was 83.7 minutes; the comparable figures for NGT were 1.21 per 100 customers and 0.38 minutes per year. Scottish Power said that, broadly, ten percent of power cuts to customers were caused by failures on the transmission networks, and 90 percent by problems on the distribution networks. This is not because the distribution companies are inefficient or inattentive to customers’ needs. The transmission and distribution networks are designed to different standards because failures on transmission networks affect far more customers. The difference in standards means that distribution networks are much more vulnerable to damage by severe weather. Also, the transmission system is designed to continue to supply electricity even if two circuits have failed, with the result that faults on one piece of equipment rarely cause a power cut to customers. Despite this, average reliability of distribution networks in

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15 Appendix 2, para 29 (DTI); see also Appendix 18, para 2 (Scottish Power) and Appendix 17 (SSE). The three transmission networks are owned and operated by NGT (for England and Wales), Scottish Power (for Southern Scotland) and Scottish and Southern Energy (for Northern Scotland). Scottish and Southern Energy is hereafter referred to in footnotes as ‘SSE’.

16 Qq 2 (NGT) and 165 (The Energy Networks Association), and Appendix 18, Table 2.2 (Scottish Power). The Energy Networks Association is hereafter referred to in footnotes as ‘ENA’.

17 Q 265

18 Q 2

19 Appendix 7, para 9 and Figure 5

20 The data cover all interruptions, both unplanned (caused by such things as bad weather or faults) and planned (for maintenance or replacement of equipment).

21 Cited in Appendix 7, para 10 (NGT); the report is called 2001–02 Electricity Distribution Quality of Supply Report, dated June 2003 and is accessible at: http://www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/3664

22 Q 176

23 Q 32 (NGT). For a more detailed discussion of construction and operating standards in the electricity industry, see Chapter 3 below.

24 NGT calculated that equipment failures on the transmission network caused only a fraction of one percent of all network failures: Q 15.
Britain is 99.98 percent as compared with 99.99 percent for the transmission networks, so both perform very well.

The incidents

12. The events leading up to the power cuts in London and the West Midlands last year have been described in a number of published reports. Several of the memoranda that we have received during the course of this inquiry also give detailed accounts. We therefore do not propose to discuss the causes of the outages in detail, but we think it may be helpful to highlight a few important issues illustrated by the incidents.

13. First, we note the view of all those who gave evidence to us that the incidents in England were different in both nature and severity from those in the USA and the European mainland. We do not underestimate the disruption caused to those caught up in the London and West Midlands incidents, but they were both limited in scale and in duration. Although the immediate causes of the events abroad differed, they had a common outcome: a cascade effect that brought down very large sections of the country's electricity network for a considerable length of time. While unwilling to state that such a cascade effect could never happen here, our witnesses said that the networks had been designed in such a way as to try to prevent it happening.

14. In fact, a cause of both incidents in England was the operation of protection equipment which is installed, at least in part, to stop the sort of cascading shutdown that occurred in the USA and Italy by shutting down a faulty piece of plant and only that faulty piece of plant. (The other main purpose of such protection devices is to prevent equipment from being damaged in the event of a disruption of the network; such preventive disconnection means that the equipment can be put back into service very quickly, and helps in the speedy restoration of supply.) However, in order to fulfil their functions, such protection devices have to work very fast and therefore be very sensitive, which leads to the danger that they will 'trip' when they should not. The balance between protecting the network from damage and avoiding unnecessary outages was, our witnesses agreed, very difficult to achieve. The industry prefers to err on the side of protection, as the consequences of this are likely to lead to less severe and shorter disruptions. We were assured that the transmission network companies had checked to ensure that none of their other protection devices had a similar installation fault to those that contributed to the incidents last year.

25 Q 165 (ENA)
26 See, for example, Appendix 7, paras 75–121 and Annex B (NGT), Appendix 4, paras 2–6 (East Midlands Electricity), Appendix 1, paras 10–22 (Aquila Networks plc), Appendix 5, paras 9–19 (EDF Energy) and Appendix 9, paras 20–37 (Ofgem). East Midlands Electricity, Aquila Networks plc and EDF Energy are referred to in footnotes to this Report as ‘EME’, ‘Aquila’ and ‘EDF’ respectively.
27 See the accounts of these outages given in Appendix 2, paras 20–23 and Appendices 3–5, and Appendix 3 (DTI)
28 See, for example, the detailed reasoning given in Appendix 2, para 23 (DTI), Appendix 19, paras 30–32 (Dr David Ward) and Appendix 7, paras 122–133 (NGT)
29 Qq 14 (NGT), 189 and 194 (Scottish Power)
30 Qq 14 and 24 and Appendix 7, para 93 (NGT)
procedures to take into account the fact that electronic devices should be checked to ensure that pre-set tripping mechanisms do not activate when they are not required to do so.\footnote{See, for example, Appendix 5, para 20 (EDF)}

15. The problems with protection equipment arose from understandable errors. We were more surprised to learn of the part played in the incidents by a lack of understanding of the possible effects on major customers of different parts of the network being affected by planned outages simultaneously. The witnesses from NGT said that their company was not aware that London Underground was wholly dependent on the Wimbledon substation for its electricity supply. In future, they stated, instead of simply considering the impact on the network as a whole when co-ordinating maintenance and planned outages with the relevant distribution companies, they would have to take specific account of “the vulnerability of particular supplies [such as for public transport operators] connected to the distribution company”.\footnote{Qq 50–3} Other network companies have also been reviewing their procedures for planning outages and for determining priorities in the event of unplanned disruptions. One of the lessons learned from the incidents last year has been that certain major customers—not just public transport operators but also hospitals and, for safety reasons, companies such as those operating gas terminals—need to know of any problems very fast.\footnote{Qq 111 and 139 (SSE) and Appendix 5, paras 20–24 (EDF)}

16. Prospect was of the view that a lack of co-ordination was an entirely predictable consequence of the break-up of the electricity industry at privatisation.\footnote{Q 98} Whether or not this is so,\footnote{And, after all, there was a CEGB/Area Board split from the 1950s to privatisation.} we are concerned that, in an industry that places great emphasis on sharing information on safety and efficiency grounds, there appears to have been a failure to take fully into account the effects on customers of decisions about planned outages. For the reasons outlined later in this Report, the companies will have to increase network disconnections for construction and maintenance, so problems of co-ordination are likely to grow. We hope that the incidents last year will lead to a greater awareness of possible consequences; and in particular that the transmission companies (which are at one remove from the major customers that are connected directly to the distribution network) inform themselves of such customers’ emergency procedures.

17. There have been suggestions that failure to perform maintenance and repair work promptly contributed to the London power cut. This is one of the issues which, we expect, Ofgem is considering in the context of its investigation into that incident. We received no evidence on this, so will not comment. However, we did hear a number of concerns about maintenance practices in general, and we discuss these in Chapter 6 below.

18. We do, however, feel that we should comment on the response by Government and the Regulator to the incidents last year. As we have noted above, both Ofgem and the DTI place responsibility for ensuring reliable electricity supplies squarely on the network companies, reserving to themselves the role of simply policing the statutory requirements and licence conditions. We are also aware that common justice, reinforced by Human
Rights legislation and the specific requirements of Section 105 of the Utilities Act 2000, requires that any companies under investigation should have a reasonable opportunity to suggest any factual corrections to, and to make representations about any conclusions in, any reports by the Department and Regulator before such reports are made public. Furthermore, we know that both the DTI (under the 2002 Regulations) and Ofgem (in relation to licence conditions) can require the companies to take remedial action before the inquiry process has finished, where breaches warrant such action. However, the inquiries initiated last autumn by the DTI and Ofgem are the first major test of the policing system under the 2000 Act, and we have some reservations about the process.

19. The first of these is the length of time that it is taking. Both the DTI and Ofgem acted swiftly in announcing investigations, and, though the DTI’s Engineering Inspectorate has completed its review, we were told by Sir John Mogg that Ofgem’s would not be finished until the middle of this year—some nine months after it started. As we have noted above, though they caused considerable inconvenience for those affected, none of the incidents in Britain last year caused huge disruption or was of long duration. If it takes nine months to reach conclusions on relatively limited disruptions, how long would it take to investigate and then implement any changes required in the event of larger scale incidents?

20. Our second concern is that the lack of transparency in the process raises suspicions amongst the public that the companies may be let off lightly. An example of this effect is the reaction to the Government’s announcement that, although the Engineering Inspectorate had completed its inquiry, the report could not be published because of the duty of confidentiality imposed by section 105 of the Utilities Act. The lack of transparency coupled with the length of the process may undermine confidence that the authorities are effective in ensuring a reliable electricity supply.

21. One of the reasons why the authorities have to be particularly meticulous in their investigations is that the penalties that may be imposed upon the transmission companies are draconian: Ofgem has the power, in effect, to fine transmission companies up to ten percent of their turnover for particularly severe breaches of their licence conditions. Such a penalty could be used only in the most extreme circumstances. We suggest later in this Report that there may be better ways of penalising companies for failure to ensure reliable power supplies: better in the sense of being based on simpler measurements of performance, so less open to argument, and of being less punitive, so easier to impose. Adopting such measures would not remove

36 Q 202 (Ofgem) and Appendix 11 (Ofgem & DTI)
37 Ibid.
38 The Minister for Energy announced the launch of the inquiry by the Engineering Inspectorate of the DTI on 10 September 2003. This inquiry was completed by 22 January 2004. Meanwhile, the DTI and Ofgem jointly commissioned external consultants (PB Power) to compile a detailed technical report on the incidents; this report was produced on 9 December 2003. Ofgem’s independent investigations had begun on the evening of the London power cut, 28 August 2003. Its preliminary findings were published on 30 September 2003. Ofgem is continuing these investigations, which are expected to lead to a final decision by the Regulator in the middle of 2004. (Q 202 (Ofgem), Appendix 2, paras 15–17 (DTI), Appendix 9, para 17 (Ofgem) and Appendix 11 (DTI & Ofgem), and Official Report, 22 January 2004, col 67WS–68WS)
39 See, for example, ‘DTI keeps blackout report secret’, The Independent, 23 January 2004, p 23
40 The situation is different for the distribution companies.
41 See Paragraph 45 below
the need for investigations into major incidents, but might help to reduce some of the sensitivities around the current investigation process.


22. The UK electricity network companies are required by their licences to construct and operate their networks to certain agreed standards to ensure a reliable electricity supply to customers. Network design is complex, so the standards themselves are complicated; but in essence the aim is to make sure that the network is resilient—in other words, that electricity continues to flow from generators to consumers—even if parts of some circuits are disrupted, whether due to bad weather, or because equipment has been taken out of operation for servicing, or whatever cause. The robustness of the network is referred to in terms of “N minus x”, where N-1 means a network designed or operated in such a way that there will be no loss of supply if there is a fault on one circuit, N-2 a network that can withstand faults on two circuits, and so on.42 We were told that a system designed to an N-2 standard would be even more robust than this implies, as in practice it would be secure against various combinations of multiple faults. This is particularly useful in bad weather, when a number of faults can occur in a short time.43

23. The transmission system in England and Wales is designed to an N-2 standard, and, in general, maintenance work is also planned to the N-2 standard. (Where it is impossible to operate to the N-2 standard during maintenance, contingency plans are made so that, if another circuit should fail, measures can be taken to minimise the risk of losing supply.)44 The standards applicable to distribution companies are not so rigorous because a failure on a distribution network is likely to affect fewer people than one on a transmission network.45

24. The standards for NGT are as high as or higher than those in many other developed countries: most transmission owners in the USA, Canada and Western and Central Europe use the N-1 standard.46 NGT’s standard, known as the Transmission System Security and Quality of Supply Standard (“SQSS”), is largely unchanged from that used before privatisation by the Central Electricity Generating Board.47 The security standards for the transmission system in Scotland are the same as those in use before privatisation, so differ slightly from those applied to the National Grid in England and Wales.48 SQSS is a version of the industry standard.49

25. The present industry standard is known as P2-5, where the “5” represents the fifth version. P2-5 sets different criteria for ensuring reliability according to the nature of the network: the highest standards are for the parts of the network operating at the highest voltage because a failure here would affect a large number of people; somewhat lower

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42 For a more detailed description of the standards, see Appendix 7, paragraphs 17–23 (NGT)
43 Appendix 19, para 12 (Dr David Ward). A similar point is made by EME (Appendix 4, para 7) and a summary of how transmission companies have performed during extreme weather conditions is provided in Appendix 2, paras 24–27 (DTI).
44 Appendix 7, para 20 (NGT)
45 Q 146 (ENA); see also Q 197 (Scottish Power)
46 Appendix 7, para 19 and footnote 12 (NGT)
47 A review of SQSS in 1996–97 to a large extent endorsed the pre-existing standard: Q 204 (Ofgem) and Appendix 19, para 13 (Dr David Ward) and Appendix 7, para 28 (NGT).
48 Appendix 19, para 14 (Dr David Ward)
49 Q 147 (ENA)
standards apply to parts of the network at lower voltages; and so on down to the lines supplying individual households. P2-5 was introduced in 1978.\textsuperscript{50}

26. The industry has decided that a P2-6 is needed, largely because of the challenges posed by the expected increase in renewable generation, both in terms of managing fluctuating supply from intermittent sources of generation such as wind power, and also because many renewable generators will be comparatively small-scale and will connect to the distribution rather than to the transmission network (to which current large-scale generators are connected).\textsuperscript{51} The Energy Networks Association thought that the new standard would probably be published towards the end of 2004.\textsuperscript{52}

27. However, at the same time as this work has been under way, operators have been wondering whether the disruption caused by the London and West Midlands outages indicates that for certain sensitive areas, such as large conurbations and/or where major public transport systems are dependent on the electricity supply, a higher standard such as N-3 should be introduced. According to our witnesses, the key question was whether the very high expenditure involved (£350–400 million to upgrade the network serving Central London alone) was justified in order to deal with what are rare and short, though severe, disruptions caused by a succession of faults, such as those in London and the Midlands. NGT appeared sceptical about whether higher standards were justified; Scottish Power thought it appropriate to consider the question.\textsuperscript{53}

28. The companies were generally of the view that a greater problem was presented by the standards for the distribution networks:\textsuperscript{54} these, as we have already indicated, have a lower level of reliability than transmission networks, not least because they are more vulnerable to the effects of bad weather. (Though the Scottish transmission operators admitted that the severe weather conditions in their areas, particularly lightning and ice accretion, could bring down parts of their transmission systems. On the other hand, the vulnerability of the Scottish networks is attributable at least in part to the fact that some of the transmission network is carried on 132kV lines, which are built to lower standards than the 400kV lines of the transmission system in England and Wales.)\textsuperscript{55} Scottish and Southern Energy told us that, as a result, the focus of the companies’ current discussions with Ofgem about standards was the distribution networks.\textsuperscript{56}

29. We asked our witnesses whether companies ever believed it necessary to exceed the designated standard when constructing or replacing parts of their networks. We were told that some parts of the network that had been built before privatisation had been constructed to a higher standard than that laid down in P2-5, and, when replacing ageing assets, for example for large conurbations, companies often wanted to replace like with like.

