



National Audit Office

Report

by the Comptroller
and Auditor General

Ofgem, Department for Business, Energy & Industrial Strategy

Electricity networks

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Report by the Comptroller and Auditor General

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Gareth Davies
Comptroller and Auditor General
National Audit Office

27 January 2020

This report examines how effectively Ofgem has used the electricity network price controls to protect the interests of consumers and achieve the government's environmental goals. It also comments on the strategic challenges the Department for Business, Energy & Industrial Strategy and Ofgem will face in ensuring electricity networks support government's climate change goals.

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Key facts

£8bn

total regulated revenues of electricity transmission and distribution companies (electricity network companies)

9%

average return on regulatory equity electricity network companies expect to make for their shareholders in the current regulatory period. This compares with historical returns of 5%–6% for UK companies on average (figures in RPI-real terms)

£17bn to £40bn

the cumulative amount of expenditure across the electricity system, including networks, that could be avoided by 2050 by using sources of flexibility such as batteries, according to research for the Department for Business, Energy & Industrial Strategy

29 million number of homes and businesses connected to the electricity networks

£40 billion estimated value of electricity network assets such as cables and substations

£70 billion Ofgem's estimate of the capital investment in electricity networks that has taken place since privatisation in 1990

Around 50% reduction in the frequency of power cuts since Ofgem introduced incentives for companies to improve reliability in 2002

£130 the amount households pay each year, on average, for electricity transmission and distribution networks. A further £10 is spent on the costs of balancing the electricity system. These payments are made via consumer energy bills

£800 million amount we estimate consumers could have saved in the current eight-year regulatory period if Ofgem had used up-to-date evidence to set network companies' returns

Summary

1 Electricity networks take electricity from the power plants where it is generated, to homes and businesses where it is used. The physical assets making up the networks, which have an estimated value of about £40 billion, include more than 800,000 kilometres of overhead and underground cables. Electricity networks comprise transmission networks, which carry electricity nationwide at high voltage, and distribution networks, which carry electricity at lower voltages and distribute it locally. A distinct company, the Electricity System Operator, is responsible for ensuring supply and demand for electricity on the transmission network remain in balance. The costs of running, maintaining and upgrading the networks are passed on to businesses and households through their energy bills. In 2019, transmission and distribution network costs made up around 20% (£130) of the typical household's annual electricity bill. Overall, they amount to £8 billion a year.

2 The electricity networks in Great Britain were privatised in 1990. Each transmission or distribution network company (network company) serves a different region, so most customers do not have the option of using a different company. To prevent network companies from overcharging their customers, and to ensure they provide a good service, their earnings are regulated by Ofgem, a non-ministerial government department sponsored by the Department for Business, Energy & Industrial Strategy (BEIS). Ofgem does this through price controls, which are multi-year regulatory settlements that provide network companies with allowances for their costs, and targets for performance.¹ BEIS has overall responsibility for energy policy and ensuring the UK meets legislated targets for reducing carbon emissions.

3 Network companies have a crucial role to play to support carbon emissions reductions in the energy sector and the wider economy. To date, nearly a million solar panel installations have been fitted, and distribution networks have ensured these can be accommodated in the electricity system. By 2050, the overall amount of electricity flowing through electricity networks may need to double, to displace carbon-emitting fuels for transport and heating buildings. Growth in the overall demand for electricity and displacement of carbon-emitting fuels by renewables means that new investment is needed to upgrade electricity networks. While upgrading networks has traditionally meant reinforcing them with new cabling and substations, new technology such as battery storage may offer lower-cost methods of upgrading them. BEIS commissioned academic research, which estimated that using this technology could ensure that the cumulative cost of reducing carbon emissions by 80% by 2050 is between £17 billion and £40 billion less than it would be if the technology were not used. However, using this technology will require significant changes to the way network companies operate.

¹ Electricity networks in Northern Ireland are part of a distinct electricity system for the island of Ireland, and are regulated by the Utility Regulator for Northern Ireland rather than by Ofgem. This report focuses on Great Britain only.

4 In 2010, Ofgem concluded that price controls must change to incentivise the network companies to support the transition to low-carbon energy. This led to the introduction of a new set of price controls known as RIIO (an acronym for ‘Revenue = Incentives + Innovation + Outputs’, pronounced “Rio”). For transmission networks, the first set of RIIO price controls (RIIO-1) applies from 2013 to 2021, and for distribution networks, the first set of RIIO price controls applies from 2015 to 2023. Ofgem is currently designing the next set of price controls (RIIO-2).

Scope of this report

5 This report examines how effectively Ofgem is using the RIIO electricity transmission and distribution network price controls to protect the interests of consumers and achieve the government’s climate change goals. It also comments on the strategic challenges BEIS and Ofgem will face in the near future in ensuring electricity networks enable the achievement of government’s climate change goals. We have chosen to focus on these price controls because:

- they have a very significant impact on consumers’ energy bills;
- they are an important policy lever for decarbonising the energy sector; and
- they are in the process of being redesigned for the next regulatory period.

Because the electricity network price controls are a large and complex subject area, we did not look in detail at other aspects of network regulation, including the regulation of network user charges, or Ofgem’s approach to incentivising the Electricity System Operator and gas companies (both of which RIIO also applies to). In other recent reports, we have examined government policies for changing non-network parts of the electricity system, and the wider consumer protection work of Ofgem and other regulators.²

Key findings

Network companies’ performance and profits

6 Network companies provide consumers with a good service. Consumers in Great Britain experience fewer power cuts than consumers in most other EU countries, and the reliability of the networks has improved substantially since 1990. Electricity network companies have met almost all the targets Ofgem has set for them in RIIO-1, which cover safety, the environment, reliability and availability, providing timely connections, customer services, and assisting vulnerable consumers. The targets reflect the level of performance Ofgem thought efficient network companies would be able to achieve (paragraphs 2.2 and 2.3, Figure 13 and Appendix Three).

² For example, see: Comptroller and Auditor General, *Nuclear power in the UK*, Session 2016-17, HC 511, National Audit Office, July 2016; Comptroller and Auditor General, *Rolling out smart meters*, Session 2017-2019, HC 1680, National Audit Office, November 2018; Comptroller and Auditor General, *Regulating to protect consumers*, Session 2017-2019, HC 1992, National Audit Office, March 2019.

7 Network companies' returns are high relative to comparable companies and Ofgem's expectations. Ofgem designed RIIO-1 so that networks' returns depended on how well they performed. Its expectations were that networks could make a real-terms return on regulatory equity of between roughly 2.5% and 10.5%, but it expected only the best-performing companies to reach the high end of the range. In practice, based on the latest available information, three of the nine network companies are forecasting returns of around 10%, and the average forecast return is 9.2%. By comparison, Ofgem estimates that FTSE-listed companies on average provide returns of 5.25%–5.75%, based on various sources of evidence including historical market data.³ An Ofgem survey suggests that in recent years investors have come to expect lower returns from the FTSE than this (around 3%–4%), although investors' views are liable to change over time. Investors accept lower returns on lower-risk companies, and regulated utilities such as network companies are seen as lower risk than FTSE-listed companies on average (paragraphs 2.6 to 2.9 and Figures 15 and 16).

8 Ofgem missed opportunities to reduce consumer costs when designing RIIO-1. When setting up price controls, Ofgem provides network companies with a baseline rate of return, which is intended to be in keeping with the amount of risk borne by these companies' shareholders. Estimates of this risk are always highly uncertain, but Ofgem's estimate of this risk for RIIO-1 now looks high. At the time of RIIO-1, other regulators tended to adopt estimates which were on the high side, as this was thought to be necessary to provide additional certainty that companies will not need to be financially rescued by consumers or taxpayers. In addition, it ensures companies are capable of raising enough finance for significant programmes of investment, such as the investment Ofgem was expecting in RIIO-1. Nevertheless, in our assessment, Ofgem erred in placing too much weight on consistency with previous regulatory decisions when it set the baseline rate of return, and not enough weight on the most up-to-date market evidence, which suggested network company risk was lower. We estimate that if Ofgem had placed greater weight on this evidence, consumers could have paid at least £800 million less (paragraphs 2.10 to 2.15 and Figure 18).

9 Consumer costs were further increased because network companies were able to exceed almost all the performance targets that Ofgem set. Of the average 9.2% returns forecast by network companies, 1.2 percentage points come from network companies spending less than their full allowances for costs, and 1.5 percentage points from operational performance other than underspend. For electricity distribution companies, most of the rewards for operational performance come from exceeding targets set under a scheme that rewards companies for preventing power cuts. Targets for this scheme were fixed too far in advance, meaning network companies were already beating their targets before the price control started (paragraphs 2.9 and 2.16 to 2.19, and Figures 16 and 19).

³ All of the returns figures in this paragraph are in real terms, deflated using the retail prices index (RPI).

10 Ofgem’s unusually long price control period has locked consumers into paying higher costs for longer. Price controls usually last for five years. Ofgem set RIIO-1 to last for eight years, expecting this to encourage increased innovation and more long-term thinking from network companies, creating better outcomes for consumers and the environment. Ofgem has now concluded that there is no evidence that longer network price controls create this additional benefit. Instead, the length of the price control period means Ofgem will wait an additional three years before it fully addresses the issues with RIIO-1 that have added to consumer costs (paragraphs 2.20 to 2.22).

11 Ofgem did not change the rules of RIIO-1 to reduce networks’ profits because of the potential for increased costs in the long term. Under RIIO-1, networks automatically pass about half of any underspend against their allowances onto consumers. In addition, during RIIO-1, four of the nine electricity network companies have made “voluntary contributions to consumers” from their high returns. Ofgem has welcomed these contributions and continued to highlight concerns around the legitimacy of existing returns to all network companies. Midway through the regulatory period, Ofgem considered changing some of the rules of RIIO-1 to enable more of those returns to be transferred to consumers. But it decided against doing this because it would mean going back on its previous commitments, which it believed could have reduced investors’ confidence in the regulatory regime, ultimately resulting in additional costs for consumers (paragraphs 2.23 to 2.25 and Figure 20).

Ofgem’s regulation in the future

12 Ofgem currently lacks robust evidence it can use to determine whether making changes during a price control period would save consumers money.

Ofgem says it would only be willing to make retrospective changes during the price control period if there was clear evidence that there would be a net benefit for consumers. The quantitative evidence base for assessing potential impacts on investor confidence is limited, making the overall impact of any retrospective changes uncertain. Ofgem would be able to make decisions during the price control period more confidently if it had an improved evidence base (paragraphs 2.25 and 2.26).

13 Several of Ofgem’s proposals for RIIO-2 aim to ensure networks only earn a fair return. Ofgem has undertaken its own review of RIIO-1 ahead of RIIO-2. For RIIO-2, Ofgem has reduced its estimate of networks’ financing costs by between 2.2 percentage points and 3.2 percentage points, to be more aligned with current market conditions. In addition, it is proposing:

- to adjust the proportion of network company savings that is returned to consumers, from 30%–55% in RIIO-1 to 50%–85% in RIIO-2;
- to adopt a more flexible price control, limited to five years, with the potential for greater use of ‘dynamic’ targets, which it updates as new evidence emerges; and
- to introduce mechanisms to adjust network company returns in the event of extreme deviations from Ofgem’s initial expectations.

These proposals are subject to consultation (paragraphs 2.27 and 2.28).

14 Ofgem recognises the need for greater scrutiny of the financing of network companies to ensure they are acting in the interests of consumers.

The performance of network companies in reducing costs and providing quality of service only provides part of the picture of whether current and future consumers' interests are being protected. Whether regulated companies provide value for money also depends on their financial structures, dividend policies and the way they incentivise their executives. Poor policy in these areas can put the sustainability of companies at undue risk, and ultimately lead to consumers or taxpayers needing to provide these companies with additional financial support. In the water sector, these issues are attracting concern and increased scrutiny from the regulator (Ofwat). Ofgem is also increasing its oversight in these areas, for example by gathering more information on dividends, executive pay and tax, areas which network companies were not previously required to report on (paragraph 2.29).

15 Ofgem needs to do more work to show in clear and simple terms that the overall cost-effectiveness of networks has improved over price control periods.

In privatising the networks, the government aimed to improve their value for money, by reducing costs and providing customers with a better service. In recent years, networks have served more customers and provided a better service, but costs have increased. Ofgem has started to create indicators of networks' overall value for money, which take both costs and quality of service into account, although this research has been hindered by limitations in underlying historical data, which Ofgem would need to work with the Office for National Statistics to address. As we noted in our report on *Regulating to protect consumers*, it is important for regulators to measure and report on what they have accomplished for consumers, not least because of public debate over regulators' effectiveness (paragraphs 1.14 to 1.16, and Figures 11 and 12).

The role of networks in tackling climate change

16 Ofgem has supported innovative efforts to reduce carbon emissions, although more work needs to be done to understand the impact of this support.

Ofgem believes that network companies must become more innovative if they are to support the transition to low-carbon power. It has given network companies dedicated funding for innovation projects since 2004 and expanded this under RIIO-1. An Ofgem-commissioned evaluation of the main innovation funding mechanism over the period 2010–2015 found that innovation projects have delivered significant cost savings for consumers and reductions in CO₂ emissions. However, the extent to which these projects would have taken place without the support of the funding mechanism is unclear. Ofgem has not yet undertaken a detailed independent evaluation of the innovation support mechanisms in RIIO-1, which would help inform the effective use of innovation funding in RIIO-2 (paragraphs 3.2 to 3.4 and Figure 21).

17 Strong pressure from government and Ofgem is needed to ensure network companies transform to support a low-cost, low-carbon energy system.

Ofgem has successfully incentivised network companies to start investing in new technology, but extensive further changes are needed. For networks to support decarbonisation of the economy at least cost, they will need to develop capabilities to contract for flexible solutions such as battery storage for both shorter-term network management and for longer-term network capacity upgrades, something that has not been done before. Ensuring networks undergo this transformation in a timely way will be a challenge for BEIS and Ofgem because it will not necessarily be in the economic interests of the network companies, yet government is dependent on them to do much of the technical planning (paragraphs 3.5 to 3.9).

18 BEIS has yet to introduce the policies for low-carbon heat that are urgently needed to determine future network requirements. To achieve the net zero emissions target, there is broad consensus that the level of low-carbon heating and transport will need to increase significantly during the 2020s, much of which is likely to use electricity. However, BEIS has not set out a fully-fledged strategy for low-carbon heat, contributing to uncertainty around future electricity network requirements. This uncertainty creates a risk of too little network infrastructure being built, endangering achievement of the net zero target, or too much infrastructure being built, at additional cost to consumers (paragraphs 3.10 to 3.12).

19 BEIS and Ofgem will need to improve coordination significantly in the energy system if it is going to reach net zero emissions at least cost. Since privatisation, the government has pursued a strategy of promoting competition and decentralising planning in the energy system. Although this has brought benefits for consumers, the current structure of the energy system may make it difficult to coordinate to meet climate change goals. To reach net zero emissions, greater coordination is needed between transmission and distribution, the electricity and gas systems, and the energy system and the wider economy. Ofgem and BEIS are taking steps to improve coordination within energy markets, including by enabling and encouraging data to be more open. But keeping network costs to a minimum while the wider economy undergoes a mass transition to low-carbon power may necessitate more strategic coordination than current energy system governance allows for. Ofgem and BEIS have said they are reviewing governance of the energy system and will publish a position paper on this in 2020 (paragraphs 3.13 to 3.17).

Conclusion on value for money

20 Under Ofgem's current regulatory framework, electricity network companies have provided a good service, but it has cost consumers more than it should have. It is now clear that targets were set too low, budgets too high, and the impact of these decisions was compounded by Ofgem extending the regulatory period from five years to eight. In some cases, Ofgem did not use the best information available to it at the time: on financing costs, for example, where better use of evidence could have saved consumers at least £800 million. To Ofgem's credit, it has sought to learn lessons from these experiences and design the next regulatory period differently.

21 Electricity networks now have a crucial role to play in helping the UK reach net zero emissions by enabling the system needed for low-carbon heat and transport. An intelligent approach to this transition could spare consumers from significant extra costs: this is illustrated by recent research which estimated that using flexible technology could help to reduce the cumulative electricity system costs, including increasing electricity system capacity, by between £17 billion and £40 billion by 2050. To maximise electricity networks' value for money in future, Ofgem must ensure it sets stretching targets for network companies in the next regulatory period, while building enough flexibility into the price controls to respond to unexpected developments. The government must help to clarify future network requirements by bringing forward further policies for decarbonising heat and transport. And BEIS will need to ensure that the energy market is governed in a way that provides enough strategic coordination of its many actors.

Recommendations

22 To ensure the interests of consumers are protected, Ofgem should:

- a** do more to demonstrate that regulation is working for consumers, by developing and publishing summary indicators of the overall value for money of networks over time and across price control periods, and improving the quality of the underlying official statistics with the Office for National Statistics;
- b** improve the evidence base on the empirical impact of regulatory decisions on investor confidence and cost of capital, and use this evidence to inform major decisions in future;
- c** assess the extent to which cost targets set in RIIO-1 were too generous in the light of likely outturn expenditure, and use this information to inform its approach to assessing individual network company business plans for RIIO-2; and
- d** ensure network companies make it clear to the public how much tax they pay; how executives are rewarded and how this links to quality of service for customers; and how dividend policies ensure companies remain sustainable.

23 BEIS, working with the Department for Transport, should:

- e** work with Ofgem to obtain as much clarity as possible on the implications of heat and transport decarbonisation for future network requirements, in advance of Ofgem making significant decisions on how distribution networks will be regulated in RIIO-2.

24 BEIS should:

- f** as part of its 2020 review on industry governance, investigate the potential benefits of more strategic coordination in the energy system; and
- g** bring forward further heat decarbonisation policies that ensure the achievement of carbon emissions targets in the 2020s.

Part One

The context of electricity network price controls

Overview

1.1 In this part we set out:

- what electricity network companies do and what they cost;
- electricity networks' role in tackling climate change; and
- how Ofgem regulates the network companies to achieve value for money for consumers.