\textsuperscript{50} Ibid. The standards are issued by the industry and enforced with Ofgem’s agreement through the licence conditions. The DTI’s only role is to respond to consultation on any changes proposed: Q 284 (DTI).

\textsuperscript{51} Qq 148–149 (ENA) and 176–177 (Scottish Power). For more detail on the implications of generators connecting directly to distribution networks, see Paragraph 57 below.

\textsuperscript{52} Q 148

\textsuperscript{53} Q 3 (NGT), 115 (SSE) and 177 (Scottish Power) and Appendix 7, para 32 (NGT)

\textsuperscript{54} Q 116 (SSE) and Appendix 7, para 31 (NGT)

\textsuperscript{55} Q 142 (SSE)

\textsuperscript{56} Q 116 (SSE)
in order to increase network reliability rather than relying on the P2-5 standard.\textsuperscript{57} The DTI pointed out that technical developments had also resulted in some standards being exceeded in practice: for example, P2-5 required companies to restore power to customers within three hours following an outage, because this was how long it took for technicians to travel to the relevant area and switch the electricity back on manually, whereas the use of new technology at substations meant power could be reconnected remotely, from a control centre, within a few minutes.\textsuperscript{58} Ofgem said that the standards formed guidance to, not a major constraint on, companies. If a company could make a reasonable case for exceeding the standard, that, Ofgem thought, was perfectly proper.\textsuperscript{59}

30. We note that NGT’s estimate of the cost of upgrading the network serving Central London to an N-3 standard equals the total amount that it currently spends annually on investment in the transmission infrastructure. Although such an upgrade would presumably take several years to achieve, so the £350 million cost would be spread over some time, this still represents a very large increase in expenditure; and the London network would not be the only one requiring such work. Elsewhere in this Report, we identify a number of issues which, we believe, will require higher expenditure on the electricity infrastructure. At present, these issues appear more urgent than a general increase in the standards laid down for the transmission network. This does not imply that we think it unnecessary to review the industry standards in the context of the Government’s renewables policy: we welcome such a review. Nor do we question companies’ decisions to exceed the P2-5 standards in specific cases to increase reliability in particularly sensitive areas: we applaud such decisions, and later argue that the Regulator should be more inclined to accept the necessity of such investment. But we do not consider that the extra resilience provided by the blanket imposition of an N-3 standard, even if limited to major conurbations, would be worth the cost. Nor do we think it feasible or necessary to require that the whole distribution network be built to the same standard as the transmission one. A hierarchy of standards seems the only sensible approach.\textsuperscript{60}

31. However, we note that the P2-5 standards were—and the P2-6 standards being developed will be—based on an assumption about equipment failure rates. While the number of failures remains at about the present level, the standards will continue to support the reliability of the system. On the other hand, if the failure rate increases (for example, because ageing infrastructure is not replaced swiftly enough or is not maintained properly) then multiple faults will occur more frequently and the standards will not in themselves be able to prevent a rapid deterioration in reliability.

\textsuperscript{57} Q 176 (Scottish Power). We discuss ‘upgrading’ the networks in Paragraphs 81–84 below.
\textsuperscript{58} Q 285
\textsuperscript{59} Qq 207–209
\textsuperscript{60} In this we agree with the DTI: Q 286.
4 Investment in the infrastructure

Introduction

32. As we have already indicated, most of our witnesses were of the view that, judging by its performance over the last few years, the transmission and distribution infrastructures were in a good condition in the UK. Given the long-term nature of construction and refurbishment operations on complex infrastructure, however, we were anxious to discover whether sufficient investment, and properly directed investment, was being made now to ensure the resilience of the electricity network for the future.

Price control review process

33. The amount of money that the transmission and distribution companies can invest in their infrastructures is to a large extent determined by the Regulator under the price control review process. Because each of the infrastructure companies is the monopoly owner of either the transmission or the distribution network in its particular region, Ofgem is required to set a limit on each company’s income to ensure that electricity supply companies and, through them, consumers are not over-charged for use of the network. At least in part, this calculation is made by reference to the value of the companies’ capital assets.\footnote{Appendix 9, para 45} The Regulator therefore has to take a view on how much investment is needed in order to maintain and develop the infrastructure while ensuring against over-investment which would increase prices to customers.

34. From the point of view of the transmission and distribution network operators, however, this price control system means that it is very difficult for them to increase capital investment without the agreement of the Regulator as they have limited scope for financing extra borrowings above the limit set down in the review. Furthermore, price control reviews take place every five years, which has led to suggestions that the system leads to investment decisions based on short-term needs rather than the long-term stability of the infrastructure.

35. We asked how the companies prepared their investment plans for submission to Ofgem and how Ofgem assessed these. NGT explained that they had to forecast how many new generators and customers would want to connect to the network and the associated upgrading of the infrastructure over the five year review period; other necessary upgrades to the infrastructure identified by the company; which assets would need to be replaced; and sundries like expenditure on Information Systems. Ofgem would then review and revise these estimates in order to produce an ‘allowed’ level of revenue to finance the capital expenditure that Ofgem considered necessary or appropriate.\footnote{Q 25 (NGT)} Ofgem said that the principal factors taken into account when reviewing companies’ capital expenditure ‘bids’ were the quality, age and methods of management of the physical assets.\footnote{Q 238}
36. Ofgem is dependent on the information supplied by the companies themselves to assess the condition and investment needs of the electricity network. While the fact that there are 14 distribution companies means that some comparisons can be made between them, it is extremely difficult to provide any benchmark against which the self-assessments of the transmission owners can be measured. We asked how Ofgem tried to overcome the problem of assessing NGT’s performance. Ofgem said that it employed external consultants to advise on a range of issues, especially in relation to accounting and engineering matters but also on other current concerns, for example (in the review underway at present) provisions for pensions. In addition, a number of Ofgem’s employees, including members of its technical department, had previously worked for one or another of the transmission and distribution companies, so were capable of making very informed judgements about the plans supplied by those companies. Ofgem also emphasised that NGT had a statutory duty to provide Ofgem and its consultants with all information necessary for reviewing its submissions relating to the price control reviews.\(^6^4\)

37. On the question of the dangers of short termism, both the companies and Ofgem assured us that the five year capital investment plans submitted for the price control reviews were examined in the context of the longer-term investment needs of the infrastructure.\(^6^5\) For the imminent price review for distribution companies, the companies themselves said that they were producing a variety of plans designed to put their investment bids for the next five year period into the context of the longer-term requirements for infrastructure renewal and development. The ENA was confident that there would be a real debate between the companies and Ofgem about future needs.\(^6^6\) Moreover, the representatives from Ofgem said that they did not rely solely on the five yearly price reviews to examine the ways in which companies were using their capital expenditure limits; Ofgem monitored the companies continuously so that it could question any company not deploying its investment in the way planned at the previous review.\(^6^7\)

38. Other witnesses were not convinced that the review mechanism was benign in its effects. Both ICE and Prospect expressed concerns that in practice companies were forced to attempt to make short-term savings and to postpone necessary investment. Prospect suggested that Ofgem was still treating the electricity companies as if they were trying to make excessive profits from customers, rather than providing the companies with the sorts of performance incentives designed to encourage the long-term development and reinforcement of the electricity networks.\(^6^8\) Prospect also alleged that the Regulator had not adopted a consistent approach to capital expenditure since the privatisation of the industry. The result of such regulatory uncertainty, according to Prospect, was that investors were reluctant to see companies commit themselves to long-running programmes because they were not sure that the company would be allowed enough revenue to finance the programme at the next price review; and this forced up the cost of capital to what essentially were low risk utility companies.\(^6^9\) While not going this far, the witness from the

\(^{64}\) Qq 238–239, 217–219 and 221–222 (Ofgem)
\(^{65}\) Q 220 (Ofgem)
\(^{66}\) Q 173
\(^{67}\) Q 222
\(^{68}\) Q 99
\(^{69}\) Qq 96–97
ICE considered that, despite Ofgem’s belief that its price controls gave enough incentive to companies to invest for the future, “in practice that is not really the case”. He thought that Ofgem was over-influenced by the hierarchy of its duties as set down by legislation: its primary duty was to promote a competitive market, with the obligation to secure a diverse and viable long-term energy supply much further down the list. The net result was that Ofgem had tended to focus on squeezing out every possible efficiency saving from the industry rather than promoting its other objectives.\(^70\)

39. The DTI, on the other hand, placed reliance on Ofgem’s statutory duty to have regard to the interests of future, as well as present, customers, arguing that this meant that Ofgem would not favour more tightly controlled prices for current customers over providing a secure electricity supply for future ones. DTI put forward as evidence of this the adaptations that Ofgem had made to the simple RPI-X formula for determining prices for the various companies, and the link it had established between income and performance of the distribution companies.\(^71\)

40. From the point of view of the companies, Professor Robin Maclaren of Scottish Power admitted that, despite the fact that they tried to plan for investment over 10–15 year periods, the very fact of a revenue review every five years tended to concentrate their minds on what was necessary over the next five years. He suggested that for some types of asset it would be more sensible for companies to draw up a 15 year programme to which they would commit themselves, for Ofgem to agree to allow funding for the whole 15 years, and for Ofgem regularly to measure the companies’ progress in implementing their programmes.\(^72\) If Ofgem does not act in this way already, we cannot understand why. Agreement to enable the funding of some long-term programmes would not reduce its ability to control the overall level of capital expenditure, but it would give companies more security and perhaps—if Prospect’s fears are correct—enable the network companies to obtain financing more easily or on better terms than regulatory uncertainty currently allows.

41. We wanted to explore Ofgem’s reasons for allowing lower capital expenditure than that requested by the companies in the price review process. We were aware that in its last price review, covering 2001/02 to 2005/06, the then NGC (National Grid Company, now NGT) received 95 percent of the capital expenditure it had requested, and we asked on what basis Ofgem had refused the other five percent. Ofgem said that NGC had made a miscalculation in its original bid, but Ofgem and the company had been unable to agree how great the effect of that miscalculation was. Ofgem further commented that if NGC had not been content with the amount allowed by Ofgem, then it could have appealed to the Competition Commission.\(^73\)

42. We also asked whether Ofgem had ever suggested that companies should spend more than they had bid for on the infrastructure. Ofgem said that at the last price review for distribution companies, in 1999–2000, while it had cut the bids by 13 percent on average,

\(^70\) Qq 78–79 and 82
\(^71\) Q 278
\(^72\) Q 187
\(^73\) Q 214. We note that, while the sum that NGC was allowed was 95 percent of its revised bid, its original bid was significantly larger. It was allowed about 85 percent of the original figure: Appendix 9, footnote 5 (Ofgem)
some companies, such as Midlands Electricity, had been allowed more than they had requested.\textsuperscript{74} Ofgem also claimed to be open to persuasion to revise the capital expenditure limits in the event of unforeseen circumstances between price reviews.\textsuperscript{75}

43. Ofgem concluded that, far from encouraging short-termism, the five year review process ensured that all necessary investment was made in the network.\textsuperscript{76} The guarantee of this, the Regulator claimed, was the transmission and distribution companies’ duty under their licences to ensure the reliability of the electricity supply, with the penalty for seriously contravening licence conditions being a fine of up to ten percent of the company’s UK turnover.\textsuperscript{77} This, Ofgem argued, meant that any company unhappy with the outcome of the price review on the grounds that it had not been permitted enough capital expenditure to ensure reliability of supply would have to use the statutory mechanism to appeal to the Competition Commission for a review of Ofgem’s decision.\textsuperscript{78}

44. We understand that the main onus to ensure that there is sufficient investment must lie with the electricity companies. However, we have less confidence than Ofgem that, if unhappy about the levels of capital investment that they had been allowed, the companies would feel able and willing to engage in a protracted dispute with the Regulator that grants them their licence to operate—and, in particular, that they would be willing to appeal to the Competition Commission, which would bring the dispute into the open. The companies would probably continue the argument over critical investment, but would they wish to sour relations over plans that, arguably, were not urgent? Although this would not matter in the short term, if enough insufficiently urgent plans were postponed then there could be longer-term problems, in the form of either unplanned outages or of difficulties in finding the personnel, capital and equipment to do a lot of work in a short time.

45. If our suspicions are correct, then the reliance on companies’ licences is insufficient to ensure reasonable standards of reliability. Ofgem has more or less conceded this by instituting for the distribution companies a system known as the Incentives and Investment Programme, under which if the companies fail to meet certain standards in relation to measures like minimising customer minutes lost and the number of faults on the system, they can be penalised by up to 1.75 percent of their income.\textsuperscript{79} We note the view of some of our witnesses that 1.75 percent of income is too low a penalty, and that between two and five percent would be better.\textsuperscript{80} We have no particular opinion on the level of the penalty—we are content to leave this to the Regulator—but we do recommend that a similar system of performance incentives and penalties is instituted for the transmission companies. This, we think, would tend to focus the attention of all

\begin{itemize}
\item \textsuperscript{74} Q 223
\item \textsuperscript{75} Q 228
\item \textsuperscript{76} Q 229
\item \textsuperscript{77} Appendix 9, para 14
\item \textsuperscript{78} Qq 228–229. The DTI also emphasised the duty on companies to ensure that they were awarded a high enough capital expenditure limit to guarantee that they could deliver reliable supplies: Q 272.
\item \textsuperscript{79} Qq 71–72 (NGT) and 165 (ENA)
\item \textsuperscript{80} Q 99 (Prospect). Prospect argued that what companies lost as penalties for power cuts was more than offset by their savings on the capital expenditure and maintenance that would have been needed to avoid the power cut: Appendix 13, para 7.
\end{itemize}
companies on the problem of the cumulative effect of a number of comparatively small and short-lived systems failures.

46. Three dangers arise from the five year price control mechanism in place at present. One is that, because the companies themselves are either the primary or the sole sources of information about their own performance, and it is likely that most of the consultants available to advise Ofgem depend heavily on those same companies for work, the Regulator has insufficient independent information and advice to assess the companies’ plans. The second is that Ofgem’s hierarchy of priorities leads it to promote cost-cutting to the detriment of the condition of the electricity network over the long term. The third is that, knowing Ofgem’s priorities and given the difficulty in practice of challenging the decision of a regulator with whom they have to work closely, companies will take the ‘easy’ option of postponing major investment programmes until there is absolutely no doubt that they are needed—which increases the risk of power cuts.

47. There is no simple solution to the first problem: with each transmission and distribution network operator forming a local monopoly, and with a fairly limited number of independent advisers and academics having detailed knowledge of the industry, Ofgem is restricted in its sources of information and analysis. It employs benchmarking where possible, and draws on in-house expertise. We have no reason to believe that it is not operating efficiently in this respect. The rest of this chapter and the next are devoted to a discussion of the second and third problems, that either Ofgem or the companies may be taking too short-term a view of the investment required to ensure the security of the electricity supply.

Overall level of investment

48. According to figures compiled by the industry, investment in the electricity transmission network has been higher in real terms in the 13 years since privatisation than it was in the 13 years before: NGT’s investment, we were told, has been 40 percent higher, Scottish Hydro Electric’s (now Scottish and Southern Energy) 80 percent, and, though there were not continuous data for Scottish Power, the available figures suggested higher investment by this company, too.81 The companies considered that levels of investment in England and Wales have been greater than those in many other developed countries.82 NGT stated boldly: “we are investing what we need to invest in all the networks that we run in the UK”.83 None of our witnesses denied that investment levels were comparatively high or that they were being maintained year on year; a number of witnesses, however, believed that they were not high enough.

49. Both the DTI and Ofgem were of the view that the only way of testing whether sufficient money was being invested in the electricity infrastructure was to look at the network’s performance; and both rested their case for the adequacy of current levels of expenditure on the fact that there was no evidence of any deterioration in network

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81 Q 271 and Appendix 2, para 29 (DTI). Scottish Power told us that they had invested a total of £480 million in their transmission network over the last 13 years: Q 179.
82 Q 11 (NGT) and Appendix 7, para 42 (NGT)
83 Q 8; see also Q 34
performance or of any failure to meet customer expectations.\textsuperscript{84} In fact, as indicated in Paragraphs 9–11 above, the performance of both the transmission and the distribution networks has been and remains very good, both absolutely and in comparison with networks abroad. However, this performance has been achieved as a result not only of the recent and continuing efforts of the industry but also as a result of the historical investment in the network. The fact that the network is performing well today is not a guarantee that it will do so in the future, and the investment made now will be a major factor in determining its future performance.

50. There are two broad categories of expenditure on the electricity infrastructure, which are referred to as ‘load-related’ and ‘non-load related’ investment. Load-related investment is in essence that needed to provide new connections to the network for either electricity generators or for customers, or to cope with growing demand from existing customers. The term covers not only the new power lines and other connection equipment required but also any work further away from the connection that is necessary to ensure that the network is resilient enough to cope with the increased supply and/or demand without affecting its overall performance. Non-load related investment is everything else, including expenditure to improve performance of the network; but the majority of it is used to replace ageing or worn-out assets.\textsuperscript{85}

51. The proportion of total investment spent on load-related programmes varies from company to company, reflecting both different rates of demand growth in the regions of Britain and the various approaches taken by companies to the problems of renewing their assets. Over the last ten years, NGT has invested about 54 percent of its total capital expenditure on load-related projects; distribution companies currently devote about 45 percent of their expenditure to load-related programmes.\textsuperscript{86} In contrast, Scottish Power has experienced far lower levels of growth in demand and since 2000 only a little over 10 percent of its capital expenditure has been on load-related investment.\textsuperscript{87}

52. NGT explained to us that companies had constantly to balance the different demands for investment. While some expenditure was, in effect, compulsory (companies had to provide new connections for customers or reinforce the infrastructure in areas of growing demand in order not to breach the requirements of their licence), they could not allow non-mandatory expenditure, such as asset replacement, to be reduced too much as a consequence, because maintaining the reliability of the network was also a licence requirement. As a result, companies might occasionally have to spend slightly more than Ofgem had allowed for in a specific year or particular price control period. NGT gave the example that it had had to spend £150 million (about ten percent) more than its capital expenditure limit in the current price control period because there had been a higher than anticipated growth in demand but NGT had believed that it had to maintain its asset replacement programme for the long-term health of the network.\textsuperscript{88} Ofgem conceded that there was a financial incentive for companies to postpone non-load related work because,

\textsuperscript{84} Qq 271–272 (DTI)
\textsuperscript{85} For more details on the two types of investment, see Q 25 (NGT) and Appendix 8, paras 1–9 (NGT)
\textsuperscript{86} Q 25 (NGT) and 163–164 (ENA); see also Appendix 8, Table 1a (NGT)
\textsuperscript{87} Appendix 18, para 2
\textsuperscript{88} Q 25
under the revenue control system, any extra capital expenditure could not be funded until after the next revenue review. However, the Regulator argued that this was offset by the knowledge that Ofgem would view very seriously any failure in a network attributable to under-investment, and could fine a company breaching its licence in this way up to ten percent of its revenue.89

53. The companies also pointed out that the distinction between load-related and non-load related expenditure was rather artificial. In practice, when companies were undertaking a programme of related works, some of the work would be to connect new customers, some to replace old assets and some might be to upgrade the network to meet anticipated rather than actual demand, simply because it was convenient and efficient from an engineering point of view to refurbish related parts of the network at the same time. NGT gave the example of the reconstruction of the St John’s Wood substation in London, when it took the opportunity both to replace some equipment and to upgrade the substation as a whole in order to meet increased demand.90

**Load-related expenditure**

54. We received no evidence of any shortfall in load-related expenditure at present. As it is, in effect, mandatory, this is not surprising. We did, however, hear concerns about the effect on capital expenditure of the Government’s targets for renewable energy, which will require a significant re-configuration of the network in terms of both the connection of many new generators and strengthening the network to deal with the problems of intermittent generation from sources such as windfarms. We were also interested to explore whether the charging structure made load-related expenditure more attractive to the network companies than asset replacement.

55. On the issue of the charging structure, we noted that the network companies may levy connection charges, which are intended to cover the local costs of connecting new generators and customers to the network. These charges are regarded by Ofgem as ‘excluded revenues’ from the point of view of the price control system, and so the companies’ total revenue will increase when they connect additional customers. While this might imply that the companies had an incentive to concentrate on new connections, possibly to the detriment of asset replacement, connection charges are not intended to cover the full cost of reinforcement to other parts of the system to cope with the extra demand.91 The distribution companies would receive some income to meet the costs of this ‘in-depth’ reinforcement because their revenues are linked to the actual volumes of electricity distributed in each year.92 NGT, however, told us that it was subject to a revenue control (which links revenues to a forecast of demand) rather than a price control. Transmitting more electricity to meet higher demand would not immediately be reflected in additional income for the company, so would not quickly contribute to meeting the costs of the reinforcement. Ofgem would adjust the company’s next price control to take this extra expenditure into account. Overall, according to NGT, the company obtained

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89 Q 226–227 and 230
90 Q 30 (NGT) and Appendix 8, para 5 (NGT)
91 Qq 36–40 (NGT)
92 See Note from Professor Green annexed to this Report: p 55.
roughly the same rate of return on capital from connections as from asset replacement, and had no incentive to bias investment one way or the other.\textsuperscript{93}

56. While there may be little direct financial incentive for companies to make load-related in preference to non-load related investment, it seems to us that it may be easier for companies to make a case for demand-led expenditure than for the replacement of assets out of which—especially with modern methods of asset management—arguably a few extra years of life might be wrung. The companies have admitted to us that there is a temptation to postpone desirable, but not immediately necessary, expenditure in favour of connection projects; and the revenue control mechanisms, not least the allowance for connections without any corresponding incentive for replacement, do nothing to reduce this temptation.

**Renewable generation**

57. Our witnesses were unanimous that one of the biggest challenges for the network owners over the next decade or more will be to make the changes to the configuration of the network needed to enable the Government’s renewable energy target to be delivered.\textsuperscript{95} As set out in our earlier Report into the Security of Energy Supply,\textsuperscript{96} the challenge posed by the growth of renewable generation does not consist simply of the need to connect a number of new generators: it also requires upgrading of the system, with, for example, new power lines in remote areas of the country where relatively little electricity has had to be conducted previously, and reinforcement to enable the network to cope with intermittent generation. Even more generally, the small renewable generating plants will have to be connected to the distribution rather than the transmission network, which requires a fundamental reappraisal of the way the distribution network presently operates.\textsuperscript{97}

58. Some in the industry are suggesting that to meet the Government’s target for renewable energy will require the largest investment in the transmission network since the peak of its construction, nearly 50 years ago.\textsuperscript{98} Scottish and Southern Energy, the transmission network owner for the northern part of Scotland where a large proportion of renewable power developments are likely to be built,\textsuperscript{99} said that almost the whole of the transmission system in northern mainland Scotland would have to be rebuilt to accommodate this, and the three island groups (the Western Isles, Orkney and Shetland Islands) would have to be connected to the transmission network.\textsuperscript{100} This provides a dramatic contrast with recent construction projects: according to one witness, the only significant new power lines built

\textsuperscript{93} Qq 40 and 36

\textsuperscript{94} For more on asset management, see Chapter 5 below.

\textsuperscript{95} See, for example, Qq 271–272 (DTI)

\textsuperscript{96} Paragraphs 35-42

\textsuperscript{97} The high voltage, transmission part of the network is constructed to receive power from large generating plants and conduct it to the lower voltage distribution networks for onward transmission to customers at still lower voltages. This means that the transmission system has to be built in such a way as to manage and balance supply and demand. The distribution networks are presently designed, in effect, to be one-way conduits of power to customers and not to receive injections of electricity direct from generators. See Appendix 2, para 4 (DTI)

\textsuperscript{98} Q 119 (SSE)

\textsuperscript{99} Most renewable generation over the next decade or so is likely to be based on wind power so will be sited largely in the windier areas of Britain.

\textsuperscript{100} Q 119
during the last 15 years have been one in North Yorkshire and one for the Northern Ireland Interconnector. Neither line was more than about 70–90 miles long, and each took a total of about ten years to steer through the planning system and build.\textsuperscript{101} The Institution of Civil Engineers quoted infrastructure costs of about £0.5 billion for two gigawatts of renewable power to be connected to the system in northern Scotland, rising to about £5 billion for six gigawatts—though, they noted, developers had been suggesting that as much as eight to nine gigawatts of generating capacity might be built.\textsuperscript{102} Scottish Power estimated its contribution to Stage 1 of the project (which would accommodate two gigawatts of renewable generation) as being about £160 million. If there was more demand from renewable generators, it would have to invest further tranches of £155 million and then £70 million in its transmission network.\textsuperscript{103} Scottish and Southern Energy used a comparison to illustrate the magnitude of the challenge: their current asset base, they said, was valued at £250 million for regulatory purposes, while the investment required for northern Scotland over the next ten years would be in the order of £1 billion.\textsuperscript{104}

59. Despite the uncertainties introduced by having to make at this stage very preliminary estimates of demand from renewable generators,\textsuperscript{105} the planning of the construction programme is already well in hand, both at individual company and at industry level. The DTI, Ofgem and transmission companies have formed a Transmission Issues Working Group to make a strategic assessment of how the network as a whole will have to change, taking as its basis the need to accommodate six gigawatts of new capacity in Scotland and a further six gigawatts in England and Wales.\textsuperscript{106} The three transmission companies (NGT, Scottish and Southern Energy and Scottish Power) have joined together on the Renewable Energy Transmission System (RETS) project to share ideas and jointly plan the necessary works.\textsuperscript{107} Scottish and Southern Energy told us that they had started feasibility studies, planning, the identification of routes and were considering sources of investment for the first tranche of work, worth about £200 million, which focused on upgrading the powerline from near Inverness to the central belt of Scotland.\textsuperscript{108} Since they gave oral evidence to us, Scottish and Southern Energy has actually announced its preferred route for this line and hopes to obtain building consent later this year in order to start construction early in 2005.\textsuperscript{109}

60. We asked the transmission and distribution companies what were likely to be the main difficulties in achieving their ambitious construction programmes: obtaining Ofgem’s

101 Q 87 (ICE)
102 Q 85
103 Q 195
104 Q 118. Though one should not draw from this the conclusion that the new construction will be substantially larger than the existing network: the £250 million is the existing network’s value for regulatory purposes, having written off large depreciation payments. It would cost considerably more to build now.
105 Qq 151–152 (ENA)
106 Q 279 (DTI) and Appendix 2, para 43 (DTI)
107 Q 195 (Scottish Power)
108 Q 118
109 ‘Scottish & Southern Energy reveals £200m new transmission line’, Glasgow Herald, 21 January 2004, p19. The ‘early 2005’ date quoted in this newspaper article was described as optimistic by Scottish and Southern’s witnesses to us: they thought that it might take longer to obtain planning consent and therefore construction was more likely to start in the summer of 2006: Qq 128–131.
agreement to the investment needed, planning problems, or shortages of equipment or staff. The companies were confident that Ofgem accepted the need for considerable extra investment and was prepared to discuss detailed investment plans with them. They agreed that organising the actual construction would pose challenges, not least because of the need to plan outages as existing overhead lines were taken down to be replaced with higher voltage equipment. Despite the misgivings expressed by the Institution of Civil Engineers about a shortage of contractors experienced in overhead line construction, the companies appeared to believe that they could schedule the works so as to avoid major delays because of a lack of skilled contracting staff. They all considered, however, that obtaining planning permission was likely to be a major concern and might lead to significant delays in the construction programme. The ICE pointed out that a 70–90 mile section of 400kV line would probably take two seasons, about 19 months overall, to build, but the two recent examples of construction of such lines had each taken about ten years to complete from start to finish because of the length of the planning process.\textsuperscript{110} Our witnesses suggested that a number of the projects scheduled for earlier in the programme were likely to prove easier and swifter than this to achieve because they involved work over existing routes of overhead lines or upgrades to existing substations, but the planning process was likely to be very demanding for proposals to build new 400kV lines.\textsuperscript{111} Even the upgrade of the comparatively short Inverness to Central Belt line was likely to take four or five years to complete, about two years of which would be occupied with obtaining planning consent.\textsuperscript{112}