What electricity network companies do

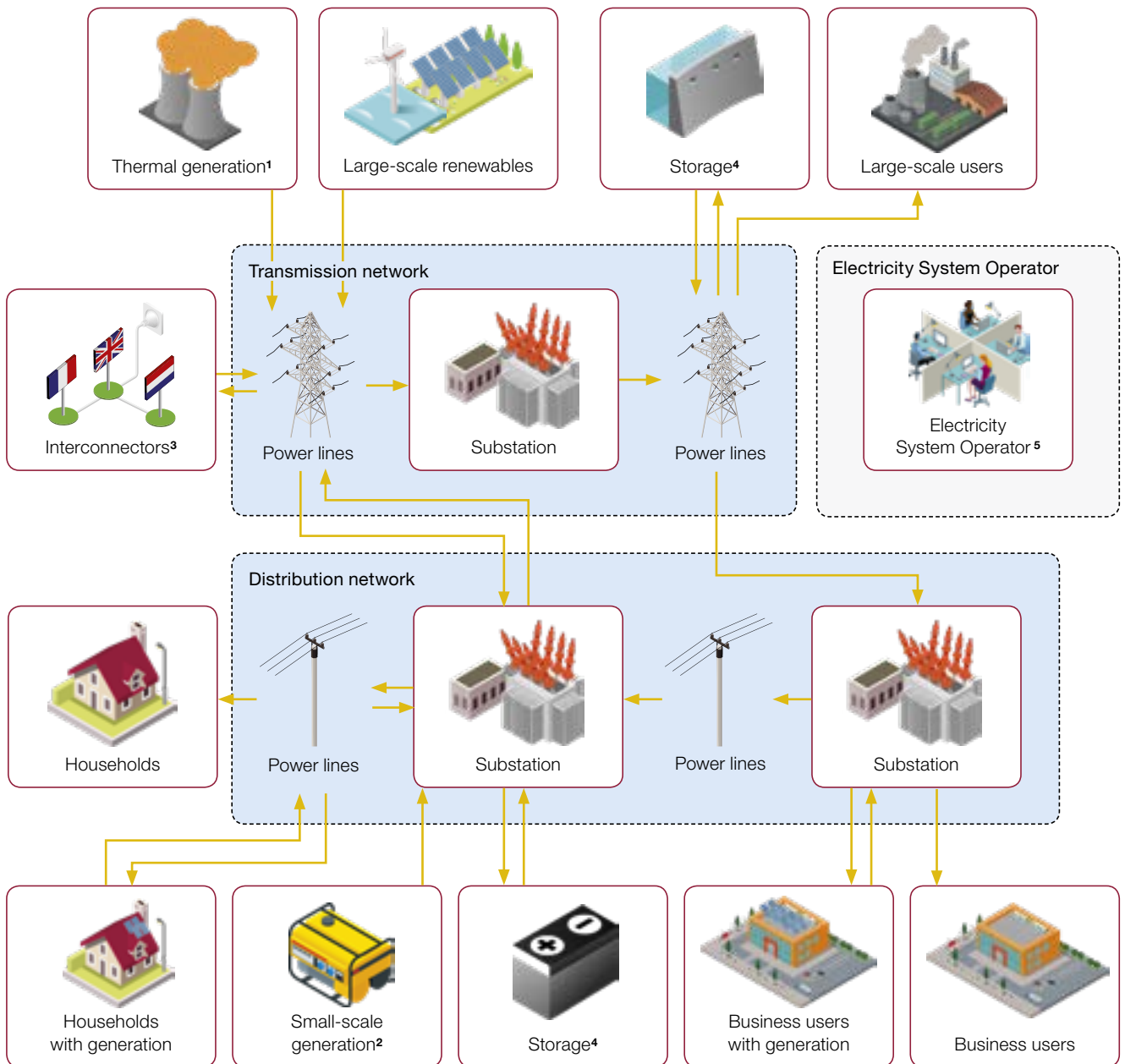
1.2 Electricity networks take electricity from the power plants where it is generated, to the 29 million homes and businesses where it is used (**Figure 1**). Electricity network companies plan, maintain and operate the networks.

- **Transmission networks** carry large amounts of electricity across the entire country at high voltage. There are three transmission networks in Great Britain, one covering England and Wales and two in Scotland, which are owned by three different companies (**Figure 2** on page 14).
- **Distribution networks** take electricity from the transmission networks and distribute it locally at lower voltages. There are 14 distribution networks in Great Britain owned by six different companies (Figure 2).
- **The Electricity System Operator (ESO)** is responsible for matching electricity supply and demand to keep them in balance at all times – loss of balance can cause power cuts. The ESO covers Great Britain, and is owned by National Grid plc, which also owns the transmission network company for England and Wales.

The physical assets making up the networks include more than 800,000 kilometres of overhead and underground cables, and hundreds of thousands of electricity substations for converting electricity between high and low voltages. The value of these and other network assets according to networks' regulatory accounts is about £40 billion.

Figure 1
How electricity flows through the electricity system

Electricity networks carry electricity between generators and consumers



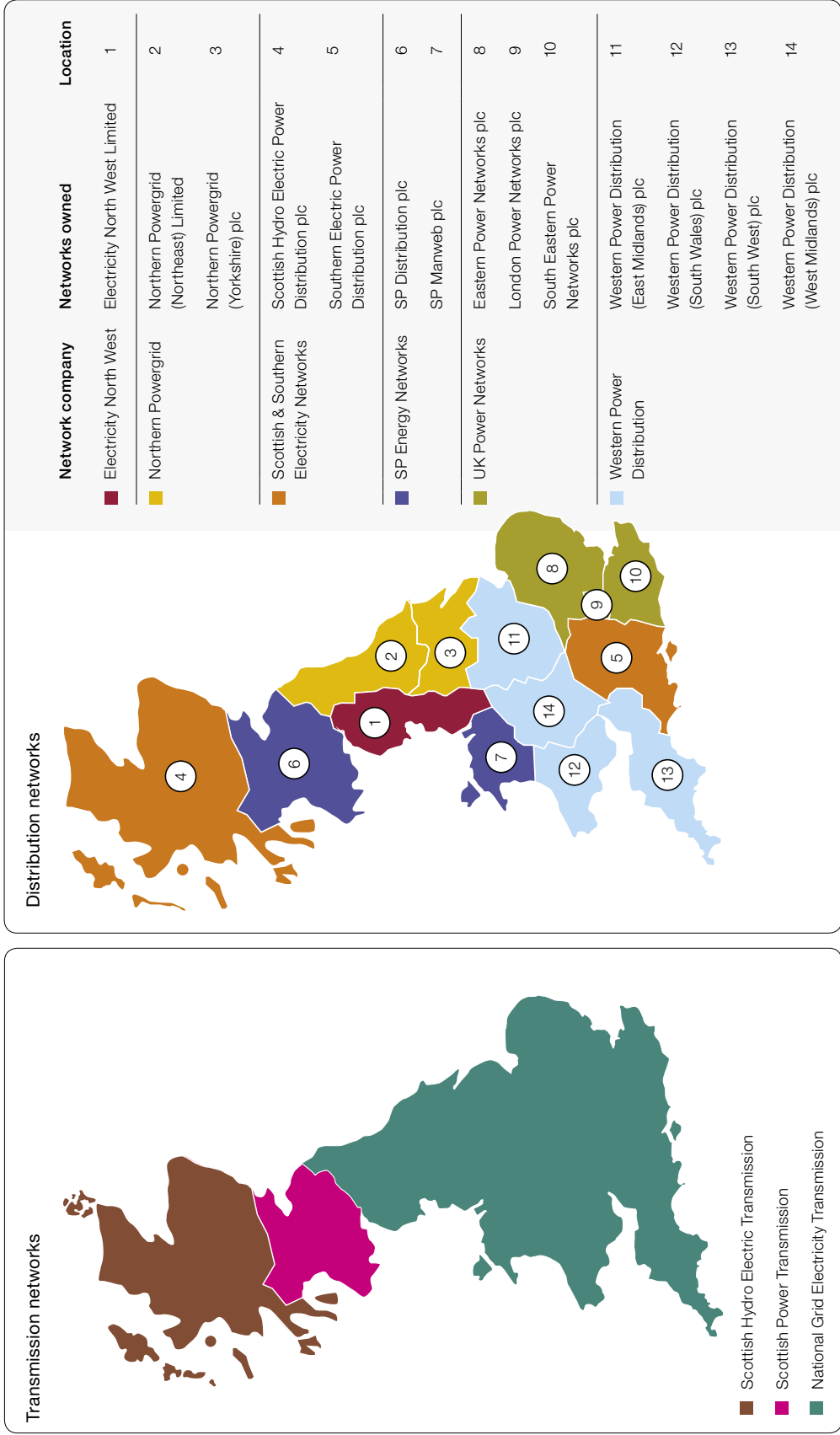
Notes

- 1 **Thermal generation:** includes nuclear, gas and coal power plants.
- 2 **Small-scale generation:** includes renewables (for example, solar panels) and fossil-fuel generation (for example, diesel generators).
- 3 **Interconnectors:** cables which currently connect Great Britain's electricity market with markets in France, the Netherlands, Ireland and Northern Ireland.
- 4 **Storage:** batteries, pumped hydro or other means of storing electricity.
- 5 **Electricity System Operator:** ensures supply and demand for electricity remain in balance.

Figure 2

Map of electricity network companies in Great Britain

There are three transmission network companies and six distribution network companies



Note

1 The Electricity System Operator (not pictured) covers the whole of Great Britain. It is owned by National Grid Electricity Transmission plc, the transmission network in England and Wales.

Source: National Audit Office

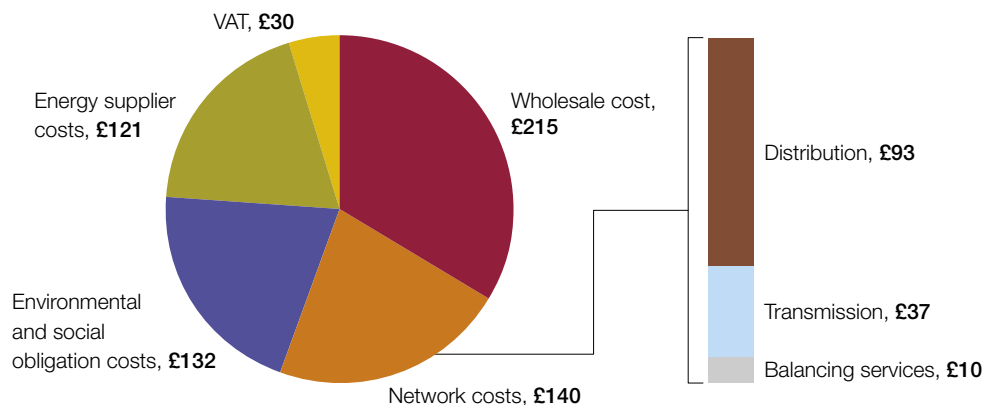
1.3 The annual regulated revenues of the electricity network companies are about £8 billion. The principal costs of the network companies include: finance, operating the network (for example, design and project management), maintenance, and reinforcing (expanding and upgrading) the network. These costs are ultimately passed on to the households and businesses that use electricity, via their electricity bills. In 2019, distribution and transmission network costs made up 20% (£130) of the typical household's annual electricity bill of £639. Balancing costs, which are the responsibility of the ESO and can also be considered to be network costs, account for a further £10 in the typical bill (**Figure 3**). Customers interact with network companies much less frequently than with energy suppliers, who bill customers for network costs alongside other costs associated with providing electricity (**Figure 4** overleaf). Many customers will only communicate with a network company when there is a power cut.

Figure 3

Breakdown of the average household electricity bill (October 2019)

Network costs account for more than one-fifth of the average electricity bill

Total average annual electricity bill £639



Notes

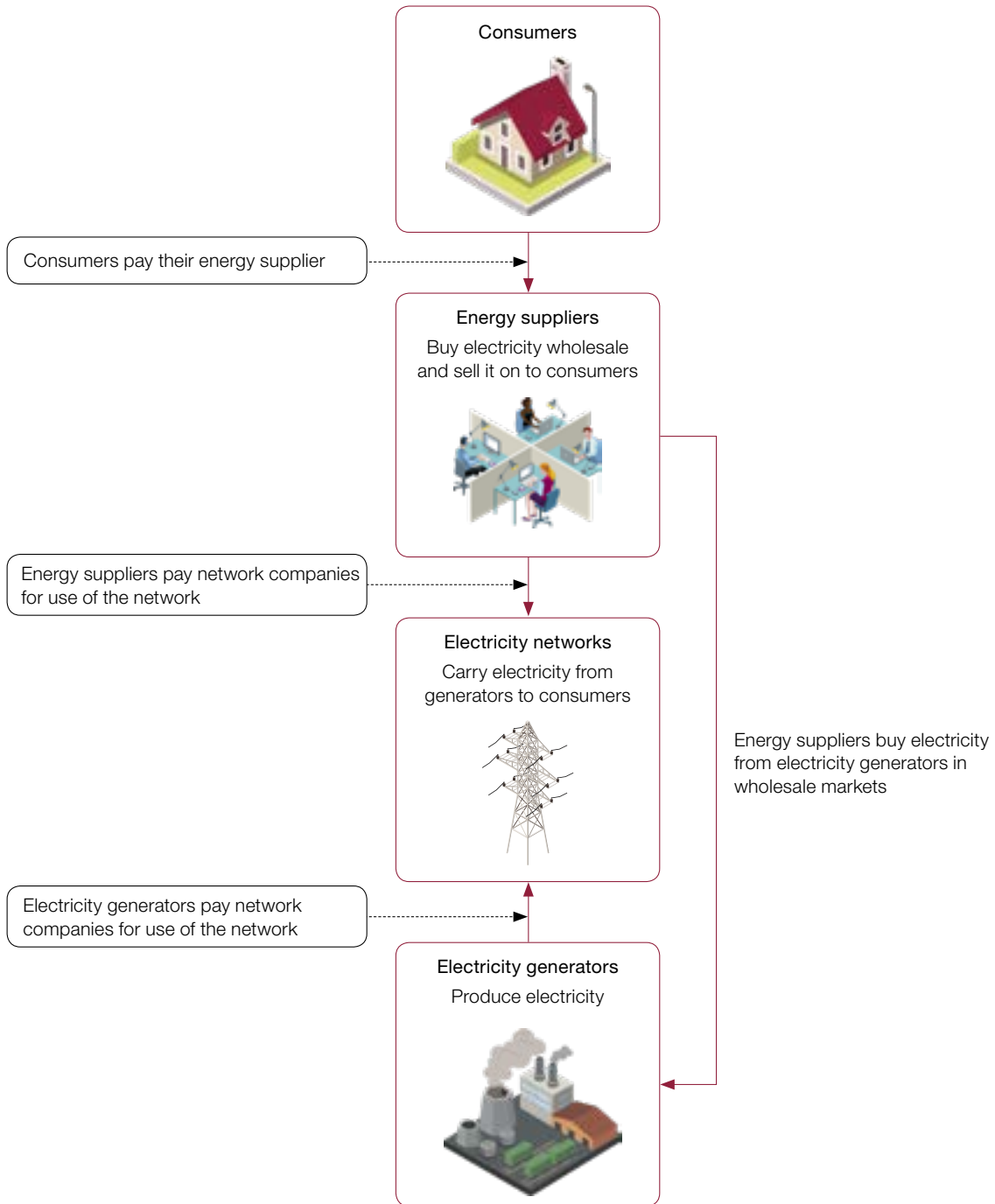
- 1 Data are for bills in Great Britain and are based on Ofgem's estimate of typical domestic electricity consumption (3,100 kWh/year). In practice, electricity consumption varies significantly by household. The breakdown of costs is based on Ofgem modelling undertaken to set the price cap on default energy tariffs.
- 2 Wholesale costs are the costs to energy suppliers of buying electricity in wholesale markets.
- 3 Energy supplier costs include operating costs and other direct costs, as well as the energy supplier's pre-tax margin.
- 4 Environmental and social obligation costs are the costs of government policies, including support for low-carbon energy generation, and schemes to improve the energy efficiency of buildings.
- 5 The total does not sum, due to rounding.

Source: Ofgem

Figure 4

Where networks get their revenues from

Networks are ultimately paid for by consumers



Note

1 This figure provides a simplified representation of relevant parts of the electricity market. In practice, electricity markets are more complex, and involve additional actors and forms of trading not shown here.

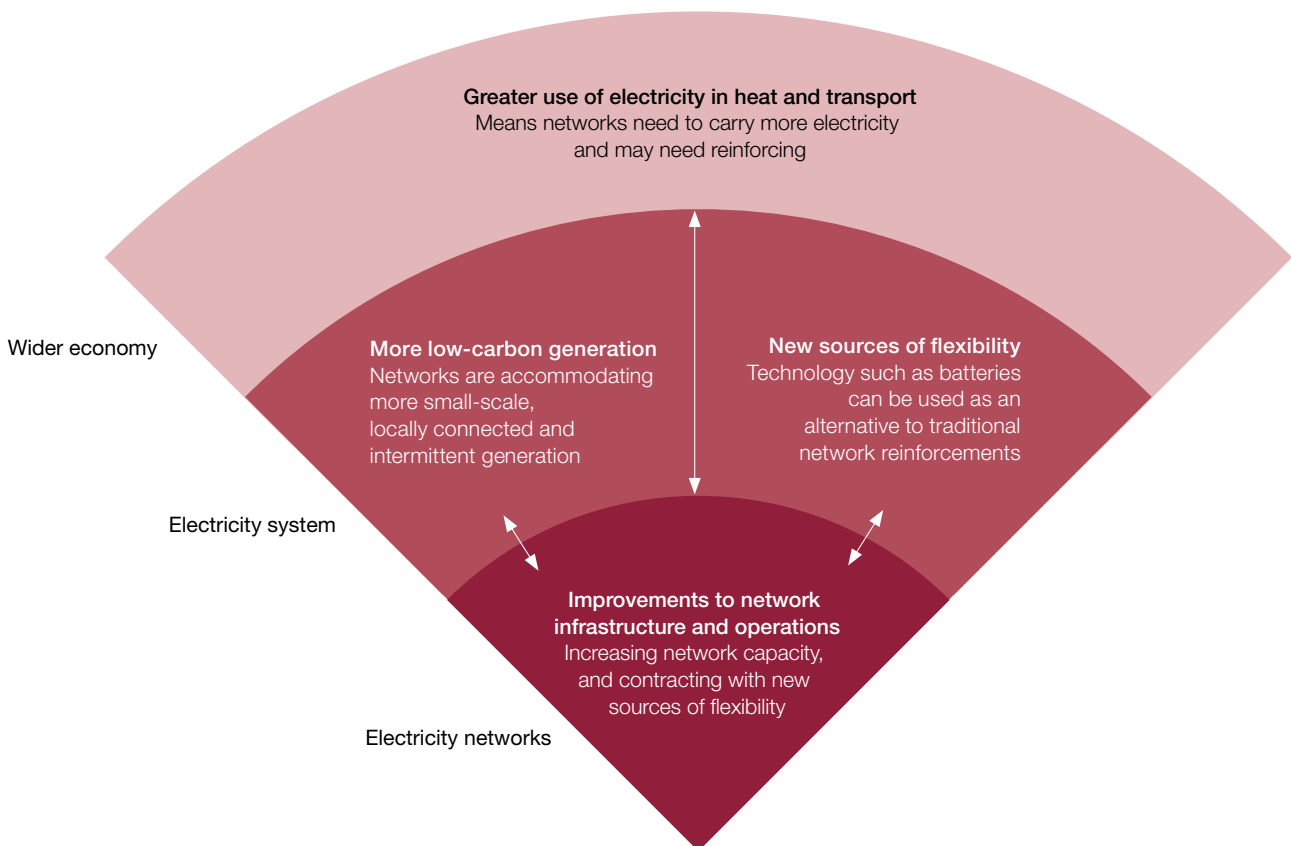
Electricity networks' role in tackling climate change

1.4 Electricity networks have a crucial role to play in reducing greenhouse gas emissions from the energy sector and the wider economy (**Figure 5**). Since the mid-2000s, government policies that aim to reduce carbon dioxide emissions in the energy system have led to rapid growth in renewable power sources, such as wind and solar, and small-scale, local energy generation. This has required network companies to accommodate more than one million new installations, mainly on the distribution network.