61. On the question of how this massive programme of work was to be paid for, Scottish and Southern Energy expected that it would be funded through transmission charges levied on the electricity companies and spread throughout the United Kingdom: though much of the work was to be done in Scotland, it was required as a result of the energy policy of the UK Government, not because of demand and supply needs in Scotland alone.\textsuperscript{113} Transmission charges are in practice passed on to customers. Scottish Power told us that, because of the way in which the industry funded capital expenditure, in round terms a tenth of the cost of this investment would be passed on to customers via their electricity bills, so that the total cost of Stage 1 of the programme, about £600 million, would produce an increase in charges to customers of £60 million overall.\textsuperscript{114} On whether the public was willing to pay such costs, the DTI said that the recent widespread consultation on the Government’s White Paper on energy policy showed that there was a strong public interest in the environmental aspects of energy supply, and a willingness to pay somewhat more for energy in order to protect the environment.\textsuperscript{115}

62. It appears that good progress has been made in planning the changes to the system required to accommodate the hoped-for increase in the supply of renewable energy generation. At present, it looks as though the network companies are well placed to meet the demand from new generators, including financing the work. While the

\textsuperscript{110} Qq 128–132 (SSE), 279 (DTI), 184–185 (Scottish Power), 87–91 (ICE)
\textsuperscript{111} Q 87 (ICE) and 184 (Scottish Power)
\textsuperscript{112} Qq 128–130 (SSE)
\textsuperscript{113} Q 118
\textsuperscript{114} Q 195
\textsuperscript{115} Q 275 The White Paper referred to is: Department of Trade and Industry, Department for Transport and Department for Environment Food and Rural Affairs, \textit{Our energy future – creating a low carbon economy}, Cm 5761, February 2003.
shortage of construction workers with relevant skills may pose some problems with timetabling, the main difficulty anticipated is the uncertainty arising from the planning process—and this is beyond the control of the companies, Ofgem or even the DTI. We have commented before on the fact that the planning process, and public attitudes to energy developments, form a considerable barrier to the achievement of a more secure and diverse energy supply in the UK, and we do not intend to repeat our arguments here. However, we are encouraged by the perception of at least some witnesses that local authorities have accepted the need for the programme in principle and are concentrating on discussing the ‘when’ and ‘how’ rather than the ‘if’.117

63. New construction forms only a proportion of the needs of the network, though, and we now consider the at least equally important question of the replacement and refurbishment of the existing electricity infrastructure.

116 Security of Energy Supply, paras 79-84
117 Q 130 (SSE)
5 Replacement of assets

Planning of the replacement programme

64. Most of the UK’s electricity transmission and distribution network was built in two main periods of activity, in the late 1950s and the mid 1960s–early 1970s. The design life of the assets used in the network was about 40 years. Much of the network therefore either has reached or is about to reach the end of its design life. Although, of course, replacement of some of these assets has been carried on in the intervening years, we were concerned that the industry was about to be confronted with a major problem which would at best require a significant rise in capital expenditure and at worst might mean that parts of the system would fail simply because old equipment had broken down.

65. The companies were unanimous in reassuring us that they were planning and taking measures to ensure that there would not be a sudden and unmanageable requirement to replace much of the network within the next few years. They explained experience had shown that many assets, although designed to last for 40 years, in practice could continue to function efficiently for longer periods: in Scotland, some 60-year old assets were still working well, and, for example, steel pylons for overhead lines could last for 80 years, depending on the severity of the weather to which they were exposed. Other equipment, however, such as circuit breakers in substations, might experience considerable wear and tear and have to be replaced earlier. Rather than having a simple policy of replacing assets that had reached the end of their design lives, over the last ten years the industry had developed a sophisticated system of monitoring the condition of equipment to judge in the case of each item whether it needed refurbishment or replacement.

66. NGT described its condition monitoring programme; the other companies which gave evidence to us followed the same approach. NGT said that the industry had undertaken careful forensic examination of equipment that had had to be taken out of service so that they understood the factors that caused equipment to age. Based on experience and meticulous research, the industry had an estimate of life expectancy for each type of equipment, consisting of the earliest age at which it might be expected to fail, the average life of that sort of equipment, and the latest age at which it might fail. This information gave the industry the ability to plan the replacement programme based on the probability of assets failing, in order to smooth out the peak of work. Then, as part of their normal maintenance programme, company engineers would use various diagnostic tests on the individual pieces of plant to estimate their continuing reliability so that each could be replaced before significant problems occurred but while providing the maximum use, and also, if possible, to enable its replacement at a time that fitted in with other planned maintenance/construction/replacement work in order to minimise the number of outages.

67. Such practices, we were told, enabled companies to draw up rational 10–15 year programmes for the replacement of network assets, and the success of this approach could

118 Qq 180 (Scottish Power) and 156 (ENA)
119 See, for example, Qq 120 (SSE), 158 (ENA), 187 (Scottish Power) and Appendix 18, para 4 (Scottish Power)
120 Q 15 (NGT)
be measured by the fact that only a tiny percentage of outages were attributable to equipment failure (a fraction of one percent).  

68. We asked whether the equipment now being installed had a different life expectancy from the existing 40 (or more) years old items; and, more broadly, whether like was replaced with like or whether the companies took the opportunity afforded by replacement to upgrade assets. We were particularly interested in the changes to the design of substations, as both the London and the West Midlands outages in August/September 2003 centred on substations of an older design.  

69. We were told that modern equipment had the same life expectancy as existing assets: the design specification for equipment would be 40 years, but if a steel tower or cable were designed to last for 40 years, it was likely to last for 80, and similarly for cable, whereas more complex equipment like a transformer would have a lower life expectancy. On the issue of replacing like with like, the companies said that they did upgrade where this would increase the resilience of the network in terms of either improving reliability or anticipating likely increases in demand: Scottish and Southern Energy gave as an example the fact that over the last ten years they had replaced half of all circuit breakers on their network with a more modern design that interrupted supply to malfunctioning equipment faster and more reliably. The calculations involved in replacing (old-style) four-switch mesh with (modern) double busbar substations are more complicated. NGT told us that there were no clear indications that four-switch mesh stations were inherently less reliable, so there appeared to be no need to undertake a special replacement programme which would be both costly and disruptive to network operations. On the other hand, four-switch mesh stations were less flexible, so, NGT said, they replaced these where technically possible during the course of their normal refurbishment and replacement operations; and, in the light of the West Midlands and London incidents, they were keeping the situation under review with Ofgem.  

70. We believe that the network companies’ approach to planning replacement, centred, as it is, on careful monitoring of the condition of individual pieces of equipment, is a reasonable and cost-effective approach to handling a large and ageing asset base. Current reliability statistics for the network indicate that it has worked well so far. However, as our witnesses recognised, obtaining the maximum working life from an asset requires careful maintenance of that asset; and the fact that companies have taken the correct approach to drawing up priorities for replacement does not mean that the rate of replacement is fast enough to keep up with the deterioration of the assets or to prevent the 40-year crisis from simply being postponed to a 50 or 60 year crisis. We discuss concerns about maintenance in the next chapter. We now turn to the rate of asset replacement.

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121 Qq 187 (Scottish Power) and 15 (NGT), and Appendix 18, para 3 (Scottish Power)  
122 Though, in the West Midlands case, the incident took place during a major refurbishment of the substation.  
123 Qq 13 (NGT) and 156 (ENA)  
124 Q 120  
125 Qq 19–21 (NGT); Appendix 19, para 21 (Dr David Ward). Replacement of transmission substations, of course, often requires the co-operation of two companies, the relevant transmission and the distribution companies, and the co-ordination of both companies’ maintenance and replacement programmes.  
126 Q 15 (NGT), and Appendix 4, para 12 (EME)
Rate of replacement

71. The starkest summary of the problem as described to us is as follows. The total asset base of NGT’s network is about £16 billion, while about £150 million is being spent each year on asset replacement; which means that less than one percent of the network is being replaced each year. At this rate it would take over 100 years to replace all the equipment on the network.127 Equipment installed now, even though in practice it might last longer than the design life of 40 years, would fail from old age before current, older assets had all been replaced.

72. The network companies have been running replacement programmes for some time, and the programmes are planned in terms of decades rather than years.128 Scottish and Southern Energy has spent a total of £150 million on asset replacement since the privatisation of the industry; Scottish Power over £480 million in the same period; NGT has had a significant asset replacement programme since 1990 which has totalled nearly £2 billion; the DNOs together have invested a total of £12.357 billion in their networks since privatisation, and if one assumes the current 55 percent non-load related/45 percent load-related split in their expenditure over this period, that means an investment of about £6.8 billion on asset replacement.129 However, all the companies agreed that they needed to spend more on replacement over the next 10–20 years. As one witness said, “We want to manage the condition of the network; we do not want to chase it.”130 The representatives from NGT said that the company’s current rate of asset replacement of about £150 million per year would have to roughly double in the forthcoming review period to keep pace with need.131 The Energy Network Association said that together distribution companies spent about £1.4 billion per year on asset replacement and enhancement at present, and recent estimates showed that this would have to rise to about £2 billion a year over the next 20 years or so in order to maintain levels of reliability.132 We asked whether the £2 billion would mean that the assets could be replaced within 20–25 years. We were told that it was not necessary to rebuild the network in its entirety—some equipment could be replaced, some refurbished and other upgraded. The key aim was to “reverse the ageing process”: instead of the net age of the assets increasing, as was happening at present, it should be decreasing.133 We were assured that enough equipment and skilled staff would be available to achieve the accelerated programme, though one witness issued a caveat about the need to increase the number of highly skilled power engineers in view of the fact that the increased rate of asset replacement would coincide with the demands caused by the renewables programme.134

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127 Q 77 (ICE) and Appendix 4, para 13 (EME). This one percent replacement rate was cited also by Scottish Power (Q 180), though in its memorandum Scottish Power stated that the levels of investment allowed in the current price control implied an overall asset turnover of over 60 years (Appendix 18, para 2).
128 Q 15 (NGT)
129 Q 117 (SSE), Appendix 18, para 2,1 (Scottish Power), Appendix 8, Table 1A (NGT) and Appendix 10 (Ofgem). We did not obtain figures for each DNO’s actual expenditure on asset replacement.
130 Q 154 (Mr Taylor of NEA). See also Q 180 (Scottish Power) and Appendix 4, para 14 (EME)
131 Qq 16 and 25
132 Q 154
133 Q 155 (NEA)
134 Q 183 (Scottish Power)
73. The latest revenue control negotiations for distribution companies have just started. The distribution companies were due on 19 December 2003 to submit forecasts for the level of investment necessary to sustain current levels of performance. We were told that they would also produce a range of estimates of, for example, how much was needed to improve performance.\textsuperscript{135} We assume from the evidence submitted to us that most, if not all, of the distribution companies will be seeking a substantial increase in investment just to maintain performance.

74. We explored how Ofgem was likely to respond to requests for significantly higher levels of investment. Ofgem said that it was restructuring its approach to the companies’ investment bids in the current round in order better to understand the companies’ new techniques for asset management and modelling of the condition of their networks.\textsuperscript{136} Ofgem also explained that, in order to assess companies’ bids, it would look at each company’s past performance in both the efficiency of its operations and the accuracy of its prediction of future needs, as well as its historical legacy of infrastructure and factors such as the effect of different regional weather patterns on the condition of the infrastructure.\textsuperscript{137} On the other hand, the Regulator repeatedly emphasised that in the last resort it was the responsibility of the companies—not of Ofgem—to ensure that they invested enough in replacement of their assets to sustain network performance.\textsuperscript{138}

75. The DTI considered that Ofgem’s approach to allowing investment for asset replacement was perfectly reasonable; but this assessment was made on the basis of network performance to date, not of any work done by the DTI itself to estimate the condition of the network and the resulting requirements for investment. Officials said that it was not the Department’s job to second guess the Regulator; they added that they did not have sufficient resources to do so anyway.\textsuperscript{139}

76. As for the suggestions that we should be concerned about the current rate of replacement of equipment, Ofgem rejected the implication that the one percent replacement rate would necessarily lead to network failure: the companies, it argued, would give priority to replacing the critical parts of the system first.\textsuperscript{140} However, we note that, though any prudent company would replace its most critical assets first—whether critical from an operational or from a safety point of view—\textsuperscript{141}—this does not mean that severe problems would not arise if other equipment failed because it had been kept in operation too long; and, indeed, because vital equipment such as transformers tend to wear out sooner and be replaced more frequently than, say, cables, without greater expenditure on replacement than at present, companies will have to wring longer and longer lives out of their less ‘critical’ assets.

\textsuperscript{135} Q 154 (NEA)  
\textsuperscript{136} Qq 235–236  
\textsuperscript{137} Qq 236–237 and 242  
\textsuperscript{138} Qq 234–236  
\textsuperscript{139} Qq 280–283  
\textsuperscript{140} Q 234  
\textsuperscript{141} Q 187 (Scottish Power) and Appendix 18, para 4 (Scottish Power)
77. We concur with NGT that the network companies and manufacturers of transmission/distribution equipment cannot and need not replace all assets when they are exactly 40 years old. Since privatisation companies have been very successful in stretching asset lives through a better understanding of equipment and network risks. However, better asset management can postpone the replacement of equipment for only a limited time. We were told, in particular by the engineers responsible for maintaining the networks, that the system had now reached the point where assets must be replaced. One of our witnesses, drawing lessons from the railway system, said that he would not like the condition of the electricity network to deteriorate to the stage where it would take several years of work before it could be restored to normal operation. \(^{142}\) Neither would we, and this, we consider, is a real danger unless investment in the replacement of the infrastructure increases significantly.

78. The Chairman of Ofgem said that the Regulator could not guarantee that equipment on the electricity network would not fail simply through old age. \(^{143}\) We understand this. However, if it took too restrictive a view of what was necessary to maintain the robustness of the network, the Regulator could discourage companies from investing enough to prevent such failures. No one can give a 100 percent guarantee of reliability. The network is operating almost at that level already. But this generation of customers has been to a certain extent living off the investment made by its predecessors. Those assets will not last for much longer and investment must increase now if reliability is not to decline.

79. Although Ofgem told us it had concluded on a previous occasion that some network operators needed to invest more than they had requested, experience of earlier revenue control rounds and the general tenor of the evidence submitted to us was that the Regulator would give a higher priority to cost control than to greater investment to improve resilience. However, we note the response of Ofgem’s Technical Director, Mr John Scott, to our questions about the replacement of ageing assets:

“we have had a period of years where [asset] lives have been pushed out so the replacement rate at the moment is probably on the relatively low side, but all assets have a finite life and Ofgem has no problem recognising that assets must be replaced. What we are looking for companies to do is to give value for money for customers by replacing those assets in an efficient and timely way—not too soon and not too late.” \(^{144}\)

80. We welcome this acknowledgement that a faster rate of replacement of capital assets is called for. We consider that there needs to be a significant rise in investment to achieve this. It is not for us to suggest how much extra capital expenditure should be allowed; this is for Ofgem and the network companies to agree on a case by case basis. But we do note signs of a consensus in the industry that expenditure on the replacement of ageing assets must double over the next 10–20 years if network performance is not to suffer. We will keep a watching brief on the current negotiations on revenue controls for distribution companies, and may return to this issue in due course.

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\(^{142}\) Professor Maclaren (Q181)  
\(^{143}\) Q 237  
\(^{144}\) Q 234
Improving network performance

81. We turn now to another element of non-load related expenditure: investment to improve the performance of the electricity network. As explained above, we received no evidence to suggest that the standards of performance needed to be increased; but we did hear that the transmission and distribution companies often wish to upgrade pieces of infrastructure, either in anticipation of (rather than as a result of) increased demand or simply to increase the resilience of the network. A significant example of the latter was EME’s decision in 2001 to install an overhead line interconnecting its Tamworth circuits to another grid supply point. This exceeded the requirements of the P2-5 standard, but was the most cost-efficient way of providing the extra security that the company desired. According to EME, the new interconnector played a key part in enabling the engineers to restore power as fast as they did after the Hams Hall incident last September.145 Another example is the upgrading of the St John’s Wood substation mentioned by NGT.146

82. Ofgem declared itself open to reasonable arguments for relaxing restrictions on investment. For example, Ofgem would not object to early replacement of some assets as part of a wider refurbishment programme, as this would be sensible operationally.147 Companies did not always view Ofgem’s decisions on expenditure in such a positive light. Scottish and Southern Energy said that during the last price control review it had been penalised for its high level of capital expenditure on its distribution network. The company’s response had been to cut investment, with the result that there had been no improvement in network performance since the review.148

83. The most expensive single upgrade to the network mentioned to us would be to replace overhead lines with underground cables. It may also be the factor most likely to increase the reliability of distribution networks: it is, for example, noteworthy that the latest available data on Customer Interruptions shows the London network, most of which is underground, as consistently having fewer than half the average number of interruptions of all 14 DNOs.149 However, while some commented that there was increased public opposition to overhead cables and that there were sometimes good environmental or operational reasons for ‘undergrounding’ cables, none of our witnesses suggested that such undergrounding should become standard. The cost of such a programme would be huge: putting 400kV cable underground is about 15 to 25 times more expensive than building overhead lines, and, although the lower voltage cables used on distribution networks would be cheaper to put underground, even 11kV cables placed underground cost about four times the overhead equivalent.150 There is no clear evidence as yet that a widespread programme of undergrounding cables is necessary to sustain the reliability of the network, and the expense of such a programme leads us to the conclusion that there are more cost-effective ways of improving network resilience. Among these are, as the

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145 Appendix 4, para 10; Q 150 (ENA)
146 Q 17
147 Q 240
148 Q 136
149 HC Deb, 28 January 2004, col 376W
150 Appendix 2, para 30 (DTI). The figure for 11kV cables is extrapolated from the supplementary information provided by EDF Energy to our inquiry on the October 2002 storms (not yet published).
Network Resilience Working Group has acknowledged, the use of more highly insulated cables, and better control of vegetation close to power lines.\textsuperscript{151}

84. We understand that the Regulator needs to ensure that the network companies do not charge more for the transmission and distribution of electricity than necessary, and that this, in turn, means that the companies are restricted in the capital expenditure that they are able to finance. However, lower costs for present customers should not be pursued at the expense of a reliable network for future customers. We acknowledge that the transmission and, to only a slightly lesser extent, the distribution networks already perform to a very high standard, both in absolute terms of reliability and in international comparisons. However, both companies and consumers have continued to benefit from the fact that the networks were built often to higher standards than were strictly required, and this has helped them to accommodate the rising demand from, and increasing expectations of reliability by, customers. This extra capacity is now close to exhaustion, if not already exhausted. It seems to us prudent to build some extra resilience into the system, rather than constructing just to meet short-term requirements. We therefore expect Ofgem to set revenue controls in order to meet the reasonable longer-term programmes and forecasts of demand submitted by the network companies, rather than (as some have suggested that it does) focussing on what is needed for the next five year period.

**Costs to consumers**

85. If the network companies are to be allowed to spend more on investing in their infrastructures, much of the cost will be passed on to electricity consumers. We therefore asked what effect greater investment would have on customers’ bills. We were told that the most significant element was the cost of generating electricity; transmission charges formed only about three percent of the average domestic electricity bill (about £7.50 pa), and distribution charges about twenty percent (about £50 – £60 pa, depending on the DNO).\textsuperscript{152} The Energy Networks Association estimated that, just to continue with present performance levels plus an allowance for the network reinforcement required because of the renewables programme, an extra £2 billion of investment in the distribution networks was needed, with the result that average distribution charges would have to rise by about ten percent (or £5 pa) over the next five to ten years.\textsuperscript{153} Investment to improve the distribution network—for example, to increase resilience to storms by improving the robustness of overhead lines or by putting them underground—would mean additional costs. The ENA could not give us a clear indication of the extra costs: they said that various options were being investigated.\textsuperscript{154}

86. We asked our witnesses whether any work had been done on the willingness of customers to pay these extra costs, particularly if they resulted in no perceptible

\textsuperscript{151} Proposals for Improved Storm Performance for Electricity Distribution Networks: Report by the Network Resilience Working Group, December 2003. This group consisted of representatives from the DTI, the DNOs, Ofgem and energywatch. We will discuss the issue of how companies may avoid storm damage to their networks more fully in our forthcoming Report on Lessons from the storms in October 2002.

\textsuperscript{152} Qq 106 (Prospect), 168 (ENA) and 215–216 (Ofgem)

\textsuperscript{153} Qq 168–169 and 171–172

\textsuperscript{154} Qq 170–172
improvement in service. Ofgem’s view was that customers were willing to accept some risk of power cuts, but there was as yet no clear indication of how customers valued reliability and the costs of blackouts as against higher electricity prices. Ofgem intends to conduct a survey on this matter within the next few months, in the context of the distribution price review process. The DTI officials said that the subject had been touched on during the recent widespread consultation on the Government’s White Paper on Energy. This had shown that, although consumers were willing to spend more on energy in order to promote environmental goals, they were not particularly concerned about interruptions to their electricity supply—from which we were left to draw the conclusion that the public would not be content to pay more to guard against power cuts because the perceived risk of such interruptions was low. However, we noted that the consultation on the White Paper took place before the incidents last year, and public attitudes to risk were likely to be affected by whether or not they had experienced the inconvenience of power cuts themselves recently. Moreover, media coverage of the potential for power cuts this winter as a result of low prices to electricity generators indicates that fears about the security of electricity supply may be growing.

87. Prospect, in contrast, pointed to the willingness of consumers to pay for security in relation to other products. An extra five pence per week per domestic consumer could, they argued, either increase NGT’s capital expenditure by a third or double the size of its maintenance programme.

88. Ofgem emphasised to us the difficult balance it had to strike between its—often conflicting—aims of ensuring security of supply, protecting the environment and reducing the incidence of fuel poverty. We recognise this. We also understand that, for various reasons, the cost of generating electricity is certain to rise over the next few years, and that the move to greater reliance on renewable generation also has a price. Also, while an expanded capital expenditure or maintenance programme might mean only a few pence extra per week to domestic consumers, the bills for industry would rise by significant amounts. Against this has to be balanced the costs to consumers, not least to industry, of power cuts; and, as we have explained above, we believe that the age of sections of the infrastructure mean that, without significantly faster replacement rates and more maintenance, power cuts are likely to increase in frequency. We conclude that a rise of ten percent in distribution charges to support network security would not be an unreasonable amount to pay, and that, in certain particularly vulnerable areas, the Regulator should be willing to consider more investment to enhance security.

155 Q 205
156 See footnote 115 above
157 Q 275
158 Qq 276–277
160 Qq 106–107
161 Q 107
162 Q 225
163 Including to accommodate renewable generation
6 Maintenance and installation of equipment

Maintenance

Maintenance techniques

89. If the transmission and distribution companies are to wring the maximum lifespan from their capital assets while maintaining the reliability of the network, they need an effective maintenance programme. NGT described its approach, which is common to that of the rest of the industry, as “a preventative maintenance policy that is based on the inspection and maintenance of assets before they are expected to fail or experience significant defects”. However, commentators have been concerned that reductions in the levels of maintenance are posing a threat to network resilience. More specifically, after the outage in London last August, various allegations were made that inadequate maintenance had played some part in causing the incident.

90. NGT told us that its maintenance policy was based primarily on routine inspection at specified intervals. For each type of assets, the company sets a minimum and maximum time interval for such routine maintenance, with a target date within the range. This enables some flexibility so that all the assets associated with the same circuit can be maintained at the same time; and this in turn reduces the amount of time that circuits are out of service for maintenance and repair work. When assets are inspected during routine maintenance operations, their condition is recorded in order not only that any necessary repairs may be arranged but also that, if required, the inspection/maintenance schedule for that equipment can be adjusted to take into account its condition. This information is also fed back into the general asset condition data which enables the company to determine its equipment replacement programme and to plan future capital needs.

91. Scottish and Southern Energy noted that the former style of “intrusive” maintenance (which involved disconnecting a piece of equipment from the circuit, taking it apart to check its components and then putting it together again) itself sometimes caused equipment failures. As well as increasing the risk of failures, intrusive maintenance was labour-intensive, so costly. Scottish and Southern Energy attributed to the new condition-based techniques an improvement in the focus and timing of maintenance that had led to a halving of the number of customer minutes lost through outages on its network in the North of Scotland over the previous four or five years.
Repairs

92. Not least because of the suggestions that the failure to repair an oil leak was a contributing cause of the London outage in August 2003, we asked the companies about the length of time it took them to repair minor faults. We were told that there was no industry-wide standard for the time taken for minor repairs, but that most companies shared a common approach. Faults were divided into three categories: major ones, which had to be repaired as soon as they were detected; those which had to be repaired or the equipment replaced within a fixed period of time (for example, eight weeks); and those which had to be recorded but for which it was perfectly feasible to delay the repair until that item of equipment’s next scheduled maintenance. NGT also emphasised that repair times varied: different pieces of equipment presented very different problems, with some, such as transformers, requiring specialist repair skills or the ordering of parts. There was also the problem of the consequent effect on the rest of the network if an item was taken out of service for repair. NGT explained:

“It is not always easy to release a piece of equipment for work when one gets a minor defect on it. Quite often the best arrangement will be to keep it in service and to manage the issue … until [the equipment] would next be out for its routine maintenance or its intermediate maintenance. We have to judge all those things and decide how urgent it is and, indeed, how urgently it is required to keep it on the system for security of supply in the short term.”

NGT took a decision to delay a repair until the next routine maintenance in the case of the transformer leaking oil in the Hurst substation in London.

93. We do not intend to comment on the repair problems preceding the London outage last year. The report by the Engineering Inspectorate of the DTI and the inquiry by Ofgem are doubtless examining these issues in detail, and we look forward to considering their conclusions as soon as they can be made public. However, we note the significant disruption that can occur when power cuts take place as a result of installation, maintenance or repair problems. This underlines for us the need for all parties to ensure that companies do not skimp on maintenance and, in particular, that they have enough skilled staff available to keep an ageing system working.