Figure 5

Why electricity networks need to change

Changes to networks are driven by decarbonisation of the electricity sector and the wider economy

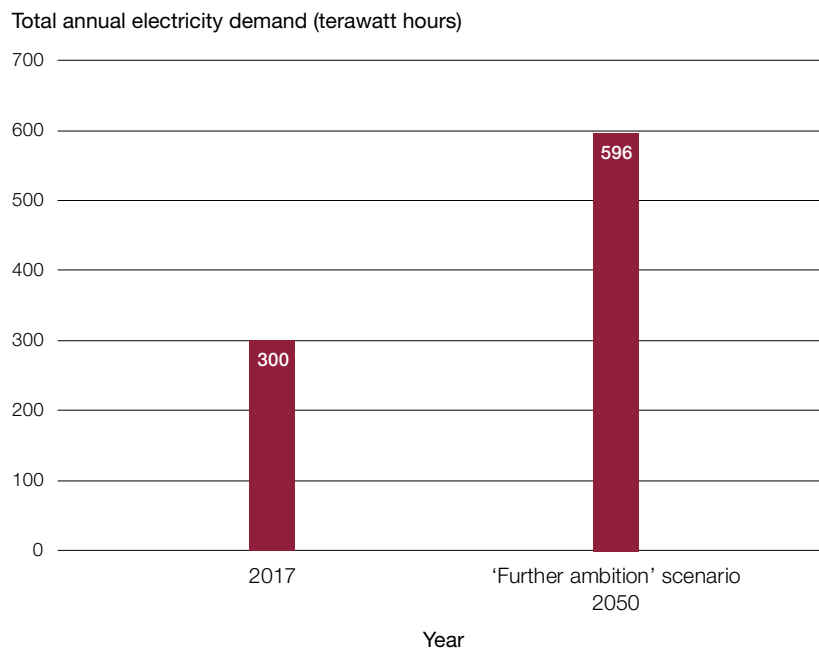


Source: National Audit Office

1.5 The government has a legal duty to reduce the UK’s net carbon emissions to zero by 2050. Reaching this target will be highly challenging and will require new policies to be introduced to drive extensive changes across the economy. Among other changes, the Committee on Climate Change expects that the electricity system will need to grow significantly so that low-carbon power generators such as wind farms can be used to provide energy for parts of the economy that currently rely on carbon-emitting fuels, such as road transport and heating of buildings. The decarbonisation of heat and transport could cause total demand for electricity to double (**Figure 6**), if heat for buildings were to be mostly provided by electricity, and in some scenarios for reaching net zero emissions, electricity demand could be higher still. These changes will require significant investment in electricity networks so that they can carry more electricity and accommodate electricity production from new locations.

Figure 6
The Committee on Climate Change’s ‘further ambition’ scenario for the future electricity system

In one of the Committee’s scenarios, electricity demand doubles by 2050



Note

1 In the Committee on Climate Change’s ‘further ambition’ scenario, carbon emissions are reduced by 99% compared to 1990s levels. In this scenario, electricity is used to power cars and vans, provide heat for the majority of buildings and produce hydrogen for use as a low-carbon fuel.

Source: Adapted from Committee on Climate Change, *Net zero: technical report*, May 2019

1.6 New technology offers opportunities to reduce the cost of reinforcing the electricity network. The traditional method of upgrading electricity networks is to reinforce them with more cabling and substations. However, new sources of flexibility in the energy system, such as battery storage, can allow networks to serve more electricity supply and demand without as much need for traditional reinforcements, significantly mitigating the need for further network investment (**Figure 7** overleaf). These technologies could also serve to help control the costs of balancing supply and demand and mitigate the need for additional generating capacity. Research commissioned by the Department for Business, Energy & Industrial Strategy (BEIS) estimated that a more flexible energy system could save the UK between £17 billion and £40 billion in avoided costs cumulatively by 2050.⁴ However, to make effective use of new sources of flexibility, network companies must change the way they operate significantly.

Challenges for the Electricity System Operator

1.7 Growth in renewable energy also presents new challenges for the ESO. The ESO must balance electricity supply and demand across the transmission network on a second-by-second basis. It does this by instructing generators to change their output and/or taking up offers from users to change their consumption (system balancing actions). The need for system balancing actions has increased with the deployment of renewables (**Figure 8** on page 21), in part because of policy decisions to connect renewables to the network even where current network capacity cannot always accommodate the electricity they generate. The ESO has announced that by 2025, it aims to be capable of balancing an electricity system that is 100% low-carbon (that is, consisting entirely of a mixture of renewable and nuclear power).








1.8 On 9 August 2019, a number of small generators (distributed generation) and two large generators stopped providing power following a lightning strike on the electricity transmission network. These combined power losses exceeded the back-up power generation arrangements that the ESO had in place to keep the system stable, leading to the interruption of more than one million consumers' electricity supply. Ofgem opened an investigation into the power outage and published its key findings on 3 January 2020. It has not found any evidence that the power outage was caused by any failure of the ESO to meet its requirements. However, the events have raised questions about the processes and procedures the ESO uses to manage the system. These include, for example, whether current processes enable the ESO to fully understand the risks to system stability posed by distributed generation, and whether the application of current standards for system security provides sufficient mitigation for these risks. The increasing role of distributed generation in the electricity system underscores the importance of Ofgem, the ESO, network companies and other stakeholders working together to address these questions quickly.

⁴ The value of additional flexibility is uncertain because the nature of the future electricity system, including total electricity demand and the costs of different electricity generating technologies, is uncertain. Imperial College London and the Carbon Trust estimated the potential value of system flexibility by modelling several different scenarios for achieving an 80% reduction in energy system carbon emissions, both with and without use of additional flexibility. Additional flexibility made cumulative system costs £17 billion – £40 billion lower by 2050 than they otherwise would have been, depending on which energy system scenarios were used. (Carbon Trust and Imperial College London, *An analysis of electricity system flexibility for Great Britain*, November 2016).

Figure 7

New sources of flexibility in the electricity system

New sources of flexibility can help networks avoid the need for traditional upgrades

Technology		What it does
Storage		Storage, such as batteries, can help to balance the system at lower cost, maximise the usable output from intermittent generation such as wind and solar, and defer or avoid the need for network reinforcement and new generation capacity.
Demand-side response		Some users can agree to temporarily reduce their energy usage at peak times, reducing demands on the network. For example, business or domestic users might turn off their heat pumps ¹ or fridges at times when electricity demand is at its highest.
Virtual power plants		Diverse and sometimes very small sources of electricity, including storage, demand-side response and small-scale generation ² , can be combined into a 'virtual power plant' providing a useful amount of electricity. This can help networks avoid the need for reinforcements aimed at supplying additional electricity from another source.
Flexible generation		Generation sources that can be quickly turned on and off on demand – such as diesel generators – provide a cheap way of bridging temporary gaps between supply and demand. This can help networks deal with capacity constraints without reinforcement.
Electric vehicle smart charging		'Smart' chargers recharge electric vehicle batteries at times when demand for electricity is relatively low, instead of drawing power at peak times. This can help to mitigate demands on the network.
Vehicle-to-grid		When electric vehicles are not in use, their batteries can supply electricity to the network. This can help networks deal with capacity constraints without reinforcement.
Energy efficiency		Consumers using electricity more efficiently, for example by improving the efficiency of buildings and technologies, can help to reduce the demands on networks.

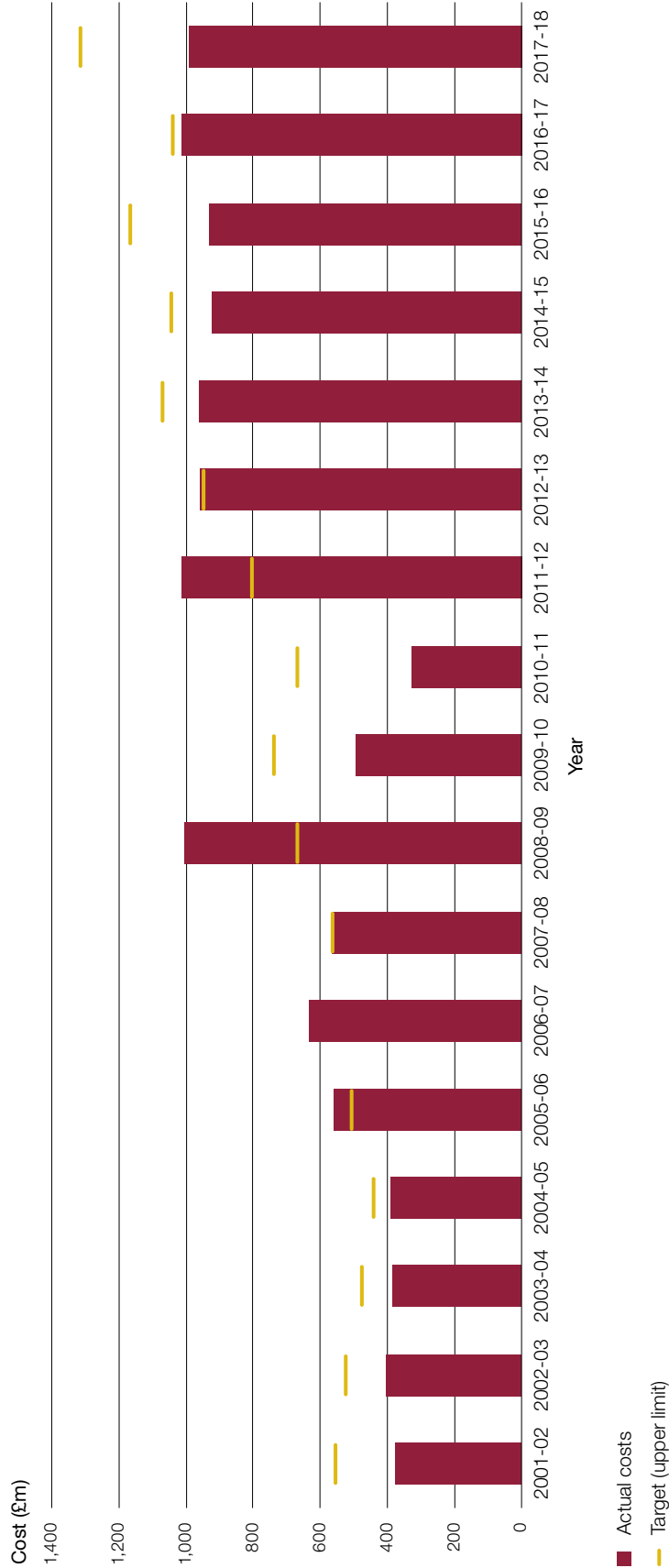
Notes

- Heat pumps are devices which provide heating and hot water for buildings. They run on electricity but are more energy efficient than traditional electric heaters (resistance heaters).
- Small-scale generation can include renewables, such as solar panels, and fossil-fuel generation, such as diesel generators.

Source: National Audit Office

Figure 8
Electricity system balancing costs, 2001-02 to 2017-18

In recent years, costs of keeping electricity supply and demand in balance have been higher than they were before renewable energy started to be widely deployed in the mid-2000s.



Notes

- 1 Costs are in 2018-19 prices.
- 2 As part of the Balancing Services Incentive Scheme, Ofgem implemented a financial target that is designed to reflect the balancing costs the Electricity System Operator (ESO) should economically and efficiently incur. If actual costs are below the upper target, the ESO receives an incentive payment, and if above, the ESO faces a penalty. Actual costs are represented by the balancing costs on the graph.
- 3 No target was set in 2006-07 as Ofgem and the ESO could not agree a target.
- 4 In April 2018 Ofgem introduced a new approach to incentivising the ESO's performance that is no longer based on ex-ante targets for annual balancing costs.

Source: Ofgem

How electricity network companies are regulated

1.9 Electricity networks were privatised in 1990, after 43 years of government ownership. The aim of privatisation was to reduce costs by harnessing private companies' profit motives. Privatisation has also allowed expenditure on electricity networks to be funded, in part, by money that companies have raised privately, rather than government borrowing. Over time, companies recover this money from the revenue collected from consumers. Ofgem estimates that around £70 billion of capital investment in electricity networks has taken place since privatisation.

1.10 Generally, customers do not have a choice of which network company they use, because each part of the country is served by only one distribution network and one transmission network.⁵ This means the government cannot rely on competition between companies to keep prices low and quality of service high. Therefore, it uses regulatory powers to create incentives for networks to act in the interests of consumers. The regulation of electricity networks is the responsibility of Ofgem, a non-ministerial department sponsored by BEIS. Ofgem's statutory purpose is to protect the interests of current and future energy consumers.

1.11 Price controls are a crucial part of Ofgem's approach to regulating the network companies. Through its price controls, Ofgem estimates the costs that efficient network companies would incur over the next regulatory period, typically five years. During this period, if a network company manages to reduce its costs below that baseline, it can keep some of the cost savings, and consumers also benefit from prices coming down over time (**Figure 9**). Ofgem also requires the network companies to meet various performance targets and build agreed capital projects, so that cost-reduction does not diminish the service consumers receive. Most of these features also exist in price controls for other companies subject to economic regulation, such as water companies.

The RIIO price controls

1.12 Between 2008 and 2010, Ofgem conducted a detailed review of energy network regulation. The review's conclusion was that price controls had to change to provide stronger incentives on network companies to play a full role in the transition to low-carbon energy. Ofgem therefore introduced a new model for price controls known as RIIO (an acronym for 'Revenue = Incentives + Innovation + Outputs', pronounced "Rio") with features intended to encourage network companies to innovate and make greater use of new sources of flexibility. Some of these were extensions of ideas in the existing price control framework:

- To encourage increased innovation and long-term investment decisions from network companies, Ofgem increased the length of the regulatory period from five years to eight.

⁵ Having two (or more) networks serving customers in the same area would not be cost-effective, as it would require a doubling-up (or more) of network infrastructure, which would be very costly.

- Ofgem increased the financial support available for network companies' innovation projects by 50%.
- Ofgem increased the potential rewards for providing a good service (and potential penalties for providing a bad one), and increased requirements for networks to engage with customers.

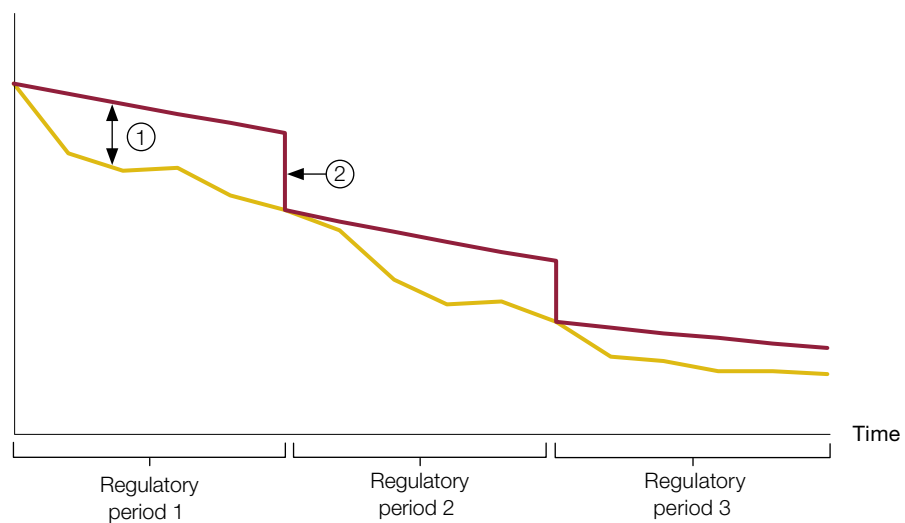
1.13 The first set of RIIO price controls (RIIO-1) are currently in effect. These consist of the price controls for electricity distribution networks (RIIO-ED1), gas distribution networks (RIIO-GD1) and transmission networks (RIIO-T1). Ofgem is currently in the process of designing the next set of price controls, known as RIIO-2 (**Figure 10** overleaf).

Figure 9

How a price control works

Price controls are designed to incentivise companies to reduce their costs and pass the benefits of this on to consumers

Costs



— Baseline

— Actual

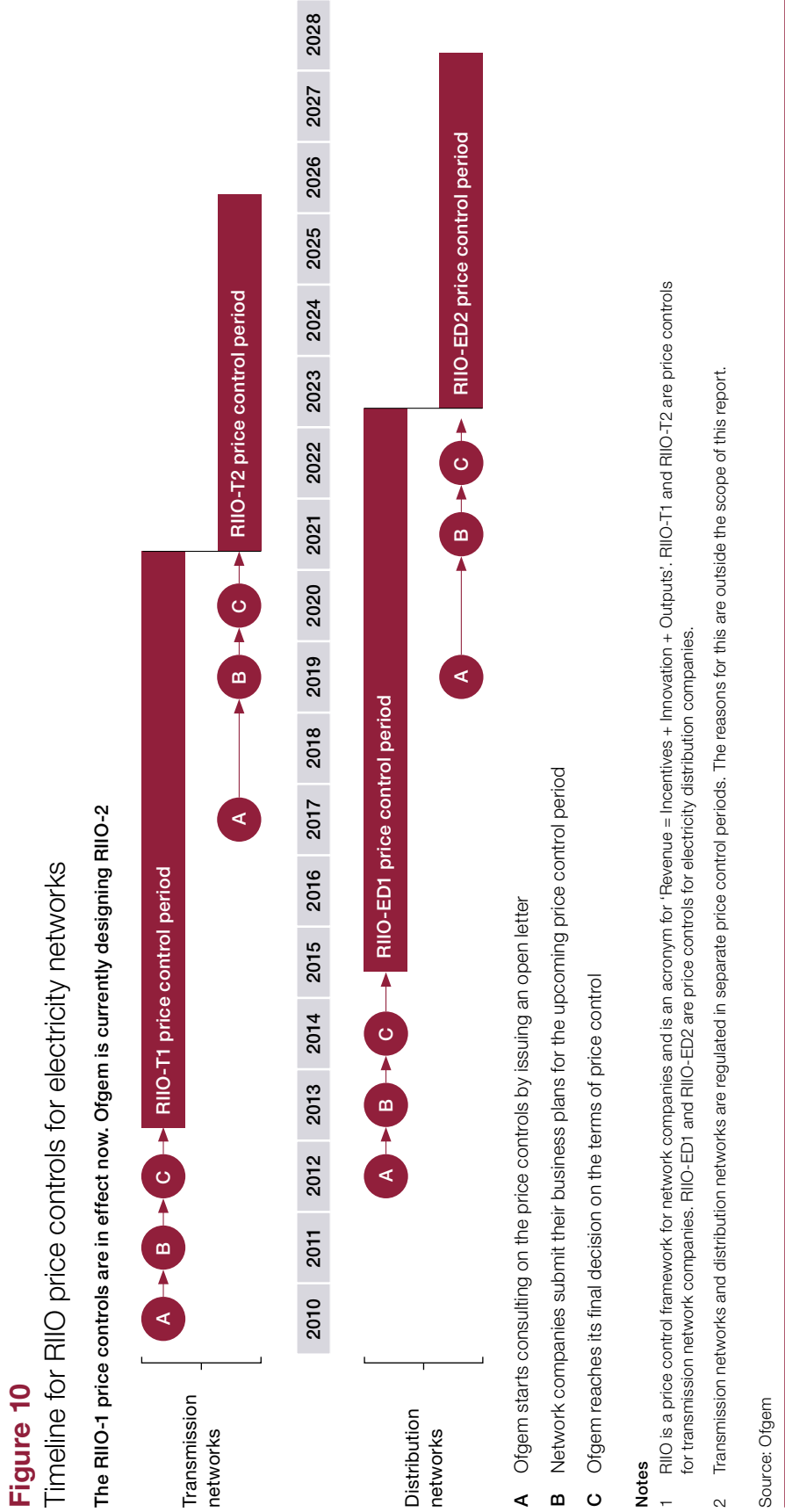
Feature

- 1 During each regulatory period, companies keep part of the difference between baseline costs and actual costs.
- 2 At the end of each regulatory period, a new baseline is estimated for the next regulatory period, based on up-to-date information on actual costs.

Effect

- Provides companies with an incentive to reduce their costs.
- Ensures consumers benefit from cost reductions over time.

Source: National Audit Office



Understanding networks' cost-effectiveness

1.14 Price controls are intended to drive improvements in cost-effectiveness. Between 1990 and 2001, network revenues fell in real terms, indicating that price controls were successfully making network companies bear down on their costs. After 2001, revenues grew again, such that they are now higher in real terms than they were in 1990.⁶ But compared to 1990, the reliability of the networks for consumers has improved (**Figure 12** on page 27), and there have been significant changes in the wider electricity system, such as the shift from centralised power stations to smaller and more dispersed sources of electricity. This makes drawing fair comparisons of cost-effectiveness over many price control periods a complex undertaking.

1.15 To date, Ofgem has made the following efforts to understand networks' cost-effectiveness since privatisation:

- Ofgem has experimented with various ways of defining and calculating unit costs of electricity networks. Unit costs are costs per unit of output, such as the cost per unit of generating capacity (**Figure 11** overleaf). These metrics have the virtue of being easy to estimate and understand, although they necessarily provide an incomplete picture of cost-effectiveness. For example, the cost per unit of generating capacity does not take into account improvements in quality of service.
- Ofgem commissioned a study by University of Cambridge researchers which attempted to quantify in a more advanced way the overall improvement in electricity networks' productivity, by taking into account quality of service improvements.⁷ The study found some evidence for productivity growth over time, if quality is considered, but recommended further research to understand the value to consumers of quality improvements.

1.16 As we noted in our report on *Regulating to protect consumers*, regulators must measure and report on what they have accomplished for consumers, not least because of public debate over regulators' effectiveness.⁸ Therefore, it is important for Ofgem to build on its network productivity research by developing clear indicators of networks' overall cost-effectiveness and showing how these have changed over price control periods. To date, issues with historical data have been a limiting factor for this research, although Ofgem may be able to improve the quality of underlying data with further work. For example, the University of Cambridge study found that there were major gaps in Office for National Statistics (ONS) data on energy networks, which Ofgem says it needs to work with the ONS to address.

⁶ Total revenues as reported in network companies' financial statements.

⁷ Victor Ajayi, Karim Anaya and Michael Pollitt, *Productivity growth in electricity and gas networks since 1990*, December 2018.

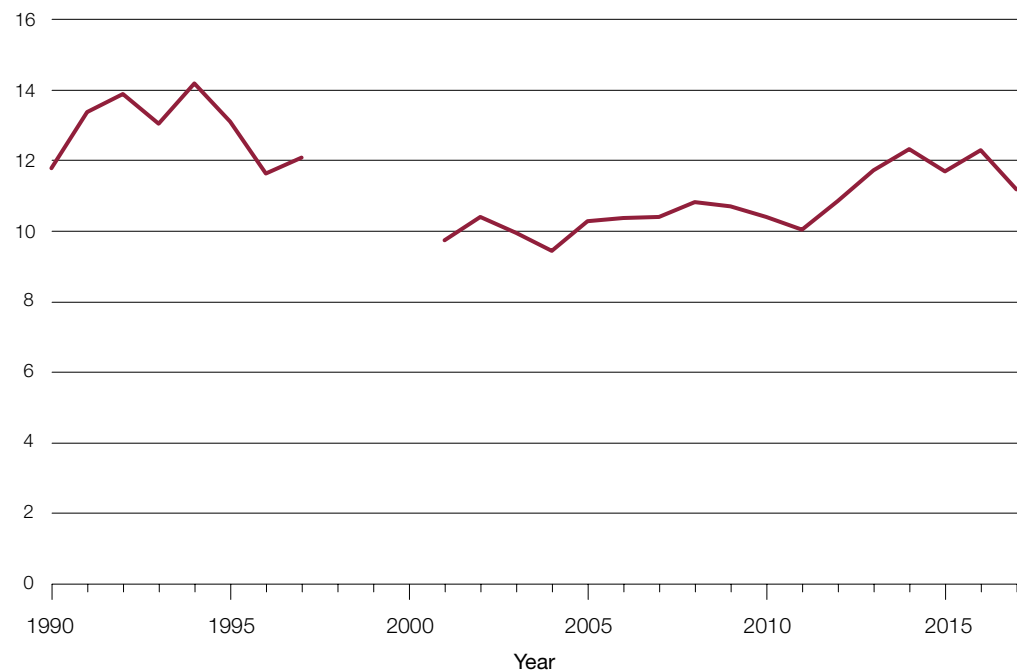
⁸ Comptroller and Auditor General, *Regulating to protect consumers*, Session 2017–2019, HC 1992, National Audit Office, March 2019.

Figure 11

Unit costs of electricity networks since 1990

Commentary

If we calculate the cost of electricity networks per unit of generating capacity, so as to adjust for changes in the overall size of the electricity system, the unit cost of electricity networks is lower than it was in the early 1990s, although it has increased over the 2010s (Figure 10). However, this metric does not provide a complete picture of networks' overall cost-effectiveness, as it does not adjust for improvements in quality of service, for example.

Pence per watt of generating capacity**Notes**

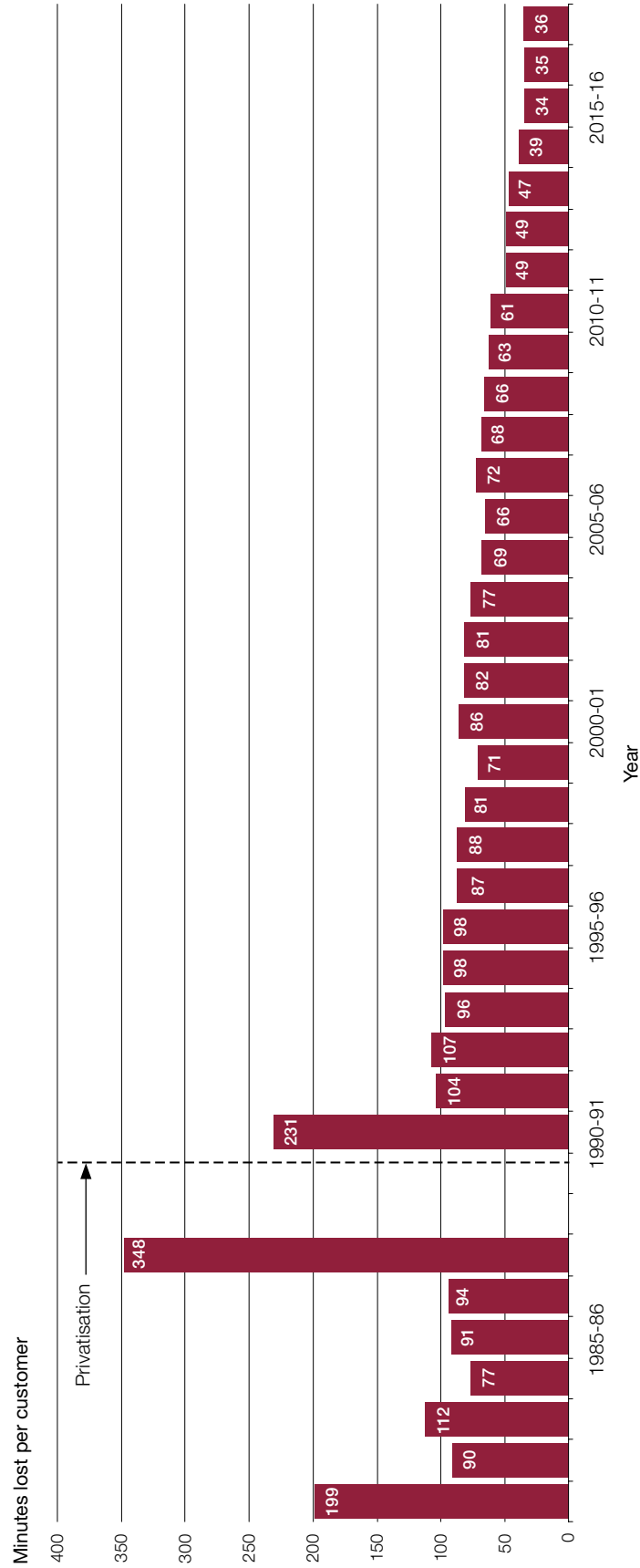
- 1 Data are for Great Britain.
- 2 Unit costs are in 2018-19 prices. We use the total turnover of Great Britain's 14 distribution networks, three transmission networks and the Electricity System Operator as our measure of costs.
- 3 Capacity includes transmission-connected capacity and, from 2011 onwards, distribution-connected capacity.
- 4 Gaps in Ofgem's data between 1998 and 2000 prevent calculation of unit costs in those years.

Source: National Audit Office analysis of network companies' accounts, and the Department for Business, Energy & Industrial Strategy's *Digest of UK Energy Statistics*

Figure 12

Changes in reliability of electricity networks over time

The reliability of the networks as measured by minutes lost per customer has improved over time



Notes

- 1 Data are for Great Britain.
- 2 Minutes lost per customer is the number of minutes per year for which customers experience a power cut of three minutes or longer.
- 3 Data for 1988-89 and 1989-90 are missing.
- 4 The Great Storm of 1987 heavily damaged electricity networks, impacting customer minutes lost.

Source: National Audit Office analysis of Ofgem data and data from Preetum Domah and Michael Pollitt, 'The Restructuring and Privatisation of Electricity Distribution and Supply Businesses in England and Wales: A Social Cost-Benefit Analysis', *Fiscal Studies* (2001), vol 22.

Part Two

Providing value for money for consumers

2.1 In this part, we evaluate whether Ofgem is achieving value for money for consumers through the first set of RIIO ('Revenue = Incentives + Innovation + Outputs') price controls, RIIO-1, with a focus on network companies' performance and returns. We also examine how Ofgem has incorporated lessons learned from RIIO-1 into its proposals for RIIO-2.

RIIO-1's value for money for consumers

Performance

2.2 Ofgem set performance targets for network companies for safety, the environment, reliability and availability, providing timely connections, customer service, and assisting vulnerable consumers ('social obligations'). The targets were different for each network, to reflect their individual circumstances, and reflect the level of performance Ofgem thought efficient network companies would be able to achieve. Many of the targets are associated with financial rewards or penalties. So far under RIIO-1, almost all of the targets have been met (**Figure 13**).

2.3 There are indications that electricity network performance in Great Britain compares favourably with other countries. Data collected by the Council of European Energy Regulators indicate that power cuts are less frequent, and more quickly remedied, in Great Britain than most other European countries (see Appendix Three for further international comparisons).

Figure 13
Electricity network company performance against targets, 2017-18

Most network companies have met targets in all areas, or almost all areas

	Safety	Reliability/ availability	Environment	Customer satisfaction	Timely connections	Social obligations
Transmission networks						
National Grid Electricity Transmission	●	●	●	●	●	N/A
Scottish Hydro Electric Transmission	●	●	●	●	●	N/A
Scottish Power Transmission	●	●	●	●	●	N/A
Distribution networks						
Electricity North West	●	●	●	●	●	●
Northern Powergrid	●	●	●	●	●	●
Northern Powergrid (Northeast) Limited	●	●	●	●	●	●
Northern Powergrid (Yorkshire) plc	●	●	●	●	●	●
Scottish & Southern Electricity Networks	●	●	●	●	●	●
Scottish Hydro Electric Power Distribution plc	●	●	●	●	●	●
Southern Electric Power Distribution plc	●	●	●	●	●	●
SP Energy Networks	●	●	●	●	●	●
SP Distribution plc	●	●	●	●	●	●
SP Manweb plc	●	●	●	●	●	●
UK Power Networks	●	●	●	●	●	●
Eastern Power Networks plc	●	●	●	●	●	●
London Power Networks plc	●	●	●	●	●	●
South Eastern Power Networks plc	●	●	●	●	●	●
Western Power Distribution	●	●	●	●	●	●
Western Power Distribution (East Midlands) plc	●	●	●	●	●	●
Western Power Distribution (South Wales) plc	●	●	●	●	●	●
Western Power Distribution (South West) plc	●	●	●	●	●	●
Western Power Distribution (West Midlands) plc	●	●	●	●	●	●

Note

- 1 Ofgem assigns a red, amber or green rating to each network company's performance in each target area. The targets are different for each network. The criteria for rating performance as green, amber or red is different for different target areas, but as a rule of thumb, green indicates that regulatory targets have been met or exceeded, amber indicates that targets have not been met but that performance is within 5% of the target, and red indicates that network company performance has fallen short of the target by more than 5%.

Source: Ofgem

Costs

2.4 Network companies have an incentive to keep their expenditure as low as possible without compromising performance against standards and targets. At the beginning of RII0-1, Ofgem gave network companies an allowance for capital and operating expenditure (a total expenditure ('totex') allowance), based on its assessment of cost forecasts provided by the network companies. Network companies can keep roughly half of the underspend against their allowance, with the other half returned to consumers.

2.5 On average, distribution networks are forecasting that they will spend 3% less than their allowance during RII0-1, and transmission networks are forecasting that they will spend 16% less. Six out of nine companies are forecasting an underspend, and one is forecasting an underspend of 22% (**Figure 14**).

Returns

2.6 Network companies are forecast to provide shareholders with real-terms returns of about 9% on average over RII0-1. By comparison:^{9,10}

- Ofgem's current assumption is that the average return provided by FTSE-listed companies is 5.25%–5.75% in RPI real terms. This assumption is based on various sources of evidence, including research commissioned by the UK Regulators Network which used historical data to estimate a total market return of 5%–6%.¹¹
- There is evidence to suggest that the total market return forecast by investors has fallen in recent years, due to adverse economic conditions. An Ofgem survey conducted in 2009 found that professional investors on average were expecting FTSE-listed companies to provide average returns of around 3%-4% in the medium- to long-term. However, this survey only provided a snapshot of investors' expectations, which are liable to change over time.

Investors require lower returns on lower-risk companies, and regulated utilities such as network companies are seen as lower risk than FTSE-listed companies on average. This is because their revenues are more certain, as they do not face competition for customers.