Maintenance costs and labour

94. NGT provided us with figures showing that over the years 1998–2003 it had spent a broadly similar number of hours of maintenance on each of the four main types of equipment (transformers, circuit breakers, overhead lines and cables). In the period 1996–2003, it had reduced expenditure on maintenance by 22 percent in real terms. NGT described the ways in which it had reduced costs as: by improving business support

168 Q 175 (ENA)
169 Q 46 (NGT); see also Appendix 8, para 14 (NGT)
170 Appendix 9, paras 22–26 (Ofgem)
171 Appendix 7, para 59 and Figure 7
172 Appendix 7, para 60 and Figure 8
processes and IT support; by minimising duplication through centralising the management of maintenance; and by improving the operational efficiency of field staff. NGT stated: “Reductions in maintenance expenditure have not been achieved by wholesale reduction in field staff nor by reducing the amount of maintenance undertaken”.173 The company argued that the statistics on the reliability and the availability174 of its network showed that its approach to maintenance was efficient and effective.175

95. NGT suggested that its cost savings of between one and two percent per year were broadly in line with those achieved by the industry as a whole. Witnesses from several of the companies emphasised the contribution made by the use of IT, both in terms of the introduction of remote control and monitoring systems at substations—which enabled a reduction in the number of manned control centres—and in terms of improving the efficiency of field staff by allowing remote accessing of maintenance data and better planning of work schedules.176 Prospect, on the other hand, listed six ways in which NGT had reduced maintenance costs, by: staff reductions; reducing the proportion of highly skilled engineers employed in the field; decreasing the number of staff available to complete plant inspections; providing lower levels of supervision for contractors; increasing maintenance frequencies; and deferring maintenance in order to make more efficient use of a smaller workforce.177 NGT conceded that some intervals between routine maintenance inspections had been increased; but our witnesses said that this was because of the greater efficiency allowed by the move to condition monitoring: some unnecessary inspections had been ended.178 The Energy Networks Association said that while the new techniques resulted in maintenance intervals being increased for some pieces of equipment, for others—especially if the company was trying to stretch the life of the asset—they produced a more intensive frequency and level of inspection and maintenance. There had not been a simple, comprehensive decrease in maintenance levels.179

96. We explored how NGT had been able to reduce costs so significantly. We asked how great the reduction in field staff had been over the period 1996–2003, and were told that it had been about 17 percent, from around 1100 to about 950 people.180 We noted that there were no comparable figures for annual hours of maintenance by asset type for the period 1996–98, with the result that we could not compare hours of maintenance against cost and personnel reductions over the same period. NGT has explained to us that the data on maintenance hours was drawn from the company’s current work management system, known as MIMS, which was introduced in 1998, and that it was not practicable to generate equivalent data from the previous management system for the years 1996 and 1997.181 We

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173 Appendix 7, para 60
174 Network availability is reduced when circuits are taken out for maintenance or construction work or because of faults. A high level of availability would therefore imply efficient management of maintenance and construction work.
175 Appendix 7, paras 61–62 and Figures 1, 2 and 4
176 Qq 45 (NGT) and 198–199 (Scottish Power)
177 Appendix 13, para 12
178 Q 62
179 Q 174; also Appendix 18, para 4 (Scottish Power)
180 Q 45 (NGT)
181 Appendix 8, paras 11–12
accept this. However, it is unfortunate that no data are available for the two years when, according to NGT’s own graph, nearly half of the overall cost savings were made.

97. NGT insisted that it was the greater efficiency provided by condition monitoring that had enabled the company to shed field staff, not the other way round: the desire to cut costs leading to reductions in staff which in turn led to a reduced frequency of maintenance inspections. The fact that the number of hours worked on maintenance had not declined was a sign, the company suggested, that its aim was to work efficiently rather than simply to do less.182 Scottish Power agreed that the aim was to do the same amount of maintenance but at a lower cost.183

98. We did not receive any evidence on the actual number of jobs cut by other companies that would enable us to judge whether NGT’s reduction is standard for the industry.184 However, it is clear that companies have reduced the number of staff employed in maintenance. It was also suggested to us that companies had cut costs by reducing the skill levels required of field staff. Prospect stated that NGT, for example, had moved a large number of its highly technically skilled staff out of field operations, substituting less skilled staff—a manoeuvre which, the union felt, accounted for much of the 22 percent saving in maintenance costs cited by NGT. Prospect argued that this strategy relied on the quality of maintenance in the past, which could not be replicated by current, less experienced and less highly trained, staff.185 The Institution of Civil Engineers was also concerned about the reduction in the skill levels of maintenance staff.186 Prospect further argued that, because of the large number of ageing pieces of equipment on the networks, increased rather than decreased engineering and other technical knowledge were required of maintenance and repair staff: IT could not of itself do much to improve the reliability of old assets that required expert repair.187 At least one of the companies from whom we took evidence agreed with this argument in principle: Scottish and Southern Energy said that, not least because some of the equipment on its network dated back to the 1940s, it needed to employ very experienced staff who were familiar with all the different types of protection and control systems that had been installed in the last 60 years. It suggested that, although it now employed fewer field staff than in the past, those employed were much more highly skilled.188

99. Prospect and the Institution of Civil Engineers both attributed some of the companies’ eagerness to cut costs to the Regulator’s determination to bear down on operational expenditure. The companies were divided on whether any more efficiency could be wrung out of the system. NGT suggested that there was still room for greater efficiency in maintenance;189 while the Scottish transmission companies were more cautious in their

182 Q 49
183 Q 198
184 The only other figure we received was from Scottish Power, which said that it had its own dedicated maintenance division that now numbered about 325 staff: Qq 198–199.
185 Q 100 and Appendix 13, para 17 (Prospect)
186 Q 92
187 Q 101
188 Qq 126 and 135
189 Appendix 7, para 64 (NGT)
assessment. Scottish and Southern Energy was of the view that the main pressure from Ofgem had been on capital expenditure rather than operational expenditure. Even though the squeeze on expenditure might lead companies to consider economising on maintenance, they were faced with contrary, and perhaps even stronger, pressure not to skimp on safety, and the need to prevent accidents was a significant element of maintenance programmes.\textsuperscript{190}

100. Ofgem explained that it assessed whether companies were providing an appropriate level of maintenance by the reliability of their networks. It used comparisons between the efficiency of the 14 DNOs to set a standard for them. However, it did not attempt to dictate to the network companies how they should approach maintenance.\textsuperscript{191}

101. \textit{It is very difficult for us to gauge whether Ofgem’s desire to reduce costs to customers or the companies’ desire to increase efficiency and therefore profits has been the main motor behind the squeeze on operational expenditure. Probably both contributed. While we do not doubt that there were inefficiencies in the system before privatisation that should have been tackled, these have now been addressed. Further pressure on costs is likely to lead to diminishing returns.}

102. \textit{We think it is too early as yet to say whether the cost cutting in maintenance has gone too far. Inadequate maintenance of a large and complicated infrastructure like the electricity network is unlikely to become apparent rapidly through catastrophic failure; it is more likely that the system would gradually deteriorate as rising numbers of, probably minor, faults occurred. This is our concern.}

103. \textit{In fact, it is arguable that the current cautious approach to replacing equipment that we have described above\textsuperscript{192} implies that more maintenance, and more highly skilled maintenance, is necessary now. If asset lives are being stretched and increasing numbers of pieces of equipment are reaching and passing their design age, then the only thing that will keep them in operation is expert maintenance. We therefore conclude that the Regulator’s policy to date of both tightly limiting capital expenditure for replacement and continuing the pressure to reduce operational expenditure on maintenance is incompatible with the long-term stability of the electricity network.}

104. \textit{We called above for Ofgem to relax the limits on capital expenditure for asset replacement. Given that companies’ replacement programmes extend for periods of 10–20 years, the requirement for extra effort in maintenance and repair will also be relatively long-term. That being so, we recommend that Ofgem carefully consider any proposal by a company for an increase in operational expenditure to improve its maintenance programme.}

\section*{Manufacture and installation of equipment}

105. There have been significant changes to the electrical transmission equipment manufacturing industry since the great wave of construction 40 to 50 years ago. Whereas

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\begin{itemize}
  \item \textsuperscript{190} Q 136 (SSE)
  \item \textsuperscript{191} Qq 244-247
  \item \textsuperscript{192} Paragraphs 71 and 72
\end{itemize}
most of the equipment first installed was of British manufacture, the industry has since consolidated with the result that the principal suppliers of all types of major plant tend to be the subsidiaries of large, well-known European companies. In addition, the Central Electricity Generating Board imposed its own standards for equipment (which gave an advantage to British manufacturers who were generally better placed to meet them), whereas now the standards used are international.\textsuperscript{193}

106. The tendering process has also altered. NGT, for example, now shares its outline five-year programme for construction and replacement with its major suppliers. While they do not know which equipment they will eventually supply, this at least informs them of the volume of work that may be available and enables them to plan their manufacturing capacity accordingly. Overall, our witnesses considered that there was sufficient manufacturing capacity, of the right quality, to meet the demands of the network operators for both construction and replacement, but the capacity was no longer based only in Britain.\textsuperscript{194}

107. All the transmission companies emphasised the importance of the design and commissioning process in ensuring network resilience. Scottish Power described the careful quality control exercised by companies in drawing up the specifications for equipment and assessing whether manufacturers’ equipment would actually meet the operational requirements.\textsuperscript{195} NGT said that their experts periodically visited their main suppliers to audit their work and processes to ensure that the necessary standards were maintained.\textsuperscript{196} However, although all the companies considered the commissioning process critical, the evidence given to us indicates that they take differing approaches to the actual process of installing equipment. NGT said that it did not install any major equipment itself; while its staff managed the testing programme to ensure that equipment was installed properly and met the required performance standards, responsibility for the co-ordination of each project was delegated to a carefully selected ‘main contractor’.\textsuperscript{197} The witnesses from Scottish and Southern Energy, on the other hand, said that they preferred not to employ a single contractor to organise the whole project but instead tended to put out contracts for individual items of plant to specialist manufacturers and then, wherever possible, their own staff supervised the commissioning of each piece of equipment.\textsuperscript{198} Scottish and Southern Energy acknowledged that this approach placed great responsibility on the commissioning engineer on site, but the company’s spokesmen were confident that their staff had the necessary skills and the company the proper culture to ensure that high standards—not least in safety—were maintained.\textsuperscript{199}

108. \textbf{In this context, we feel some concerns about the maintenance of skill levels in the industry. It is arguable that unless staff have direct experience of designing and commissioning equipment themselves, they will not be able effectively to supervise}
contractors. This is not the sort of skill that universities can teach but must be learnt 'on the job'.

109. As mentioned above, problems with the installation of protection equipment played a part in both the London and the West Midlands outages last year. NGT assured us that all similar electronic protection devices on their network had been checked and that they had reviewed and modified the site testing procedures for such equipment to ensure that the problem would not recur. However, EDF suggested that the London and West Midlands power cuts were not isolated incidents. The company stated that a disproportionate number of problems with switchgear and protection equipment had occurred with new assets; it concluded that there should be greater emphasis on quality control in the manufacture and installation of equipment.

110. Though statistics show that there is only a low probability of newly installed equipment causing a problem, as Scottish Power acknowledged, when something does go wrong it has a major impact. The outages last year have served to focus the minds of company managers on the need to ensure that procedures are kept up to date so that equipment is correctly designed and installed. As for the question of whether to contract out or keep in house responsibility for the installation of equipment, we have received no clear indication that one is better than the other in terms of ensuring network resilience. We would be interested to learn whether the companies intend to make any changes to their approach in the light of the reports of the DTI Inspectorate and Ofgem on the problems last year.

Skills

111. A recurring issue in the evidence given to us was a concern that too few skilled staff were available. The industry representatives agreed that there had been a significant reduction in the number of universities and other academic institutions offering power engineering as a mainstream course. NGT was of the view that only five major universities still had "strength and depth" in power engineering. Several companies told us that they were developing relationships with the remaining universities offering courses to try to increase the number of graduate engineers and to finance the research needed by the industry. The companies are also actively supporting a new recruitment initiative for power system engineers, the Electricity Networks Academy, which was formally launched on 17 December 2003. The relevant trade union, Prospect, welcomed this move and was ready to help with the initiative though, at the time when the representatives of Prospect gave evidence to us, the companies had not invited that union to become involved. The industry faces some important hurdles if it is to attract undergraduates into courses.

200 Paragraph 14
201 Qq 23–24
202 Appendix 5, paras 26–27
203 Q 190
204 See, for example, Appendix 13, para 15 (Prospect)
205 Qq 5–6 (NGT) and 183 (Scottish Power), and Appendix 7, paras 71–74 (NGT)
206 Appendix 8, para 21 (NGT)
207 Q 104
addition to the widely recognised general image problems of the engineering industries, the
power industry is a mature area that offers little scope for making exciting new discoveries
or obtaining large salaries: it lacks glamour. Some of our witnesses also thought that the
knowledge that there had been large-scale job losses in the industry in the 1990s caused
young engineers to hesitate to join it.208

112. There appears to be less difficulty in recruiting people for training in the ‘craft’ skills.
NGT said that the company had continued with its apprenticeship scheme and, although
apprenticeships were not as popular as they used to be, it was able to recruit as many staff
as necessary.209 The Scottish companies were aware that they needed to plan manpower
needs carefully in order to cope with the major construction programme arising from the
Government’s renewables policy, but they foresaw no major recruitment difficulties.210
Other commentators were less sanguine. The Institution of Civil Engineers noted that in
the last ten to 15 years the number of staff employed directly in the electricity industry
(including by the generating companies) had decreased by half211 and, although the
number of field staff had fallen less steeply (by about 17 percent), the ICE was still
cconcerned that there were too few staff, and particularly too few staff with adequate skills,
to do the work on the infrastructure that was required. More and more of both the
operational and the construction work had been outsourced to contractors. However, the
ICE further argued that because companies had been able to make only limited investment
in building and replacing infrastructure, the contractors to the industry had also shed staff
in response to the lower demand, so that, in an emergency, the contractors to whom the
electricity companies would turn for help would not be able to make good the shortfall in
company staff.212

113. Ofgem felt that it had no direct role to play in ensuring a sufficient supply of skilled
labour to the industry, though it admitted that it would be concerned if a shortage of
suitably qualified staff led to an inability by companies to meet their licence conditions.
Ofgem said that it would be inclined to look sympathetically at any reasonable extra costs
incurred by the network companies in their attempts to deal with skills shortages.213
Prospect suggested that Ofgem should go further—it should adjust the price control
mechanism to reward companies that invested in training technical staff.214

114. The Government has addressed the problems generally faced by the science and
engineering sectors through initiatives arising from the Greenfield report (on attracting
more women into scientific and engineering careers) and the Roberts recommendations,215
and by setting up the Sector Skills Councils. However, Prospect suggested that there was

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208 Q 104 (Prospect)
209 Qq 55–57; and Appendix 8, paras 17–19
210 Qq 119 (SSE) and 184 (Scottish Power)
211 According to the ENA, from about 160,000 employees before privatisation to about 60,000 now: Q 174.
212 Qq 92–93 and Appendix 6, para 4
213 Q 251
214 Appendix 15
215 Set Fair: A Report on Women in Science, Engineering and Technology from The Baroness Greenfield CBE to the
Secretary of State for Trade and Industry, available at http://www.set4women.gov.uk; and Set for Success: The
supply of people with science, technology, engineering and mathematics skills, Report by Sir Gareth Roberts,
available at http://www.hm-treasury.gov.uk
more that the Government could do, for example encouraging employers to improve the
career paths of engineers (a Roberts recommendation); and clarifying the responsibilities
of the Sector Skills Councils in relation to other bodies involved in the area, such as the
Regional Development Agencies and the Learning and Skills Councils.216

115. Another issue was the question of whether the industry had lost, and was continuing
to lose, vital skills and experience. NGT said that the company regarded retention as very
important, and was proud that its apprentices were three times more likely to stay with the
company than those doing apprenticeships elsewhere.217 However, the argument centred
less on retention rates now than on the possible loss of skills during the period of highest
job cuts in the mid 1990s. Both Prospect and the ICE suggested that many of the people
“released” had been among the most skilled and experienced staff;218 the witnesses from
NGT admitted, “We undoubtedly lost expertise” during the 1990s, but said that the
company carefully planned the process to ensure that knowledge was transferred to
remaining staff.219 The process of knowledge transfer adopted by NGT had been developed
by Scottish Power and, according to that company, now constituted best practice and was
widely adopted by other companies.220

116. Even if there is no significant problem with skills shortages at present (and views
differ on that), it is clear that the electricity industry is not attracting enough
engineering graduates at the moment. If the pace of construction and infrastructure
replacement increases—which it will because of the need to accommodate renewable
generation, and will do so even more if replacement rates rise to the extent we think
necessary—then there may well be shortages in the ‘craft’ grades as well. Both
employers and unions are addressing the problem; we cannot suggest any further
initiatives they should take. The Government, too, has taken some action in the context
of the general difficulty with recruiting engineers. However, we were not given the
impression that either the Government or the Regulator is fully apprised of the
particular difficulties faced by the electricity industry. If engineering is regarded as
unattractive by potential undergraduates, power engineering is even less attractive. The
industry can no longer ‘make do’ with the experience already available: the skilled
workforce is ageing, and besides, after a period of relatively little activity, the industry
has to gear itself up to a sustained construction programme. Although the Sector Skills
Councils provide a welcome opportunity to raise and try to solve the industry’s
problems of skill shortages, we note that at least three Sector Skills Councils have some
involvement with the energy sector, and we are concerned that none will take a lead in
pressing the needs of this industry. We expect the Government as a matter of priority
to take appropriate measures to guarantee that this country has the skills required to
ensure the resilience of the electricity infrastructure.

216 Q 104. Prospect argues, for example, that because of a mismatch between the strategies of the RDAs and the central
Learning and Skills Council, a bid to set up a Centre of Vocational Excellence for the energy sector will fail: Appendix 14.
217 Q 54
218 Q 100 (Prospect) and Appendix 13, paras 12 and 17 (Prospect)
219 Q 73
220 Qq 192–193
7 Other issues

117. During the course of our inquiry, we briefly considered three other issues relating to the reliability of electricity supply: generating capacity (and in particular the margin of available capacity over demand, to meet peaks in consumption or temporary loss of other generators from the system); the effect of interconnectors on network resilience; and any possible changes resulting from the separation between the owners of the transmission infrastructure in Scotland and the system operator under the British Electricity Trading and Transmission Arrangements (‘BETTA’).

Generating capacity

118. An issue that has caused public concern over the last six months has been the question of whether the squeeze on electricity generating costs has left the UK with too little spare generating capacity. NGT produces an annual Statement giving an overview of security of supply for the next seven years, and it issues quarterly updates on matters such as installed generating capacity, and the margin of such capacity over predicted demand (‘plant margin’). The quarterly update for July 2003 showed the plant margin for the peak of demand in winter 2003–04 as 16.5 percent. Commentators compared this with the situation before privatisation, when the Central Electricity Generating Board set a margin which it considered effectively guaranteed that enough power could be generated to meet demand; this margin was usually about 25 percent.

119. At the time of our Report into Security of Energy Supply, which was published in February 2002, the margin of reserve capacity was about 30 percent, and the then National Grid Company was predicting that generating capacity margins would remain in excess of 25 percent over the period to 2007–08, even taking into account the planned closure of the Magnox nuclear and other generating plants. The DTI admitted that a margin in excess of 20 percent was usually considered to be healthy. Commentators were already expressing fears over whether the 25 percent margin would endure, and what effect on supply any decrease in margin would have, given the time lag between price rises resulting from supply shortages and the return to generation of mothballed capacity or construction of new capacity. We shared their concerns. We were therefore keen to learn how the market had reacted to such a low predicted plant margin in 2003.

120. NGT’s October update reported a significant improvement in the plant margin, to 19.3 percent. NGT told us it felt confident that it could manage any unplanned outages or rises in demand caused by very cold weather within this margin. NGT concluded that the market could function effectively without government intervention.

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221 Appendix 2, para 34 (DTI)
222 Security of Energy Supply, paragraph 75
223 Security of Energy Supply, paragraph 77
224 For further details, see Security of Energy Supply, paragraphs 74–78. For an account of why the electricity market as regulated under NETA may not provide incentives to invest in enough generating capacity, see Appendix 12 (Mike Parker and Tony White).
226 Q 65
concurred. Ofgem officials explained that companies had brought mothballed plant back into operation as forward prices had risen during the summer of 2003. They also suggested that various factors were helping the market to operate more efficiently—greater openness about the availability of offshore gas supplies, which helped owners of gas-fired generating plants to plan better; an improvement in NGT’s analysis of how companies brought mothballed plants back onto line; and the increased understanding of gas supplies caused by the merger of the National Grid Company and Transco. However, they would not give a guarantee that the margin was sufficient to avoid power cuts if there were a combination of serious events.

121. We therefore asked whether there was still any mothballed capacity that could be brought into operation this winter. Ofgem said that another 1300 megawatts of mothballed capacity could be brought back into operation in under 12 months; 1650 megawatts of capacity was under construction; and a further 5,000 megawatts already had planning permission and could be built in two to three years. As far as this winter was concerned, however, almost everything that could be deployed had already been deployed. On the other hand, Ofgem argued, it was important also to take into account the demand side: on the Continent, network operators made far greater use of targeted supply interruptions than in the UK. In fact, a number of major electricity customers in Britain have agreements that, in the event of difficulties, their supplies may be interrupted, in return for lower electricity prices. However, we noted that some of these customers, such as NHS Trusts, were reviewing this policy: they appeared to have entered into the contracts on the assumption that supplies were very unlikely to be interrupted (and that therefore they need not worry too much about ensuring that they had alternative fuel supplies and/or back-up generators), but now feared there was an increasing likelihood of supply problems and therefore of being disconnected.

122. Although the market responded quickly to the low predicted plant margin last year, we consider that it is too soon to judge whether market forces will ensure adequate generating capacity. The country has not experienced a particularly long and severe cold snap this winter, so the system has not yet been tested fully. Electricity prices do not seem likely to decline after the recent increases (which are attributable mainly to increased gas prices), so there is a greater probability that some of the planned generating capacity will be built. However, the industry has already made use of most of the reserve of mothballed plant that could return to service in under a year, and a number of large generators in the form of Magnox stations are due to be phased out over the next few years; so, unless extra capacity is constructed soon, the plant margin may decrease again. We also wonder whether big consumers of electricity will be as willing to enter into supply interruption agreements in the future as they were in the past.

227 Qq 255–256. Neither would NGT: Appendix 7, para 145
228 Qq 257–258. Other figures are given in Appendix 2, para 35 (DTI).
229 Q 258
230 Qq 258–259 (NGT)
Interconnectors

123. We noted that National Grid has an interconnector with the French transmission network, and that the Scottish transmission systems are interconnected with the England and Wales network. Scotland also has an interconnector with Northern Ireland, and Northern Ireland one with the Republic of Ireland. We wondered whether these added to the security of the system overall, or whether there was a danger that a major power outage in one area would have a cascade effect in another. The DTI and the Scottish transmission companies assured us that our fears were unfounded. The DTI did not believe that the interconnector with France would permit problems with the French system to spill over onto the grid in England and Wales; and NGT said that its network had already experienced—and survived—the loss of the French interconnector “at full import”.231 The Scottish companies noted that the Scottish transmission system as a whole, and the northern and southern parts of it, could all operate as separate grids if necessary.232 Furthermore, until now the Scotland–England interconnector had been used to export excess power generated in Scotland, so if parts of the English network were in difficulty, all the Scots would need to do was to decouple a power station; both domestic and industrial consumers in Scotland would suffer no loss of supply.233 Professor Maclaren of Scottish Power foresaw a time when, with ageing fossil fuel generators and increasing supplies of intermittent renewable energy, Scotland might well need to import power from England to balance supply and demand on the Scottish grid.234 The DTI was also of the view that the interconnectors to Northern Ireland contributed to the resilience of the transmission system there.235

BETTA

124. We will not describe here the changes likely to come about as a result of the institution of BETTA: we reported on the proposals for BETTA last year.236 In the context of this inquiry, we confined ourselves to asking whether the Scottish transmission companies were concerned that the proposed separation of transmission owners and the system operator would lead to a lack of clarity about responsibility for maintaining the network, and therefore to possible problems with ensuring resilience. We were assured that the companies had no worries about this; and the DTI explained that if there were any faults on the system, while it would be the responsibility of the system operator to minimise the impact of the fault, it would be for the owner of the infrastructure to investigate the physical cause and take appropriate remedial action.237

231 Appendix 7, para 131
232 Q 113–114 (SSE) and 261–262 (DTI)
233 Q 112
234 Q 200
235 Appendix 2, para 32
237 Q 191 (Scottish Power) and Appendix 2, para 38 (DTI)
Conclusions and recommendations

Risk of Major Power Cuts

1. We do not underestimate the disruption caused to those caught up in the London and West Midlands incidents, but they were both limited in scale and in duration. Although the immediate causes of the events abroad differed, they had a common outcome: a cascade effect that brought down very large sections of the country’s electricity network for a considerable length of time. While unwilling to state that such a cascade effect could never happen here, our witnesses said that the networks had been designed in such a way as to try to prevent it happening. (Paragraph 13)

Inquiries arising from last year’s incidents

2. The inquiries initiated last autumn by the DTI and Ofgem are the first major test of the policing system under the 2000 Act, and we have some reservations about the process. (Paragraph 18)

3. The first of these is the length of time that it is taking. Both the DTI and Ofgem acted swiftly in announcing investigations, and, though the DTI’s Engineering Inspectorate has completed its review, we were told by Sir John Mogg that Ofgem’s would not be finished until the middle of this year—some nine months after it started. None of the incidents in Britain last year caused huge disruption or was of long duration. If it takes nine months to reach conclusions on relatively limited disruptions, how long would it take to investigate and then implement any changes required in the event of larger scale incidents? (Paragraph 19)

4. Our second concern is that the lack of transparency in the process raises suspicions amongst the public that the companies may be let off lightly. An example of this effect is the reaction to the Government’s announcement that, although the Engineering Inspectorate had completed its inquiry, the report could not be published because of the duty of confidentiality imposed by section 105 of the Utilities Act. The lack of transparency coupled with the length of the process may undermine confidence that the authorities are effective in ensuring a reliable electricity supply. (Paragraph 20)

5. One of the reasons why the authorities have to be particularly meticulous in their investigations is that the penalties that may be imposed upon the transmission companies are draconian: Ofgem has the power, in effect, to fine transmission companies up to ten percent of their turnover for particularly severe breaches of their licence conditions. Such a penalty could be used only in the most extreme circumstances. There may be better ways of penalising companies for failure to ensure reliable power supplies: better in the sense of being based on simpler measurements of performance, so less open to argument, and of being less punitive, so easier to impose. Adopting such measures would not remove the need for investigations into major incidents, but might help to reduce some of the sensitivities around the current investigation process. (Paragraph 21)
Incidents last year: failure to share information

6. We are concerned that, in an industry that places great emphasis on sharing information on safety and efficiency grounds, there appears to have been a failure to take fully into account the effects on customers of decisions about planned outages. Over the next few years, electricity companies will have to increase network disconnections for construction and maintenance, so problems of co-ordination are likely to grow. We hope that the incidents last year will lead to a greater awareness of possible consequences; and in particular that the transmission companies (which are at one remove from the major customers that are connected directly to the distribution network) inform themselves of such customers’ emergency procedures. (Paragraph 16)

Maintenance

7. We do not intend to comment on the repair problems preceding the London outage last year. The report by the Engineering Inspectorate of the DTI and the inquiry by Ofgem are doubtless examining these issues in detail, and we look forward to considering their conclusions as soon as they can be made public. However, we note the significant disruption that can occur when power cuts take place as a result of installation, maintenance or repair problems. This underlines for us the need for all parties to ensure that companies do not skimp on maintenance and, in particular, that they have enough skilled staff available to keep an ageing system working. (Paragraph 93)

8. We think it is too early as yet to say whether the cost cutting in maintenance has gone too far. Inadequate maintenance of a large and complicated infrastructure like the electricity network is unlikely to become apparent rapidly through catastrophic failure; it is more likely that the system would gradually deteriorate as rising numbers of, probably minor, faults occurred. This is our concern. (Paragraph 102)

9. In fact, it is arguable that more maintenance, and more highly skilled maintenance, is necessary now. If asset lives are being stretched and increasing numbers of pieces of equipment are reaching and passing their design age, then the only thing that will keep them in operation is expert maintenance. We therefore conclude that the Regulator’s policy to date of both tightly limiting capital expenditure for replacement and continuing the pressure to reduce operational expenditure on maintenance is incompatible with the long-term stability of the electricity network. (Paragraph 103)

Installation of equipment

10. The outages last year have served to focus the minds of company managers on the need to ensure that procedures are kept up to date so that equipment is correctly designed and installed. As for the question of whether to contract out or keep in house responsibility for the installation of equipment, we have received no clear indication that one is better than the other in terms of ensuring network resilience. We would be interested to learn whether the companies intend to make any changes
to their approach in the light of the reports of the DTI Inspectorate and Ofgem on the problems last year. (Paragraph 110)