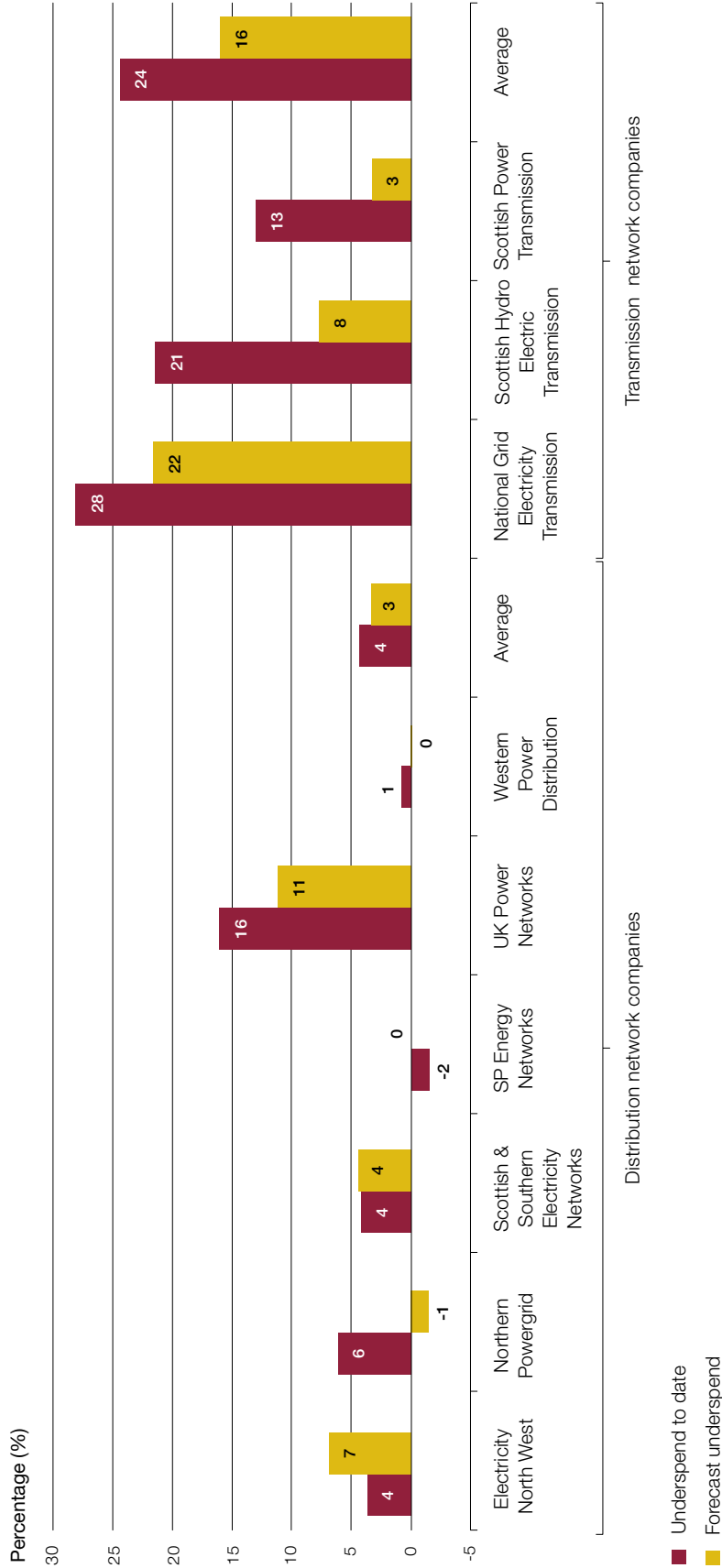
9 To convert returns into real terms, we use the retail prices index (RPI). RPI is the inflation measure used by Ofgem in RII0-1, although for RII0-2 Ofgem intends to shift to the consumer prices index (CPI).

10 We define 'returns' as the return on regulatory equity (RORE). RORE is the financial return achieved by shareholders during a price control period as a result of the network company's performance against the targets and allowances of the price control. It is a useful way to understand how the company's financial performance compares with Ofgem's assumptions prior to the price control starting. We do not include the effects on the shareholder return of network companies' financing or tax arrangements differing from Ofgem's assumptions, as these effects can mask the underlying performance of the company against the price control targets and allowances. On average across network companies during RII0-1, these effects have been broadly neutral anyway.

11 Stephen Wright, Phil Burns, Robin Mason and Derry Pickford, *Estimating the cost of capital for implementation of price controls by UK Regulators*, March 2018. The estimate is presented here in RPI real terms.

Figure 14
Electricity network companies' underspends against their RIIO-1 budgets as of 31 March 2019

Six out of nine companies are forecasting an underspend by the end of RIIO-1



■ Underspend to date
■ Forecast underspend

Notes

- 1 RIIO is a price control framework for network companies and is an acronym for "Revenue = Incentives + Innovation + Outputs". For electricity distribution network companies, the RIIO-1 period is 1 April 2015 – 31 March 2023. For transmission companies, the RIIO-1 period is 1 April 2013 – 31 March 2021.
- 2 The forecast figures represent the underspend expected by the end of the RIIO-1 period. The actual underspends achieved by networks by the end of the price control may differ from these forecasts. Forecasts are more uncertain for electricity distribution network companies, as they are further from the end of their price control than transmission network companies are.
- 3 Negative values indicate overspends.

2.7 Ofgem designed RIIO so that a range of returns were possible for each network company. Ofgem estimated that shareholders expected a return of 6% to 7% from businesses with similar risk profiles to network companies and used this as a starting point for the returns network companies would get (the baseline rate of return). Ofgem made it possible for companies to earn less than the baseline if they did not meet high standards, or more than the baseline if they exceeded expectations. Its expectations at the time it designed RIIO were that networks could make a range of returns, from around 2.5% to around 10.5%, but it expected only the best-performing companies to reach the high end of the range.¹²

2.8 In practice, based on the latest available information, three of the nine distribution and transmission network companies are forecasting returns of around 10%, and the average forecast return is 9.2%, close to the upper end of Ofgem's expectations at the time the price control was set (**Figure 15**).¹³ These figures may change as the price control progresses. The distribution network company figures have a greater element of forecasting: at the point when these forecasts were made, distribution companies were four years into their eight-year regulatory period, whereas transmission companies were six years into their eight-year regulatory period.

2.9 As of 2019, distribution networks are forecasting returns of 9.1% on average and transmission networks are forecasting returns of 9.3% (**Figure 16** on page 34). This consists of:

- the baseline rate of return (6.1% on average for distribution companies, 7% on average for transmission companies);
- rewards for network companies for spending less than their full allowances for costs (0.9% for distribution, 1.6% for transmission); and
- rewards for meeting or exceeding other operational performance targets (2.1% for distribution, 0.7% for transmission).

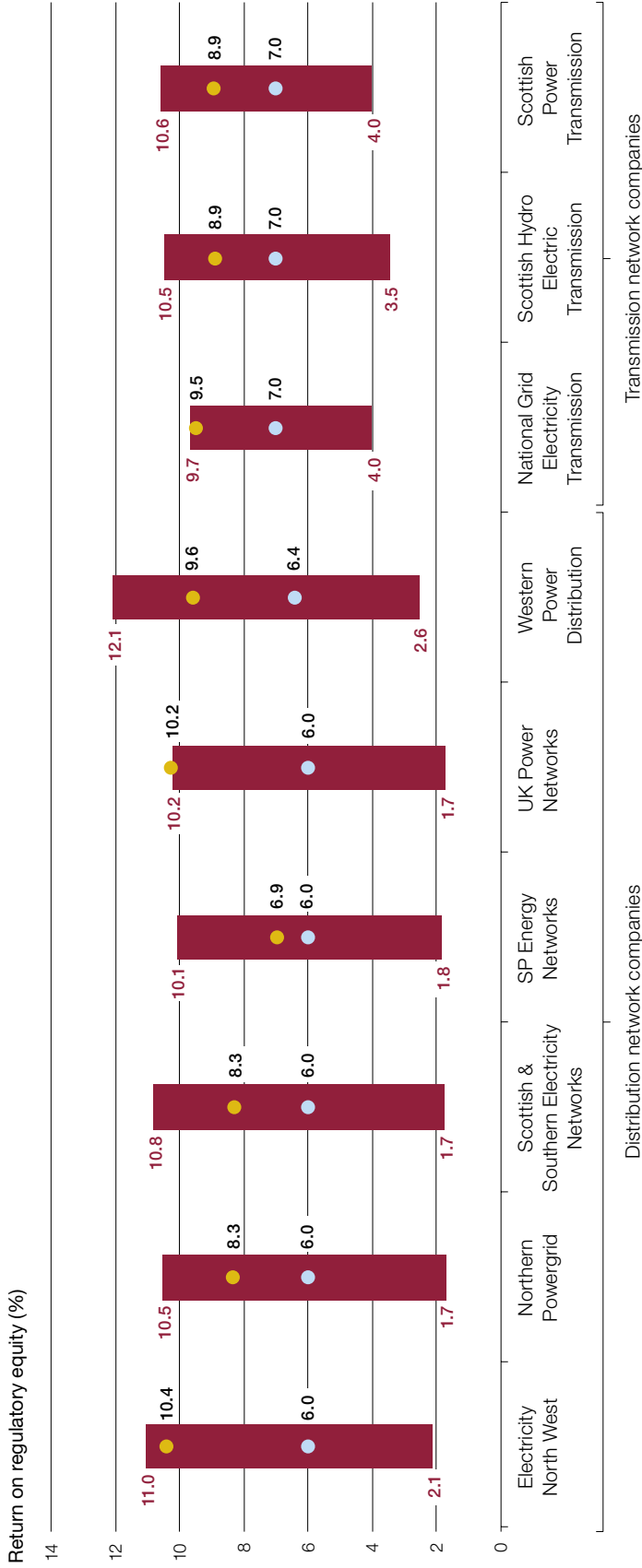
Networks' actual returns over RIIO-1 will depend in part on their performance over the remaining years of the price controls.

¹² The ranges of returns anticipated by Ofgem varied across the networks, but the average low point of the range was 2.5% and the average high point was 10.5%.

¹³ Three of the networks are forecasting returns of 10% or more.

Figure 15
Returns forecast by electricity network companies over RII0-1

Most network companies are earning returns close to the upper end of Ofgem's expectations at the time the price control was set



- Ofgem's initially expected range of returns
- Current forecast return
- Baseline return on equity

Notes

- 1 These are network company forecasts as of 1 April 2019. RII0 stands for "Revenue = Incentives + Innovation + Outputs". For electricity distribution network companies, the RII0-1 period is 1 April 2015 – 31 March 2023. For transmission companies, the RII0-1 period is 1 April 2013 – 31 March 2021.
- 2 The actual returns achieved by networks by the end of the price control may differ from these forecasts. Forecasts are more uncertain for electricity distribution network companies, as they are further from the end of their price control than transmission network companies are.
- 3 Returns are in real terms, using the retail prices index (RPI) as the measure of inflation.
- 4 We have not included the effects of network companies' financing and tax arrangements differing from Ofgem's expectations at the outset of the price control.

Source: National Audit Office analysis of Ofgem and network company data

Figure 16

Breakdown of network companies' forecast return on regulatory equity over RIIO-1

Network companies' returns consist of the baseline return on equity, plus additional money from underspending against allowances and meeting other performance targets

	Transmission network companies	Distribution network companies	Total
Baseline return on equity (£m)	3,390 (7.0%)	4,200 (6.1%)	7,590 (6.5%)
Rewards for spending less than full cost allowances (£m)	800 (1.6%)	580 (0.9%)	1,380 (1.2%)
Rewards for meeting or exceeding other operational performance targets (£m)	320 (0.7%)	1,440 (2.1%)	1,750 (1.5%)
Total (£m)	4,510 (9.3%)	6,220 (9.1%)	10,720 (9.2%)

Notes

- 1 These are network company forecasts as of 1 April 2019. RIIO stands for "Revenue = Incentives + Innovation + Outputs". For electricity distribution network companies, the RIIO-1 period is 1 April 2015 – 31 March 2023. For transmission companies, the RIIO-1 period is 1 April 2013 – 31 March 2021.
- 2 The actual returns achieved by networks by the end of the price control may differ from these forecasts. Forecasts are more uncertain for electricity distribution network companies, as they are further from the end of their price control than transmission network companies are.
- 3 Returns are shown in absolute terms (£m, 2018-19 prices) and as a real-terms return on regulatory equity (%). Absolute returns have been rounded to the nearest £10m and therefore totals do not always sum.
- 4 We have not included the effect of network companies' financing and tax arrangements differing from Ofgem's expectations at the outset of the price control.
- 5 The split of returns between underspend and other operational performance is imperfect, because of interactions between the two: some performance improvements, such as improvements in reliability, are only realised by incurring additional expenditure.

Source: National Audit Office analysis of Ofgem data

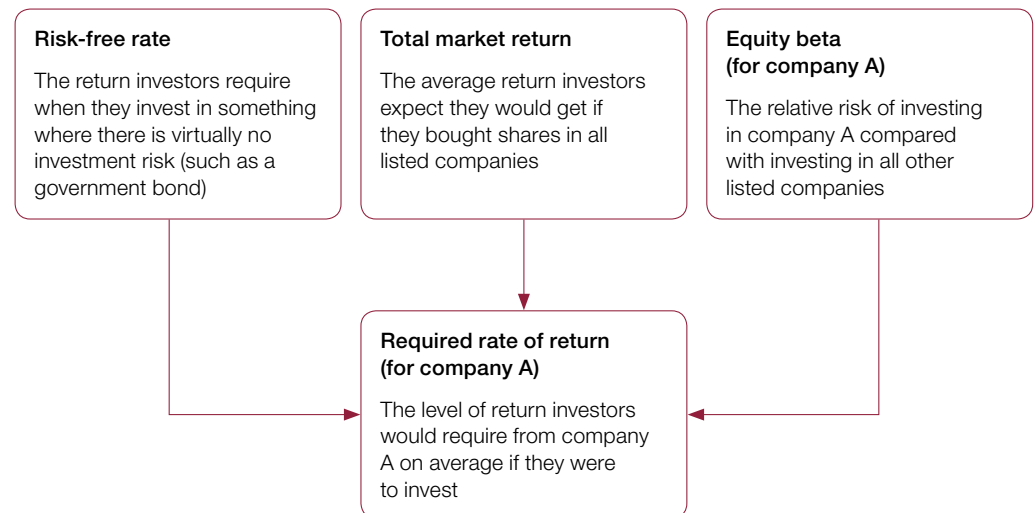
Baseline rate of return

2.10 Shareholders in any company seek returns that are in keeping with the risk to their investment. When Ofgem sets the baseline rate of return, it tries to ensure that it is equal to the minimum return shareholders require from investing in network companies as compensation for the risk to that investment. However, the minimum required return can only be estimated, not measured, and experts' views on how to estimate it change over time. Regulators, including Ofgem, build up an estimate of the return shareholders require from a company mainly by estimating three numbers (**Figure 17**).

Figure 17

How regulators estimate the required rate of return for a company

To estimate the required rate of return, regulators combine estimates of three other numbers

**Notes**

- 1 The formula used to estimate the rate of return is: Required rate of return = Risk-free rate + (Total market return – Risk free rate) × Equity beta.
- 2 This is a simplification. Ofgem's process for estimating the required rate of return involves additional steps.

Source: National Audit Office

2.11 Ofgem has a difficult balance to strike when setting the baseline rate of return, because setting either a too high or too low return for shareholders could add to consumer costs in the long run. Regulators have historically erred on the side of setting returns high ('aiming up'), because although this results in higher consumer costs, it provides greater certainty that companies will be able to raise necessary finance. If companies were not able to raise necessary finance, this would lead to them underinvesting in their assets (that is, the network). Alternatively, if companies were compelled to maintain levels of investment in their assets despite their financial difficulties, consumers and taxpayers might have to provide them with additional financial support.

2.12 For the first RIIO price control, RIIO-T1, Ofgem made what it called a ‘conservative’ estimate of shareholders’ required return, which was towards the top end of the range of values suggested by its external consultants’ analysis. As part of that decision, Ofgem cast doubt on recent market analysis by one of its consultants that indicated network companies’ risk relative to companies in other sectors (their equity beta) was substantially lower than Ofgem had assumed in previous price controls.¹⁴ Instead, Ofgem used a value of equity beta which was outside the range indicated by the market analysis, but consistent with previous price control decisions. Ofgem documents from the time say that Ofgem did this because it thought the RIIO framework was not any less risky for companies than previous price control frameworks. The following factors may have also played a role in its decision:

- **Regulatory practice at the time.** At the time, other regulators believed aiming up was good practice.
- **The importance of securing investment.** Ofgem was anticipating a large amount of investment would be needed during the RIIO-1 price controls, and wanted to ensure the baseline rate of return was high enough that companies did not struggle to raise the capital required for this investment.
- **The consultation process.** Ofgem held bilateral meetings with transmission network companies close to the point at which the price control was finalised to hear their concerns. From a network company perspective, the baseline rate of return Ofgem allowed would have been among the most important considerations when deciding whether to exercise its right to appeal the final terms of the price control to the Competition & Markets Authority.

2.13 After the RIIO-T1 decision, Ofgem received more evidence that network companies’ risk was lower than it had assumed in previous price controls. In 2014, the Competition Commission finalised a price control for a Northern Irish electricity network company which used a lower value of equity beta than Ofgem had used for RIIO-T1. These considerations contributed to Ofgem setting a lower baseline rate of return for RIIO-ED1.¹⁵

2.14 Ofgem no longer considers aiming up to be necessary, because of increased evidence that investors will accept lower returns than have traditionally been allowed in the price controls, and because there are other mechanisms in RIIO for ensuring companies remain financially sustainable. It has also decided to place more weight on up-to-date evidence in RIIO-2 when estimating the minimum required return. These shifts in approach have contributed to Ofgem adopting a much lower value of equity beta in RIIO-2 than it did in RIIO-1 (**Figure 18**). It is also changing its process for consulting on the baseline rate of return so that multilateral meetings are held with all stakeholders instead of bilateral meetings with network companies.

¹⁴ Europe Economics, *The Weighted Average Cost of Capital for Ofgem’s Future Price Control*, December 2010; Ofgem, *Decision on strategy for the next transmission and gas distribution price controls - RIIO-T1 and GD1 Financial issues*, March 2011.

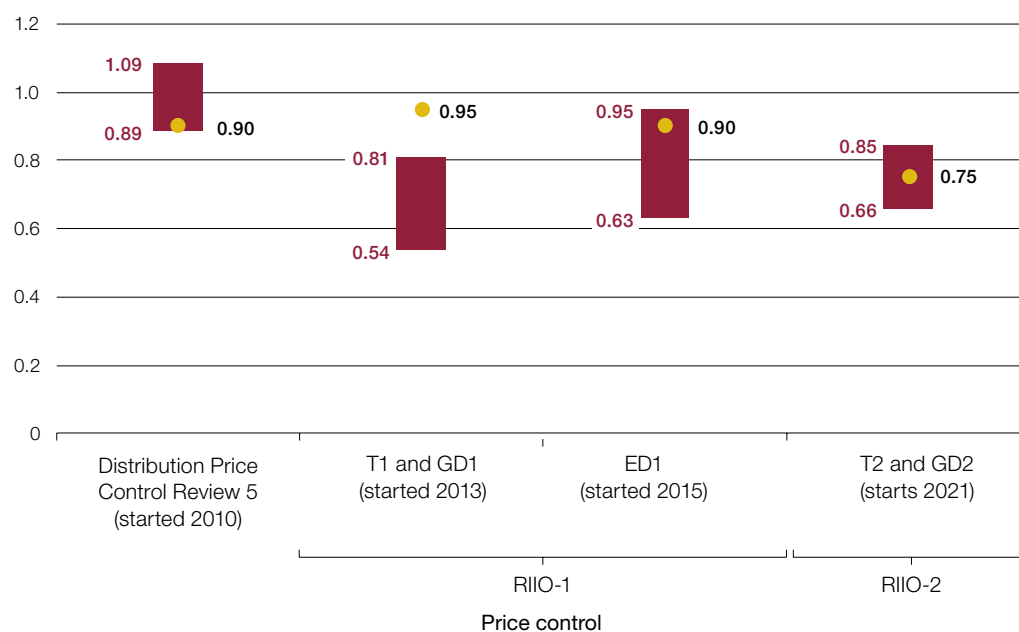
¹⁵ Ofgem, *Decision on our methodology for assessing the equity market return for the purpose of setting RIIO-ED1 price controls*, February 2014.

Figure 18

Ofgem's estimates of 'equity beta' – the measure of electricity network companies' risk relative to other companies

Ofgem has reduced its estimate of equity beta over time in light of evidence from its external consultants

Equity beta (higher values represent higher risk)



■ Consultants' estimated range (adjusted using Ofgem assumptions on financial risk) ● Ofgem decision/working assumption

Notes

- 1 RIIO: Revenue = Incentives + Innovation + Outputs; T1 and T2: transmission networks in RIIO-1 and RIIO-2 respectively; ED1 and ED2: electricity distribution networks; GD1 and GD2: gas distribution networks.
- 2 Ofgem's proposed equity beta for RIIO-2 is subject to consultation.
- 3 We have adjusted (re-gearred) the equity beta ranges proposed by Ofgem's consultants, using Ofgem's assumptions on financial risk (gearing and debt beta). In RIIO-1, this has the effect of making the consultant's estimated range higher for ED1 than for T1, because Ofgem assumed distribution companies would have a higher level of financial risk than transmission companies. If we did not make this adjustment, the consultant's estimated ranges for ED1 and T1 would be the same.
- 4 For ED1, Ofgem specified a baseline return on equity of 6.0% without breaking this down into estimates of equity beta, risk-free rate and total market return. The equity beta of 0.9 shown here is just Ofgem's best estimate of the value it would have adopted in ED1, if it had broken down the return on equity into individual components.

Source: Ofgem

2.15 In our assessment, for RIIO-1, Ofgem placed too much weight on consistency with previous regulatory decisions rather than using the most up-to-date evidence at its disposal. We estimate that the impact was to increase consumer costs by at least £800 million. This estimate is based on changing the values of equity beta in RIIO-1 to the value Ofgem is proposing to use for RIIO-2 (with an adjustment for financial risk), while keeping other numbers used in the price control the same.¹⁶

¹⁶ We used the value of equity beta Ofgem is proposing for RIIO-T2 (0.75) and combined this with the other parameters used to estimate the required return on equity in RIIO-1. For distribution companies, the equity beta of 0.75 increases to 0.84 after we apply an adjustment for network companies' higher notional gearing in RIIO-ED1 compared with RIIO-T2.

Target setting

2.16 A significant proportion of distribution companies' expected returns come from the Interruptions Incentive Scheme (IIS). The IIS incentivises network companies to innovate and invest to reduce the frequency and length of power cuts, by providing rewards for meeting targets. Distribution network companies are forecasting revenues of £890 million from the scheme over RIIO-1, although some of this will be offset by the investments they are making to improve reliability.¹⁷ Since the introduction of the IIS in 2002, the number of power cuts has fallen by around 50% and the length of power cuts has decreased by around 60%. The increased reliability of the network has benefited consumers, who now enjoy a network that is more reliable than networks in many other countries (Appendix Three).

2.17 Although the scheme has successfully driven improvements in reliability, targets for the scheme have not kept pace with improvements in performance in recent years. By the start of the RIIO-ED1 price control, networks were already exceeding the targets Ofgem set (**Figure 19**). This is partly because Ofgem gives network companies advanced notice of the targets for future years, restricting its ability to change the targets in light of more up-to-date data which reflect network companies' improved performance. For RIIO-1, Ofgem increased the rewards linked to reducing customer interruptions. These may have helped drive better performance, but they also led to greater payments to network companies than would otherwise have been made.

Underspend

2.18 Of network companies' expected returns above the baseline return on equity, 44% comes from them spending less than their full totex allowances. The underspends in RIIO-1 can be explained by:

- **lower inflation and lower demand for network connections** than Ofgem expected when it set the allowances. This is an inherent risk of any price control based on forecasting; and
- **network companies being more cost-effective than Ofgem expected.** Ofgem told us that network companies made greater improvements in the efficiency of their operations than could have been foreseen at the start of RIIO. But it also believes that network companies probably overstated their likely costs in some areas.

2.19 When regulators assess network companies' cost forecasts, it is often difficult for them to tell to what extent costs might be being overstated, because regulators have less information than the companies. Ofgem will face this issue when determining network companies' allowances for RIIO-2. Therefore, it would be worthwhile for Ofgem to investigate the extent to which network companies may have overstated their costs at the outset of RIIO-1, to inform its approach to RIIO-2. We note that Ofgem has proposed to increase the proportion of underspends or overspends that is passed on to consumers. Ofgem told us that now that RIIO-1 has been in effect for several years, there should be enough evidence to make this assessment, although it will rely on a degree of judgement as well as evidence.

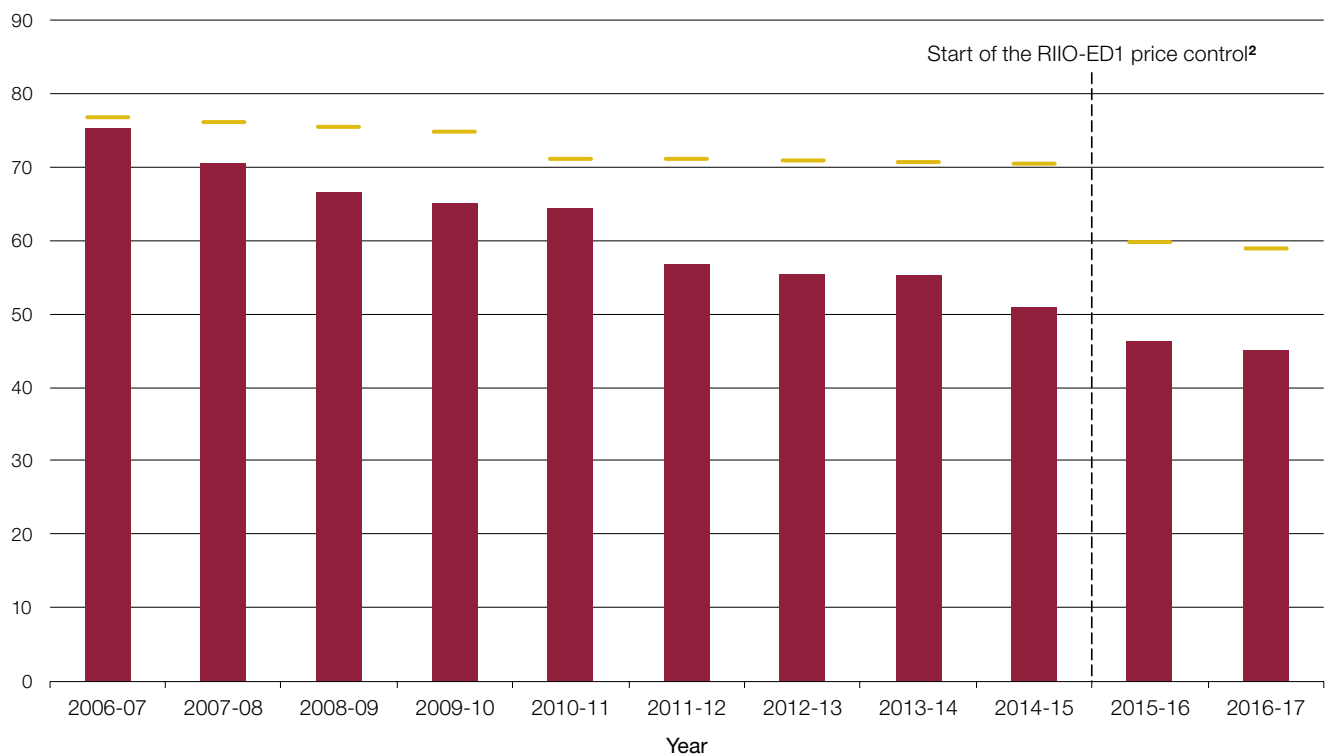
¹⁷ A similar scheme (the network reliability incentive) applies to transmission companies. They expect to earn £40 million from the scheme over RIIO-T1.

Figure 19

Network company performance against targets for reducing the frequency of power cuts, 2006-07 to 2016-17

Networks have successfully reduced the number of power cuts per customer, but targets have not kept pace with improvements in performance

Interruptions per 100 customers



- Actual performance
- Targets (upper limit)

Notes

- 1 Data are for Great Britain and reflect the national average of individual network company performance and targets.
- 2 'RIIO' stands for 'Revenue = Incentives + Innovation + Outputs' and 'ED1' stands for 'Electricity Distribution 1' (the first RIIO price control for electricity distribution companies).

Source: Cambridge Economic Policy Associates

Consumer lock-in

2.20 Consumers will pay higher costs for network services for an extra three years because Ofgem chose to lengthen the period covered by RII0-1. Across utilities, including electricity, price control periods typically last for five years. But in October 2010, Ofgem decided the RII0-1 price controls would last for eight years and limited the scope for making changes midway through. This was because Ofgem did not want network companies to engage in short-term thinking at a time when they may need to make strategic investment in the networks. However, Ofgem now concludes that there is no evidence that extending the length of RII0-1 drove longer-term thinking from network companies.

2.21 When Ofgem consulted on its plans in 2010, some stakeholders highlighted that an eight-year price control period risked locking consumers into paying excessive costs, particularly if Ofgem's estimates of the cost of equity and cost of debt proved generous to network companies. Some of these stakeholders suggested that Ofgem could mitigate this risk by linking companies' allowances for the cost of equity and cost of debt to market indicators and annually updating these during the price control period ('indexation'). Although Ofgem did this for the cost of debt, it did not consider doing so for the cost of equity until it was too late to act. Ofgem calculates that if it had used equity indexation for RII0-1, costs to consumers would have been between £0.2 billion and £0.8 billion lower.¹⁸

2.22 Ofgem told us equity indexation could have equally led to higher costs to consumers than the approach it took (which was essentially to forecast the cost of equity over the price control period using historical data), therefore its decision was not unreasonable. More broadly, any use of indexation exposes consumers to a risk of higher costs, as well as the prospect of lower costs. But Citizens Advice, which is the statutory consumer body for energy consumers in Great Britain, argues that when regulators make forecasts instead of using indexation, they tend to err on the side of providing generous cost allowances.

¹⁸ Equity indexation on its own would have saved consumers £0.2 billion, but if it had been combined with a lower value of beta (in line with the value chosen for RII0-2), it would have saved consumers £0.8 billion.

Recovering money for consumers

2.23 Under RII0-1, networks pass about half of any underspend against their allowances on to consumers. On current forecasts, transmission network companies expect to return £1 billion to consumers this way over RII0-T1, and distribution networks expect to return £500 million to consumers over RII0 ED-1. In addition, amid stakeholder concern about the level of returns network companies are making, four of the nine electricity network companies have made voluntary contributions to consumers from their high returns (**Figure 20**). These contributions amount to network companies deciding to hand back money for projects which did not take place, and which Ofgem was not able to recover with any specific process in the price control, or companies agreeing to perform additional work at no cost to consumers. Ofgem has welcomed these voluntary contributions to consumers, while continuing to highlight concerns around the legitimacy of existing returns to all network companies.

Figure 20

Electricity network companies' voluntary contributions during the RII0-1 period

Some network companies have made no voluntary contributions to consumers

Transmission networks

Company	Agreed contribution
National Grid Electricity Transmission	Voluntarily reduced its price control allowances by about £590 million relating to projects that were not proceeding.
Scottish Power Transmission	Committed up to £20 million to a Green Economy Fund, supporting the transition to a low-carbon economy and vulnerable consumers.
Scottish Hydro Electric Transmission	Made a contribution to consumers worth around £65 million in allowance terms, which included returning unspent allowances on large investment projects and not claiming extra allowances it was entitled to.

Distribution networks

Company	Agreed contribution
Western Power Distribution	Voluntarily returned £77 million in unspent funding related to cancelled rail electrification projects.
Electricity North West	No voluntary contributions.
Northern Powergrid	No voluntary contributions.
Scottish & Southern Electricity Networks	No voluntary contributions.
SP Energy Networks	No voluntary contributions.
UK Power Networks	No voluntary contributions.

Note

¹ RII0 is a price control framework for network companies and is an acronym for 'Revenue = Incentives + Innovation + Outputs'. For electricity distribution network companies, the RII0-1 period is 1 April 2015 – 31 March 2023. For transmission companies, the RII0-1 period is 1 April 2013 – 31 March 2021.

Source: Ofgem

2.24 In light of the high returns network companies were making, midway through the regulatory period, Ofgem considered changing the targets and rewards for outputs such as reducing power cuts. It estimated this could have benefited consumers by reducing the rewards network companies would receive in the latter half of the RIIO-1 price control period. However, it chose not to implement these changes because it believed they could be offset by higher financing costs (which would be passed on to consumers) in future.¹⁹ Such changes were also likely to be challenged by the network companies, given the tightly defined scope written into the arrangements when the price control was initially set.

2.25 Ofgem is reluctant to make adjustments to price controls that could be seen as retrospective changes to the rules. This is because it believes these would damage investor confidence in the regulatory regime, and in the long term this would result in higher financing costs for network companies and therefore higher costs for consumers. It told us it would only make retrospective changes if it was clear that the scale of consumer benefit outweighed the potential detriment of higher financing costs. But impacts on financing costs are difficult to estimate due to a lack of appropriate quantitative evidence, in part because there are few precedents for significantly changing price controls midway through a price control period. In the absence of useful quantitative evidence, Ofgem relies to a large extent on feedback from stakeholders and its own judgement.

2.26 Because the overall impact of retrospective changes is uncertain, there is a risk that Ofgem could inadvertently miss opportunities to save consumers money. Therefore, any work Ofgem is able to do to improve further its understanding of impacts on investor confidence could help to ensure consumers' interests are protected. It is also important for Ofgem to consider carefully in advance what would have to transpire (for example, in terms of network company profitability outstripping its expectations) for it to re-open the price controls, and for it to make these expectations clear to investors.

¹⁹ Ofgem, *Decision on a Mid-Period Review for RIIO-ED1*, April 2018.

Lessons learned from RIIO-1

2.27 Ofgem has undertaken a review of RIIO-1 and published an evaluation of the RIIO framework in March 2018.²⁰ It has made a considerable effort to understand the underlying reasons for network companies' high returns in RIIO-1 and to devise proposals for RIIO-2 that address those issues.

- It has reduced its estimate of transmission networks' cost of equity by 3.2 percentage points for transmission networks, to better align with current market conditions. For distribution networks, it intends to apply the same methodology as it is using for transmission networks, which at present would imply a 2.2 percentage point reduction in the baseline cost of equity.²¹
- It is adjusting the proportion of network company underspend which is returned to consumers, from 30%–55% in RIIO-1 to 50%–85% in RIIO-2.
- It is introducing mechanisms to adjust network company returns in the event of extreme deviations from Ofgem's initial expectations.
- It will return to a five-year price control period, compared with the eight-year RIIO-1 period.
- It will make greater use of indexation, so that the price control is less reliant on forecasting key variables. This includes indexing the cost of equity allowance to changes in the risk-free rate.²²
- It is proposing a framework with the potential for greater use of 'dynamic' targets, which are updated during the price control rather than being determined several years in advance. Dynamic targets are more likely to remain challenging over time.

2.28 Ofgem considers that one of the lessons that can be drawn from price controls in general (not just RIIO-1) is that regulated companies tend to outperform the targets and allowances set for them, giving them higher returns than the regulator expected. One factor which may partly explain this is that regulators have to set targets and allowances on the basis of demonstrably robust evidence, otherwise these may be overturned on appeal to the courts or the Competition & Markets Authority. But regulators tend to have less evidence at their disposal than regulated companies, and this may put companies at an advantage when targets and allowances are set. Ofgem is proposing to compensate for networks' historical tendency to outperform price controls by reducing the cost of equity allowance by a further 0.5%, in addition to the 2.2–3.2 percentage points reduction it is making to reflect current market conditions.

20 Cambridge Economic Policy Associates, *Review of the RIIO Framework and RIIO-1 Performance*, March 2018.

21 Ofgem's most recent published estimate of the cost of equity for RIIO-2 is 4.8% on a CPI-real basis (which is equivalent to 3.8% on an RPI-real basis). This compares to a cost of equity of 6% on an RPI-real basis for RIIO-ED1 and 7% on an RPI-real basis for RIIO-T1.

22 The risk-free rate is one of several factors determining the cost of equity (Figure 17).

Oversight of network company financing and executive pay

2.29 The performance of network companies in reducing costs and providing quality of service only provides part of the picture of whether current and future consumers' interests are being protected. Whether regulated companies provide value for money also depends on their financial structures, dividend policies and the way they incentivise their executives. This is because poor policy in these areas can put the sustainability of companies at undue risk. Financial and corporate ownership structures can also be used to alter companies' UK tax liabilities. In the water sector, concerns about complex financial structures undermining the financial resilience of water companies, and performance-related executive pay policies being out of line with what has been delivered for consumers, have led the water regulator (Ofwat) to request more information from water companies on how their approaches to finance and executive pay reflect the interests of consumers. Ofgem is also increasing its oversight in these areas, although there is no evidence that it has identified similar issues to those observed in the water sector. For example, Ofgem is gathering more information on dividends and executive pay, two areas on which network companies were not previously required to report.

Part Three

Networks' contribution to tackling climate change

3.1 The government has a legal duty to reduce the UK's net carbon emissions to zero by 2050. Achieving this will be highly challenging and will require extensive changes across the economy. Networks will need to be upgraded to cope with significant increases in electricity demand. New sources of flexible energy offer the opportunity to significantly reduce the cost of these upgrades (Part One). However, realising these cost savings will require network companies to develop and deploy innovative technology, operational capabilities and commercial arrangements. In this part of the report, we:

- examine the progress Ofgem has made so far in encouraging networks to make those changes; and
- highlight the remaining challenges the Department for Business, Energy & Industrial Strategy (BEIS) and Ofgem face in ensuring networks help the UK reach net zero carbon emissions by 2050 at least cost.