**Performance of the electricity networks**

**11.** The performance of both the transmission and the distribution networks has been and remains very good, both absolutely and in comparison with networks abroad. However, this performance has been achieved as a result not only of the recent and continuing efforts of the industry but also as a result of the historical investment in the network. The fact that the network is performing well today is not a guarantee that it will do so in the future, and the investment made now will be a major factor in determining its future performance. (Paragraph 49)

**Price controls imposed on network companies**

**12.** There have been suggestions that Ofgem focuses too much on short-term investment requirements in order to control costs to consumers. If during its five yearly review Ofgem agreed to enable the companies to fund some longer-term capital expenditure programmes, this would not reduce its ability to control the overall level of capital expenditure, but it would give network companies more security and perhaps enable them to obtain financing more easily or on better terms than regulatory uncertainty currently allows. (Paragraphs 40 and 84)

**Willingness of companies to challenge Ofgem’s price controls**

**13.** The main onus to ensure that there is sufficient investment must lie with the electricity companies. However, we are not confident that, if unhappy about the levels of capital investment that they had been allowed, the companies would engage in a protracted dispute with the Regulator that grants them their licence to operate—and, in particular, that they would be willing to appeal to the Competition Commission, which would bring the dispute into the open. The companies would probably continue the argument over critical investment, but would they wish to sour relations over plans that, arguably, were not urgent? Although this would not matter in the short term, there could be longer-term problems, in the form of either unplanned outages or of difficulties in finding the personnel, capital and equipment to do a lot of work in a short time. (Paragraph 44)

**Incentives on companies to make sufficient investment**

**14.** The distribution companies are subject to a system known as the Incentives and Investment Programme, under which if the companies fail to meet certain standards in relation to measures like minimising customer minutes lost and the number of faults on the system, they can be penalised by up to 1.75 percent of their income. Without stimulating the level of the penalty, we recommend that a similar system of performance incentives and penalties is instituted for the transmission companies. This, we think, would tend to focus the attention of all companies on the problem of the cumulative effect of a number of comparatively small and short-lived systems failures. (Paragraph 45)
Investment to meet customer demand

15. While there may be little direct financial incentive to do so, it seems to us that it may be easier for companies to make a case for demand-led expenditure than for the replacement of assets out of which a few extra years of life might be wrung. The companies have admitted to us that there is a temptation to postpone desirable, but not immediately necessary, expenditure in favour of connection projects; and the revenue control mechanisms, not least the allowance for connections without any corresponding incentive for replacement, do nothing to reduce this temptation. (Paragraph 56)

Meeting the Government’s target for renewable energy

16. Good progress has been made in planning the changes to the system required to accommodate the hoped-for increase in the supply of renewable energy generation. At present, it looks as though the network companies are well placed to meet the demand from new generators, including financing the work. While the shortage of construction workers with relevant skills may pose some problems with timetabling, the main difficulty anticipated is the uncertainty arising from the planning process—and this is beyond the control of the companies, Ofgem or even the DTI. The planning process, and public attitudes to energy developments, form a considerable barrier to the achievement of a more secure and diverse energy supply in the UK, However, we are encouraged that local authorities have accepted the need for the programme in principle and are concentrating on discussing the ‘when’ and ‘how’ rather than the ‘if’. (Paragraph 62)

Managing ageing equipment

17. Much of the electricity network is reaching the end of its design life, of 40 years. The network companies cannot and need not replace all assets when they are exactly 40 years old. Since privatisation companies have been very successful in stretching asset lives through a better understanding of equipment and network risks. However, better asset management can postpone the replacement of equipment for only a limited time. One of our witnesses, drawing lessons from the railway system, said that he would not like the condition of the electricity network to deteriorate to the stage where it would take several years of work before it could be restored to normal operation. Neither would we, and this, we consider, is a real danger unless investment in the replacement of the infrastructure increases significantly. (Paragraph 77)

18. If Ofgem takes too restrictive a view of what is necessary to maintain the robustness of the network, it must discourage companies from investing enough to prevent equipment from failing simply through old age. Investment must increase now if reliability is not to decline. It is not for us to suggest how much extra capital expenditure should be allowed; this is for Ofgem and the network companies to agree on a case by case basis. But we do note signs of a consensus in the industry that expenditure on the replacement of ageing assets must double over the next 10–20 years if network performance is not to suffer. We will keep a watching brief on the
current negotiations on revenue controls for distribution companies, and may return to this issue in due course. (Paragraphs 78 and 80)

Improving network resilience

19. There is no clear evidence as yet that a widespread programme of undergrounding cables is necessary to sustain the reliability of the network, and the expense of such a programme leads us to the conclusion that there are more cost-effective ways of improving network resilience. Among these are, as the Network Resilience Working Group has acknowledged, the use of more highly insulated cables, and better control of vegetation close to power lines. (Paragraph 83)

Design and operational standards for electricity network

20. The estimated cost of upgrading the network serving Central London to an N-3 standard is £350 million. This represents a very large increase in expenditure; and the London network would not be the only one requiring such work. We have identified a number of issues which, we believe, will require higher expenditure on the electricity infrastructure. At present, these issues appear more urgent than a general increase in the standards laid down for the transmission network. This does not imply that we think it unnecessary to review the industry standards in the context of the Government’s renewables policy, nor do we question companies’ decisions to exceed the P2-5 standards in specific cases to increase reliability in particularly sensitive areas. But we do not consider that the extra resilience provided by the blanket imposition of an N-3 standard, even if limited to major conurbations, would be worth the cost. Nor do we think it feasible or necessary to require that the whole distribution network be built to the same standard as the transmission one. A hierarchy of standards seems the only sensible approach. (Paragraph 30)

21. However, we note that the P2-5 standards were—and the P2-6 standards being developed will be—based on an assumption about equipment failure rates. While the number of failures remains at about the present level, the standards will continue to support the reliability of the system. On the other hand, if the failure rate increases (for example, because ageing infrastructure is not replaced swiftly enough or is not maintained properly) then multiple faults will occur more frequently and the standards will not in themselves be able to prevent a rapid deterioration in reliability. (Paragraph 31)

Costs to customers

22. For various reasons, the cost of generating electricity is certain to rise over the next few years, and the move to greater reliance on renewable generation also has a price. Also, while an expanded capital expenditure or maintenance programme might mean only a few pence extra per week to domestic consumers, the bills for industry would rise by significant amounts. Against this has to be balanced the costs to consumers, not least to industry, of power cuts; and, without significantly faster replacement rates and more maintenance, power cuts are likely to increase in frequency. Lower costs for present customers should not be pursued at the expense
of a reliable network for future customers. We conclude that a rise of ten percent in distribution charges to support network security would not be an unreasonable amount to pay, and that, in certain particularly vulnerable areas, the Regulator should be willing to consider more investment to enhance security. (Paragraphs 84 to 88)

Skills

23. Even if there is no significant problem with skills shortages at present (and views differ on that), it is clear that the electricity industry is not attracting enough engineering graduates at the moment. If the pace of construction and infrastructure replacement increases—which it will because of the need to accommodate renewable generation, and will do so even more if replacement rates rise—then there may well be shortages in the ‘craft’ grades as well. Both employers and unions are addressing the problem; we cannot suggest any further initiatives they should take. The Government, too, has taken some action in the context of the general difficulty with recruiting engineers. However, we were not given the impression that either the Government or the Regulator is fully apprised of the particular difficulties faced by the electricity industry. If engineering is regarded as unattractive by potential undergraduates, power engineering is even less attractive. We expect the Government as a matter of priority to take appropriate measures to guarantee that this country has the skills required to ensure the resilience of the electricity infrastructure. (Paragraph 116)

24. Although the Sector Skills Councils provide a welcome opportunity to raise and try to solve the industry’s problems of skill shortages, we note that at least three Sector Skills Councils have some involvement with the energy sector, and we are concerned that none will take a lead in pressing the needs of this industry. (Paragraph 116)

Generating capacity

25. Although the market responded quickly to the low predicted plant margin last year, we consider that it is too soon to judge whether market forces will ensure adequate generating capacity. The country has not experienced a particularly long and severe cold snap this winter, so the system has not yet been tested fully. However, the industry has already made use of most of the reserve of mothballed plant that could return to service in under a year, and a number of large generators in the form of Magnox stations are due to be phased out over the next few years; so, unless extra capacity is constructed soon, the plant margin may decrease again. We also wonder whether big consumers of electricity will be as willing to enter into supply interruption agreements in the future as they were in the past. (Paragraph 122)

DTI’s Engineering Inspectorate

26. We accept that the Engineering Inspectorate of the DTI has sufficient staff for the work it currently carries out. However, the electricity network will change significantly over the next decade or so, in terms both of new construction and of the pace at which infrastructure has to be replaced. At the same time, public tolerance of
interruptions to electricity supply appears to be decreasing. We believe that over the next few years the Inspectorate is likely to experience both an increase in its workload and growing public interest in the Government’s role in maintaining electricity supplies. If our predictions are correct, the Inspectorate will need more resources; we expect the Government to provide them. (Paragraph 8)
Price Controls for Electricity Networks

The charges for using transmission networks and distribution networks in Great Britain are regulated by the Gas and Electricity Markets Authority and by Ofgem. This regulation uses the “RPI-X” system of incentive regulation, in which the real level of prices is determined by a formula set for five years at a time. There are some differences between the formulae for transmission and for distribution, however, which may give the companies involved slightly different incentives.

The formula for distribution companies is expressed in terms of the average revenue received by the company per unit of electricity distributed, but it can be converted to the form:

Total revenue # Base price × volume driver × (1 + %RPI-X + other terms)

The company is required to ensure that the total revenue it collects each year is less than an amount given by the formula. The base price is set at the start of the period and does not change. The volume driver is a 50–50 mix of the number of customers and the number of units distributed. The group of terms in brackets allows revenues to rise by the percentage change in the retail price index (as compensation for inflation), less X percentage points (an efficiency gain), and adjusts them for other factors determined by Ofgem. At present, these include the number and length of interruptions, and the time that the companies take to answer telephone inquiries. The company is also allowed to pass some cost changes (such as transmission exit charges) on to consumers, and the formula does not include some of its revenues (such as charges to local authorities for work on the distribution networks that they have requested).

The impact of this formula is that if the number of units distributed rises by 10%, then the company’s revenues will rise by 5%. If the number of customers is forecast to rise by 8%, then the company’s revenues will rise by 4%. (Note that an agreed forecast of customer numbers is used, to prevent any disagreements over how to interpret actual changes in the number of connections to the grid.) The companies also make connection charges that are not included in the price control revenue, however, to cover the cost of connecting the new customers to the grid. In 2001, these charges amounted to just over £½ billion, compared to £3½ billion of revenue covered by the price control.

Do the distribution companies have any incentive to encourage new consumers, or increased consumption? This depends on how their costs would change, and on the extra revenues that they would get. The formula was intended to keep revenues and costs broadly in line if consumption differed from the predictions used when the control was set. To the extent that it succeeds, there would be no incentive to encourage additional consumption.
The transmission price controls are similar in concept, but the volume driver is a forecast of maximum demand (for National Grid Transco) or of units transmitted (for the Scottish transmission operators). This means that the companies’ revenues do not directly increase if demand increases. National Grid Transco’s price control, however, includes an adjustment term which raises the company’s allowed revenues if more generation capacity is connected to the grid than was predicted when the control was set. As with the distribution companies, the transmission companies impose connection charges to cover the cost of connecting new power stations (or making new connections with the distribution system)—these are intended to cover the local costs of the connection, but will not include the cost of more distant reinforcement.
Formal Minutes

Tuesday 2 March 2004

Members present:

Mr Martin O’Neill, in the Chair

Mr Roger Berry
Mr Jonathan Djanogly
Mr Nigel Evans

Judy Mallaber
Linda Perham

The Committee deliberated.

Draft Report (Resilience of the National Electricity Network), proposed by the Chairman, brought up and read.

Ordered, That the Chairman’s draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 124 read and agreed to.

Summary agreed to.

Annex agreed to.

Ordered, That the Chairman do make the Report to the House.

Ordered, That the provisions of Standing Order No. 134 (Select Committees (reports)) be applied to the Report.

Ordered, That the Appendices to the Minutes of Evidence taken before the Committee be reported to the House.

[Adjourned till Tuesday 9 March at 9.00am]
Witnesses

**Tuesday 2 December 2003 (morning)**
- Dr Roger Unwin, Mr Nick Winser and Mr Jon Carlton, National Grid Transco (Ev 1)
- Mr David Anderson and Dr John Bennett, Institution of Civil Engineers (Ev 16)
- Mr Mike MacDonald and Ms Sue Ferns, Prospect (Ev 20)

**Tuesday 2 December 2003 (afternoon)**
- Mr Ian Marchant and Mr Colin Hood, Scottish and Southern Energy plc (Ev 25)
- Mr Bob Taylor, Mr Frank Duffy and Mr Gary Flynn, Energy Networks Association (Ev 30)
- Professor Robin MacLaren, Scottish Power (Ev 36)

**Tuesday 9 December 2003**
- Sir John Mogg, Mr Alistair Buchanan, Mr Boaz Moselle and Mr John Scott, Ofgem (Ev 42)
- Mr Neil Hirst, Ms Elizabeth Baker, Mr Duncan Millard and Mr Giles Scott, Department of Trade and Industry (Ev 53)
List of written evidence

1. Aquila
2. Department of Trade and Industry
3. Department of Trade and Industry (Supplementary)
4. East Midlands Electricity
5. EDF Energy
6. Institution of Civil Engineers
7. National Grid Transco
8. National Grid Transco (Supplementary)
9. Ofgem
10. Ofgem (Supplementary)
11. Ofgem and Department of Trade and Industry (Joint memorandum)
12. Mike Parker and Tony White
13. Prospect
14. Prospect (Supplementary)
15. Prospect (Further Supplementary)
16. Scottish and Southern Energy
17. Scottish and Southern Energy (Supplementary)
18. Scottish Power
19. Dr David Ward