Progress with changing the way network companies work

Investing in innovation

3.2 Following privatisation in 1990, electricity network companies significantly reduced their expenditure on research and development.²³ This was because price controls did not provide strong incentives to invest in projects with uncertain financial benefits and long payback periods. Ofgem started to see this as a significant problem as climate change policy began to drive rapid changes in the energy system, which it wanted network companies to support by undertaking technological and commercial innovation. Therefore, from 2004 onwards, Ofgem has provided network companies with additional support for innovation. The scale of support has gradually increased over successive price controls. For the first set of RIIO ('Revenue = Incentives + Innovation + Outputs') price controls, RIIO-1, Ofgem has made an average of £70 million per year available for electricity networks through the Network Innovation Competition, and around £20 million per year for smaller projects through the Network Innovation Allowance (**Figure 21** overleaf).

²³ HC Energy and Climate Change Committee, *The future of Britain's electricity networks*, Second Report of Session 2009-10, HC 194-I, February 2010.

Figure 21

Innovation support mechanisms in RIIO-1

There are two main mechanisms that provide additional financial support for innovation in RIIO-1

Scheme	Network Innovation Allowance	Network Innovation Competition
Total support available	£20m/year ¹	Electricity: £70m/year Gas: £20m/year
Criteria	Projects must: <ul style="list-style-type: none"> • be novel; • have the potential to develop learning for network companies; and • deliver net financial benefits for consumers. 	Same as for the Network Innovation Allowance, plus: <ul style="list-style-type: none"> • projects must accelerate the development of a low-carbon energy sector.
Projects awarded support so far ²	Electricity: approximately 500 Gas: approximately 500	Electricity: 18 Gas: 7
Examples of projects supported	Northern PowerGrid was funded to develop a forecasting tool for low-carbon technology growth.	National Grid Electricity Transmission is trialling organisational, commercial and technical arrangements for restarting the electricity system following a blackout using locally-connected energy sources such as solar panels instead of centralised power plants.

Notes

- 1 Network Innovation Allowance funding is set at 0.5% to 0.7% of revenue, which is roughly equivalent to £20 million/year.
- 2 Projects registered by electricity network companies on the Smarter Networks Portal as of November 2019.
- 3 RIIO is a price control framework for network companies and is an acronym for 'Revenue = Incentives + Innovation + Outputs'. For electricity distribution network companies, the RIIO-1 period is 1 April 2015 – 31 March 2023. For transmission companies, the RIIO-1 period is 1 April 2013 – 31 March 2021.

Source: National Audit Office

3.3 These schemes have generally been welcomed by energy stakeholders, and network companies say they have helped them foster new cultures of innovation within their business. An Ofgem-commissioned evaluation of the Low-Carbon Networks Fund (the predecessor to the Network Innovation Competition) found that it delivered significant cost savings for consumers and reductions in CO₂ emissions.²⁴ However, this evaluation was limited in the following respects:

- Ofgem did not require the evaluators to provide a robust estimate of how much innovation might have taken place in the absence of the innovation support. This is always difficult, but evaluators could have been required to take a more advanced approach to estimation than they did.

24 Pöyry and Ricardo Energy & Environment, *An independent evaluation of the LCNF*, October 2016

- It had to rely on the self-reported benefits of projects that network companies were required to submit as a condition of the funding. The evaluators found that the format and quality of these data varied.

3.4 Ofgem has not yet undertaken a detailed independent evaluation of the innovation support mechanisms in RIIO-1, although it has undertaken targeted evaluations of some Network Innovation Allowance schemes. A more detailed evaluation would help to identify how support for innovation can be improved for RIIO-2. There are some indications that the funding in RIIO-1 might have been better directed. While all approved projects have sought to accelerate the development of a low-carbon energy sector, only five out of 22 projects focused on the decarbonisation of heat or transport, arguably the two largest strategic issues for networks. For RIIO-2, Ofgem is proposing to work with other bodies, including BEIS, UK Research and Innovation (UKRI) and devolved administrations, to identify a set of strategic priorities which the network innovation funds could support. Ofgem has not yet secured the participation of these organisations. Ofgem will remain responsible for deciding what innovation should be supported by the price controls and how this should be done.

Making full use of innovative technology

3.5 Since 2010, Ofgem has adapted its regulatory framework to provide incentives for networks to invest in technology that could enable them to upgrade networks at lower cost. Previously, price controls incentivised network companies to prefer capital expenditure solutions – such as new cables and substations – to operating expenditure solutions, such as procuring battery storage. This was because capital expenditure added to the companies' asset bases, and their returns were proportional to the size of those asset bases. In 2010, Ofgem merged network companies' operating expenditure and capital expenditure allowances and fixed the proportion of expenditure which can be capitalised into the asset base. This means network companies have stronger incentives to contract with new technology, such as battery storage, if it can reduce the costs of upgrading networks.

3.6 Network companies and Ofgem agree that this change has helped to encourage them to procure more new technology as an alternative to cabling and substations. However, procurement volumes remain low. Ofgem believes there may still be some residual reluctance in network companies to invest in new technology. Ofgem thinks network companies may be sceptical that it will continue to remunerate them for these assets in the same way as it does for cables. To reduce this scepticism, Ofgem must continue to demonstrate that it is taking a stable and predictable approach to allowing network companies to recover the costs of these assets.

Future challenges

Transforming local electricity networks

3.7 New sources of flexibility such as virtual services and battery storage offer new means to balance supply and demand on the network (Figure 7). These sources have been connecting mainly to distribution networks rather than transmission networks. Contracting with these sources offers the opportunity to manage supply and demand on distribution networks more actively, and potentially reduce the need to upgrade network capacity through the traditional, costly approach of creating additional cabling and substations. The set of functions required to realise these benefits are referred to as distribution system operation (DSO).

3.8 Although the potential benefits of DSO are thought to be significant, realising them will require a transformation of distribution networks. Network companies, or other actors in the energy system, will need to develop DSO functions. These functions are in areas such as long-term network planning, real-time network operations, and designing and operating markets for flexibility.²⁵ As a first step towards making this transformation, network companies have worked together to identify these functions. Ofgem has said that before RIIO-2 for electricity distribution companies (RIIO-ED2) comes into effect, it wants network companies to have already started delivering on the key enablers of these functions such as sharing data, managing any real and perceived conflicts of interest, and routinely contracting for flexible technology using competitive processes, where this provides best value for customers. Ofgem says this will give it a strong basis for designing RIIO-ED2 in a way that appropriately incentivises distribution networks to continue to transform their businesses.

3.9 One of the strategic risks Ofgem faces in performing this work is that it is heavily dependent on cooperation from the network companies themselves to do technical thinking on how DSO should work, but these companies face different circumstances on their networks requiring some to move faster than others:

- Some distribution networks have a strong incentive to invest in flexibility to manage rising demand. But others require relatively little additional capacity in the short term, and so there is less immediate need for them to contract with flexible technology.
- In the long term, the proportion of total network expenditure that is directed towards assets such as cables and substations will decline, and a greater share will go towards DSO functions. Some of these functions might be provided by competitors, such as the Electricity System Operator (ESO), other distribution networks, or other companies.

Ofgem therefore needs to exert continuous pressure over network companies using its full range of powers to ensure they continue to make fast enough progress.

²⁵ Ofgem, *Position paper on Distribution System Operation: our approach and regulatory priorities*, October 2019.

Creating detailed policies for hitting net zero emissions

3.10 To achieve the net zero emissions target, there is broad consensus that the level of low-carbon heating and transport will need to increase significantly during the 2020s, much of which is likely to use electricity. Committee on Climate Change (CCC) analysis suggests a cost-effective path to net zero emissions in 2050 could involve at least a quarter of heat for buildings coming from low-carbon sources by 2030, and electric vehicles making up 60%–100% of new cars sold in 2030. Although these changes are likely to have profound impacts on electricity networks, the scale, pace and nature of change is unknown. This is due to uncertainty over where consumers will charge their electric vehicles in future, and where and when electric heat will be deployed. There is also uncertainty about how these changes will be funded.

3.11 In these uncertain conditions, there is a risk that investment in new network infrastructure will not keep pace with demand, delaying progress on decarbonisation. There is also an opposing risk that new network infrastructure will be built in anticipation of demand which does not materialise, leaving consumers and taxpayers paying for under-used assets. Ofgem says it will balance the risks of over- and under-investment when assessing network companies' plans for the RII0-2 price control period. We recently reported in *Regulating to protect consumers* that regulators often face difficult trade-offs like this when trying to protect consumers' interests, and they can be made more challenging when the government does not provide regulators with a strategic steer on how to manage them.

3.12 The National Infrastructure Commission and the CCC, both of whom make independent recommendations to government, have made a case for strategic investment in networks ahead of demand, despite the risks of under-used assets, to ensure that heat and transport can be decarbonised. Other stakeholders have proposed linking parts of the price control to indicators of demand – such as the number of electric vehicles – and updating these annually, to ensure the price control provides sufficient flexibility while minimising the risk of under-used assets.

3.13 To maximise the chances of achieving net zero at least cost, Ofgem must work with other government departments to mitigate uncertainty as much as possible in advance of making decisions on how distribution networks will be regulated in RIIO-2.

- BEIS and Ofgem can mitigate uncertainty by continuing to model future network requirements, considering the demands of the heat and transport sectors, and the cost-saving potential of new sources of flexibility.
- BEIS, the Ministry of Housing, Communities & Local Government and the Department for Transport can mitigate uncertainty by bringing forward further heat and transport policies that ensure the achievement of carbon emissions targets in the 2020s.²⁶ In areas such as innovation funding for the electrification of transport, where BEIS, the Department for Transport and Ofgem all run their own schemes, the departments need to work together to ensure these are coherent.
- HM Treasury recently started an economy-wide review of how the costs of reaching net zero should be allocated, and aims to report in autumn 2020. It will be important for HM Treasury to ensure its approach to allocating costs drives the right behaviours and can provide sufficient funding for decarbonisation of heat and transport, and to this end, HM Treasury will need to work closely with BEIS, the Department for Transport and Ofgem.

Coordinating a complex energy market

3.14 Since 1990 the government has pursued a strategy of promoting competition and decentralising planning of the energy system. Privatisation split the businesses of distribution and transmission from energy generation, and divided the ownership of the gas and electricity networks. In the energy generation sector, privatisation and technological change have increased the number of companies and households producing energy. Today, there are more than a dozen different gas and electricity network companies, around 200 major electricity generators competing in open markets and close to one million solar panel installations also providing electricity. Therefore, although decentralisation and competition have provided consumers with the benefit of more choice and lower prices, they have also resulted in a complex energy system with many actors.

3.15 To reduce emissions to net zero at the least cost, more coordination will be needed between these actors: between new sources of flexibility and electricity networks; between transmission and distribution; between the electricity and gas networks; and between the electricity system and the heat and transport systems. Network companies, Ofgem, BEIS and other government departments will also need to think across the entire system ('whole systems thinking').

²⁶ The Ministry of Housing, Communities & Local Government has a key role to play in decarbonising heat in new homes due to its policy responsibilities for building regulations and the planning system. For example, the current consultation on its Future Homes Standard proposes that all new homes will have low-carbon heating, as a standard to be introduced by 2025.

3.16 RIIO-1 has laid some of the ground for greater coordination in future by funding innovation projects that have required the collaboration of network companies with each other and with other actors in the energy system. In RIIO-1, Ofgem is proposing to introduce a licence requirement for network companies to consider the needs of the combined distribution–transmission network rather than focusing on their own assets only. BEIS and Ofgem are also taking other actions to improve coordination between electricity networks and other parts of the energy system, such as enabling and encouraging energy data to be more open, removing barriers to participation of new sources of flexibility in energy markets and enabling ‘smart’ homes and businesses. The actions BEIS, Ofgem and industry are taking to enable a smarter and more flexible energy system have been set out in an overarching plan (the Smart Systems and Flexibility Plan), which BEIS and Ofgem published in July 2017 and updated in October 2018.²⁷

3.17 Some stakeholders argue that government could achieve additional cost savings with more strategic coordination in the way the energy system is developed. For example, at present, competition is used to select sites for offshore wind farm development individually, and then the offshore transmission network is extended to connect these sites to the mainland. A better process might involve a coordinating body considering the potential to reduce network costs by prioritising the development of groups of nearby sites that can share common network connections. Once a group of sites is selected, competition could be used to tender contracts to develop those areas. Although proposals like these have support among some experts, others contend that they could lead to worse outcomes by stifling competition and innovation.

3.18 If the government were to decide more strategic coordination is needed, some stakeholders have suggested that the ESO would be well placed to take on some of this work. Over time, Ofgem has gradually granted the ESO more responsibilities for planning the electricity system, although these remain limited. In 2015, Ofgem gave the ESO an obligation to propose several major projects each year that it believes could reduce the overall costs of the electricity network. One option for increasing the amount of strategic coordination in the electricity system would be to give the ESO responsibility for considering whole-system outcomes and developing integrated strategic plans for the network instead of incremental options. However, if the government were to give the ESO this amount of influence over the electricity system, it would need to ensure it is made sufficiently independent of other companies, to avoid conflicts of interest.²⁸ BEIS plans to publish a position paper on governance of the energy system in 2020.

²⁷ Department for Business, Energy & Industrial Strategy and Ofgem, *Upgrading our energy system: smart systems and flexibility plan*, July 2017; Department for Business, Energy & Industrial Strategy and Ofgem, *Smart systems and flexibility plan: progress update*, October 2018.

²⁸ The ESO is currently owned by National Grid plc, which also owns National Grid Electricity Transmission plc, the transmission network in England and Wales. Ofgem and BEIS have taken steps to make the ESO more independent of the other parts of National Grid plc, including making the ESO a legally separate entity in 2019. Ofgem plans to review the legal separation of the ESO in 2020.

Appendix One

Our audit approach

1 This report examines how effectively Ofgem is using the RIIO ('Revenue = Incentives + Innovation + Outputs') electricity network price controls to protect the interests of consumers and achieve the government's climate change goals. It also comments on the strategic challenges the Department for Business, Energy & Industrial Strategy (BEIS) and Ofgem will face in ensuring electricity networks support government's climate change goals. Electricity networks are regulated by Ofgem, a non-ministerial department sponsored by BEIS. BEIS has overall responsibility for energy policy and ensuring the UK meets legislated targets for reducing carbon emissions. We provide details of our audit approach in **Figure 22**.

Figure 22

Our audit approach

The objective of government

The Department for Business, Energy & Industrial Strategy's (BEIS's) strategic objective is to ensure the energy system provides clean, reliable, affordable power.

Ofgem's objectives in relation to electricity networks are:

- to protect the interests of the users of the electricity system;
- to promote efficiency and economy on the part of network companies; and
- to ensure electricity networks support achievement of government's climate change targets.

How this will be achieved

Ofgem uses a range of regulatory powers to influence network companies, including price controls (limits on the amount of revenue network companies can earn, coupled with targets for performance).

Our study

This report examines how effectively Ofgem has used the electricity network price controls to protect the interests of consumers and achieve the government's environmental goals. It also comments on the strategic challenges BEIS and Ofgem will face in ensuring electricity networks support government's climate change goals.

Our evaluative criteria

Ofgem has ensured that networks provide a good service and only earn a fair return.

Ofgem has learned lessons from the current price control and has incorporated these into its proposals for the next price control.

Ofgem has used the price controls to ensure networks support long-term environmental goals.

Our evidence
(see Appendix Two for details)

We analysed data on networks' performance and returns.
We interviewed network companies, senior government officials and energy stakeholders.

We reviewed Ofgem's work to evaluate the current price controls.
We reviewed Ofgem's proposals for the next price control.

We reviewed Ofgem's work to evaluate the current price controls.
We interviewed network companies, senior government officials and energy stakeholders.

Our conclusions

Under Ofgem's current regulatory framework, electricity network companies have provided a good service, but it has cost consumers more than it should have. It is now clear that targets were set too low, budgets too high, and the impact of these decisions was compounded by Ofgem extending the regulatory period from five years to eight. In some cases, Ofgem did not use the best information available to it at the time: on financing costs, for example, where better use of evidence could have saved consumers at least £800 million. To Ofgem's credit, it has sought to learn lessons from these experiences and design the next regulatory period differently.

Electricity networks now have a crucial role to play in helping the UK reach net zero emissions by enabling the system needed for low-carbon heat and transport. An intelligent approach to this transition could spare consumers from significant extra costs: this is illustrated by recent research which estimated that using flexible technology could help to reduce the cumulative electricity system costs, including increasing electricity system capacity, by between £17 billion and £40 billion by 2050. To maximise electricity networks' value for money in future, Ofgem must ensure it sets stretching targets for network companies in the next regulatory period, while building enough flexibility into the price controls to respond to unexpected developments. The government must help to clarify future network requirements by bringing forward further policies for decarbonising heat and transport. And BEIS will need to ensure that the energy market is governed in a way that provides enough strategic coordination of its many actors.

Appendix Two

Our evidence base

1 We reached our independent conclusions on the value for money of the RIIO ('Revenue = Incentives + Innovation + Outputs') price controls by analysing evidence collected between April and November 2019. We considered relevant findings from our previous reports on the changing electricity system, and on regulators. Our evaluative criteria were informed by the strategic objectives of Ofgem and the Department for Business, Energy & Industrial Strategy (BEIS), HM Government's principles for economic regulation and the approach we previously took to evaluating the economic regulation of the water sector.

2 We interviewed:

- senior officials in Ofgem and BEIS;
- officials in the Office for Low-Emission Vehicles;
- network companies and the Electricity System Operator;
- academics;
- professional engineers;
- the Committee on Climate Change;
- Citizens Advice; and
- other experts and stakeholders in the energy system.

3 In Part One we provided context for the electricity network price controls:

- We drew on our programme of interviews with senior officials and stakeholders across the energy system.
- We reviewed published research on electricity networks, including on network productivity and the potential value of new sources of flexibility.
- We reviewed published BEIS and Ofgem documents on the network price controls and energy policy.
- We reviewed reports by the Committee on Climate Change.
- We carried out analysis of the unit costs of electricity networks since 1990.

4 In Part Two we assessed value for money for consumers:

- We drew on our programme of interviews with senior officials and stakeholders across the energy system.
- We examined published Ofgem data on network company performance and returns.
- We examined network companies' published financial statements.
- We reviewed published and unpublished Ofgem documents relating to key decisions made in the design of RIIO-1 and RIIO-2.
- We reviewed an evaluation of RIIO-1 commissioned and published by Ofgem.
- We reviewed written material submitted to us by network companies.

5 In Part Three we commented on the networks' role in tackling climate change:

- We drew on our programme of interviews with senior officials and stakeholders across the energy system.
- We reviewed published documents on historical and current price controls, including an evaluation of RIIO-1 commissioned and published by Ofgem.
- We reviewed published evaluations of the Low Carbon Networks Fund, and examined the scope of projects that had been commissioned under the Network Innovation Competition.
- We reviewed Ofgem's published proposals for the next set of price controls.
- We reviewed published government policy documents on the future of the electricity system.

Appendix Three

International comparisons

1 This appendix compares Great Britain's electricity networks with networks in European Union (EU) countries.

Market structure and regulation

2 There are a number of similarities in the way electricity networks work throughout Europe. In all EU countries, transmission and electricity distribution networks tend to exist as regional monopolies (that is to say, any given area is only served by one distribution network and one transmission network). This is because the fixed costs of building an electricity network are very high, and so it is difficult for competing networks to establish themselves, and in any case, having two networks serving the same area would not be cost-effective. In many member states, these monopolies are privately owned companies (as they are in the UK), although there are exceptions to this such as the Swedish state-owned transmission network company Svenska kraftnät. Regardless of ownership, EU law requires that network companies are kept legally separate from energy generation businesses, and that the activities of network companies are regulated by an independent regulator. In broad terms, these regulators try to incentivise cost-effective behaviour by the network company in a similar way to Ofgem: by limiting the total revenue network companies can raise, while rewarding them financially for achieving agreed performance targets.

3 In some other respects, the market set-up in other countries can differ substantially from Great Britain. For example, Great Britain has six electricity distribution companies, whereas Germany has around 850 small regional network companies, and France, Italy and Portugal each have one dominant network company providing at least 80% of the country's distribution network.

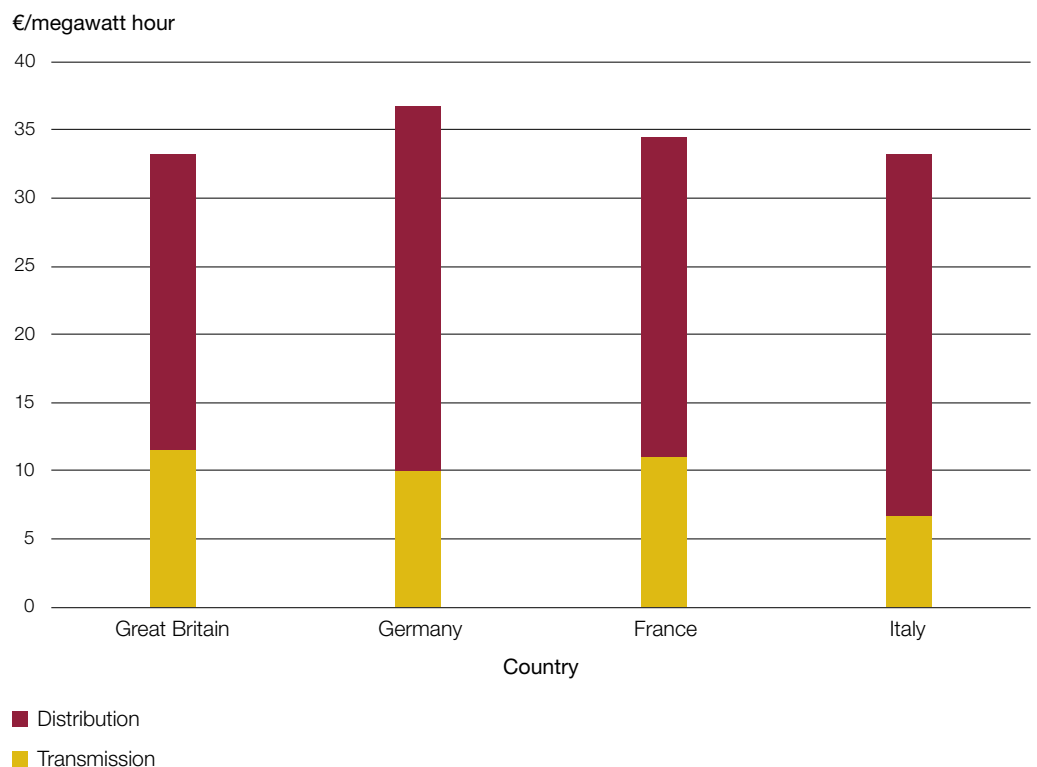
Costs

4 International cost comparisons should be made cautiously, because cost differences can be reflective of differences in the geography of the areas different networks serve. For example, other things being equal, networks serving areas with lower population densities or more mountainous terrain might be expected to have higher unit costs. Research commissioned by the Aldersgate Group found that network costs in the UK are broadly comparable with Germany, France and Italy on the basis of cost per unit of electricity generated (**Figure 23**). This metric does not take geographical differences into account.

Figure 23

Cross-national comparison: electricity network costs per unit of electricity generated, 2015-16

Costs in Great Britain are comparable with Germany, France and Italy



Notes

- 1 Costs are defined as network companies' total allowed revenues (amount of revenue the regulator allows network companies to raise).
- 2 Cost differences can be reflective of differences in the geography of the areas different networks serve, therefore comparisons between countries should be made cautiously.
- 3 Countries shown are those selected by the authors of the source report.

Source: Michael Grubb and Paul Drummond, *UK industrial electricity prices: competitiveness in a low-carbon world*, February 2018

Reliability and availability

5 The reliability of electricity supply varies significantly across the EU. Official statistics typically distinguish between planned interruptions to electricity supply (for example, to carry out maintenance) and unplanned interruptions (for example, caused by a technical failure). Unplanned interruptions tend to be more frequent but shorter than planned interruptions – in 2016, unplanned outages comprised 79% of all interruptions in the EU but only 55% of the total duration of interruptions.

Unplanned interruptions

6 According to data collated by the Council of European Energy Regulators (CEER), electricity networks in Great Britain outperform the EU average both in terms of frequency and duration of unplanned interruptions (**Figure 24** on page 59 and **Figure 25** on page 60).

7 Although the CEER data indicate that some countries significantly outperform Great Britain on these measures, it is possible that some of these differences may be accounted for by differences in the way different countries record interruptions. For example, France only includes high-voltage networks in its data on the frequency of unplanned interruptions. This may be part of the reason why the frequency of unplanned interruptions in France appears to be much lower than in Great Britain.

Planned interruptions

8 Compared to other EU countries, Great Britain has a very low number of planned interruptions. In 2016, Great Britain had around two planned interruptions of electricity supply per 100 customers, while Germany had eight, France had 14 and Italy had 41.

Renewable electricity

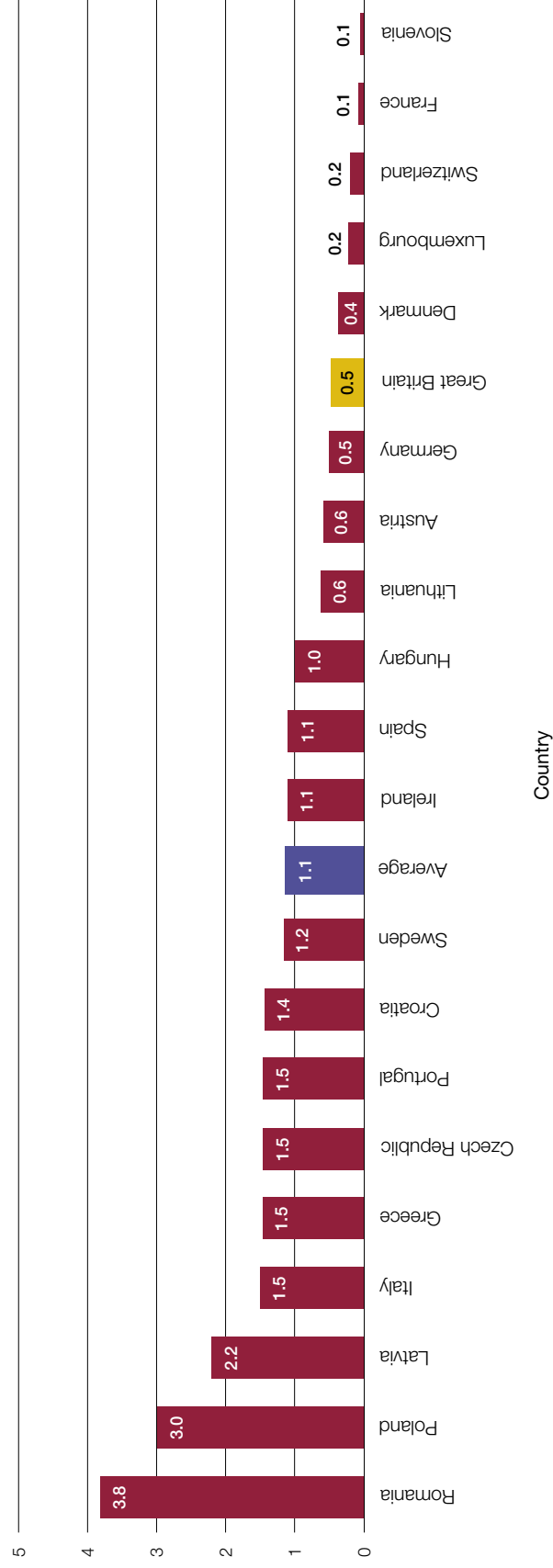
9 Electricity networks are not responsible for the proportion of renewables in the electricity system, but they have a supporting role to play in ensuring they can accommodate renewables, for example by providing new network connections. Great Britain has already exceeded the government's ambition for 30% of electricity to come from renewables by 2030, and the proportion of renewable electricity in system is in line with the EU average (**Figure 26** on page 61).²⁹ This suggests that networks have successfully enabled wider electricity system changes to take place. The changes are likely to have contributed to rising real-terms networks' costs in recent years, including balancing costs (Figure 8 and Figure 11 in Part One).

²⁹ By the end of 2018, renewables accounted for 37.1% of electricity generation in the UK, according to Department for Business, Energy & Industrial Strategy data.

Figure 24
Cross-national comparison: frequency of unplanned interruptions in electricity supply, 2016

Great Britain compares favourably to other countries

System average interruption frequency index (SAIFI)



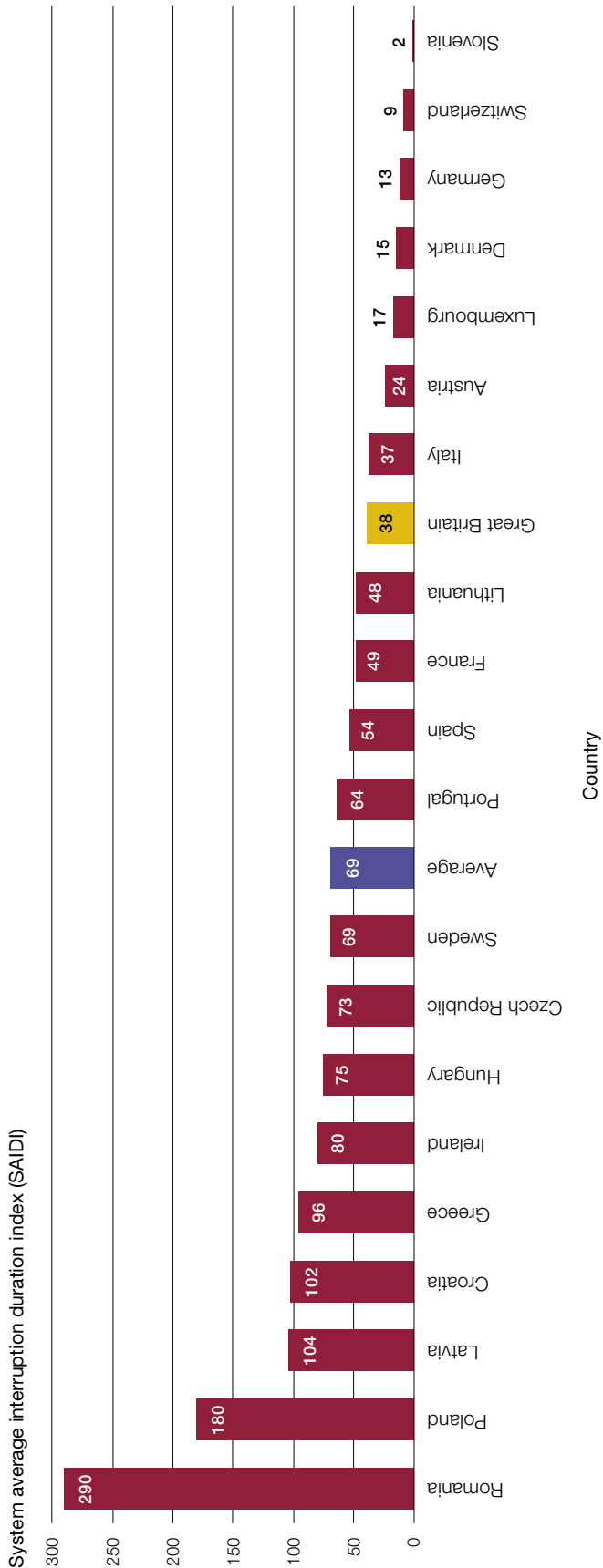
Notes

- SAIFI is a semi-standardised measure of the frequency of interruptions. It is approximately equivalent to the number of unplanned interruptions per customer per year. However, data are not perfectly comparable across countries due to differences in the way interruptions are recorded.
- Data exclude exceptional events. If exceptional events were included, the frequency of interruptions would be higher.
- Countries listed are members or observers of the Council of European Energy Regulators.

Source: Council of European Energy Regulators, Benchmarking Report 6.1 on the Continuity of Electricity and Gas Supply, July 2018

Figure 25
 Cross-national comparison: duration of unplanned interruptions in electricity supply, 2016

Great Britain compares favourably to other countries



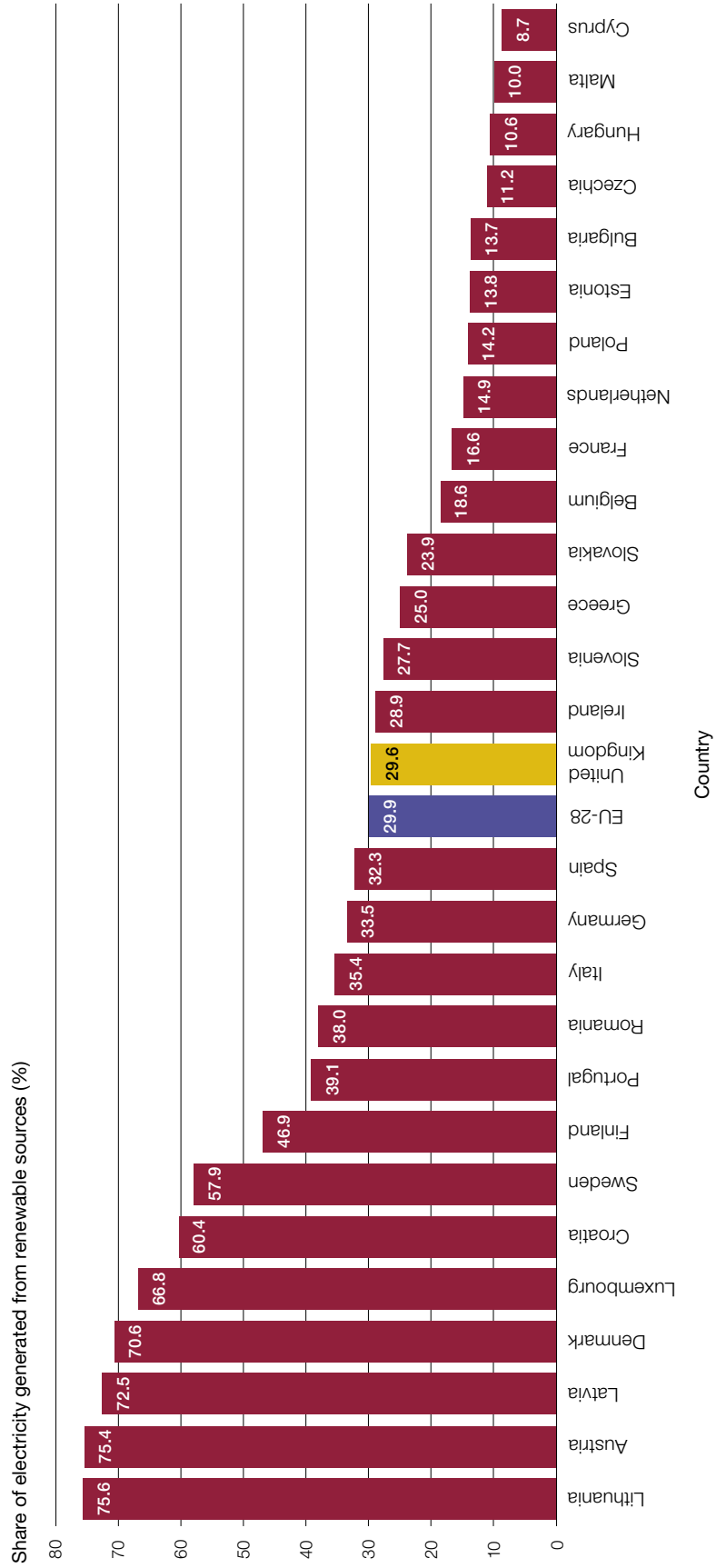
Notes

- SAIDI is semi-standardised measure of the duration of interruptions. It is approximately equivalent to the amount of time a typical customer will experience without electricity in a year. However, data are not perfectly comparable across countries due to differences in the way interruptions are recorded.
- Data exclude exceptional events. If exceptional events were included, the duration of interruptions would be higher.
- Countries listed are members or observers of the Council of European Energy Regulators.

Source: Council of European Energy Regulators, *Benchmarking Report 6.1 on the Continuity of Electricity and Gas Supply*, July 2018

Figure 26
Cross-national comparison: share of electricity generated from renewable sources, 2017

Great Britain has exceeded the government's ambition for 30% of electricity to come from renewables by 2030



Note

1 'EU-28' is the weighted average of the 28 countries which are members of the EU as of 30 January 2019.

Source: Eurostat

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