WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Business Plan 2023 - 2028

SA-06 Supplementary Annex Expenditure

December 2021

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Appendix A05 - NERA (April 2021), *Ongoing Efficiency Improvement at RIIO-ED2*, prepared for the ENA 277
Appendix A06 - NERA (June 2021), *Price Effects for RIIO-ED2*, prepared for the ENA 277
Appendix A07 - NERA (November 2021), Price Effects for the RIIO-ED2 Price Control Review - Addendum, prepared for the ENA 277

1. Introduction

1.1. The next regulatory price control review period, known as RIIO-ED2 is a five year period and is the second for electricity distribution to be determined using Ofgem's Revenue = Incentives, Innovation and Outputs framework. This price control period runs from 1st April 2023 to 31st March 2028.

1.2. Western Power Distribution (WPD) is required to submit a 200 page Business Plan document, supplementary annexes, detailed cost tables, financial information and a range of other documents which form our submission under RIIO-ED2 to Ofgem, which will be used to determine allowed revenues for the price control period.

1.3. Our RIIO-ED2 Business Plan has been produced and compiled in line with the following key principles:

- Co-created with our stakeholders and supported by them.
- Our Plan – 'prepared with our stakeholders for delivery by us'.
- Aligned with WPD's purpose and values.
- Affordable for all of our customers.
- Sustainable and will enable net zero before 2050.

1.4. Everything in our business plan submission is driven to achieve the following four strategic outcomes for customers.

Figure SA-06. 1: Our four strategic outcomes for customers.

1.5. The diagram below (Figure SA-06. 2) shows the structure of the full Business Plan submission with the red box showing where this document fits into the overall suite of documents.

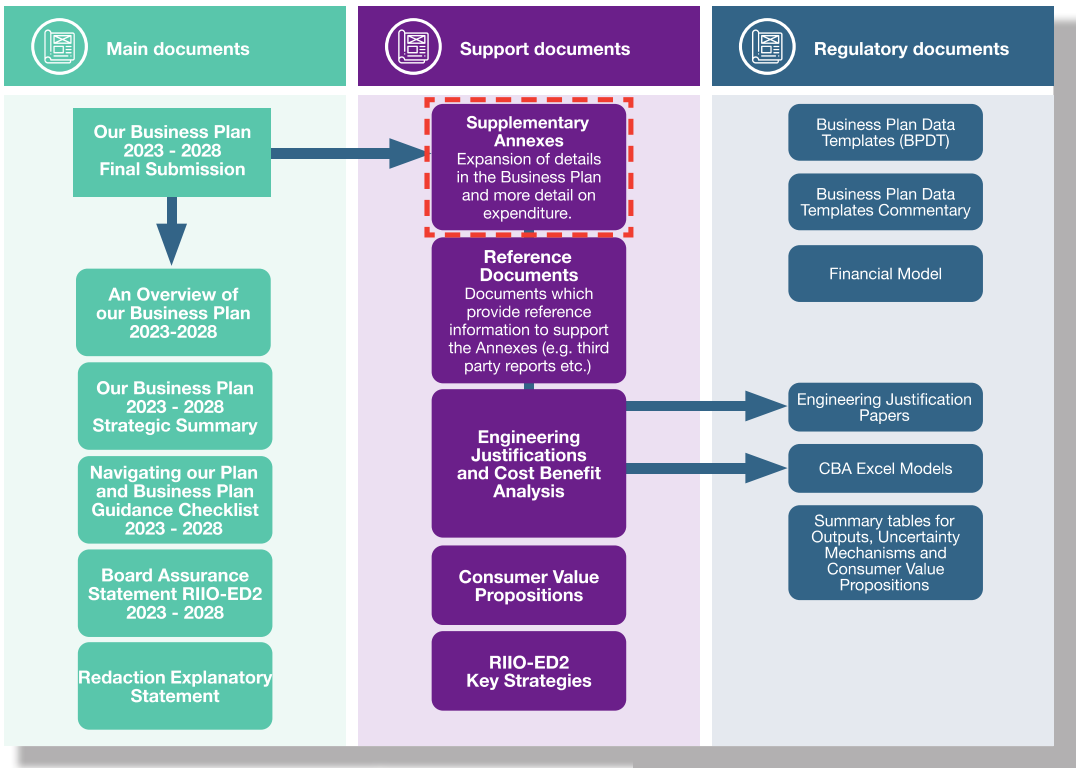


Figure SA-06. 2: Business plan submission structure

1.6. Chapter 6 – Expenditure of Our Business Plan 2023 -2028 Final Submission details our expenditure plans for the period from 2023 to 2028. RIIO-ED2 will be a period of significant change as the UK works towards achieving a net zero carbon future. Our expenditure plans reflect this challenge to deliver a network which meets future energy requirements, as well as ensuring we continue to deliver industry-leading service levels to customers at an efficient cost.

1.7. This document is a supplementary annex to Chapter 6 of WPD's RIIO-ED2 Business Plan document and provides more details on our expenditure plans for the for the five year period from 1st April 2023 to 31st March 2028. It sets out our expenditure plans for all of the different cost categories that we report under to Ofgem and explains why costs are forecast to be different in RIIO-ED2 and compares the values to those being incurred in the current price control. It covers expenditure for the four WPD distribution licences of West Midlands, East Midlands, South Wales and South West.

Structure of this document

1.8. We appreciate that the readers of the WPD RIIO-ED2 Business Plan suite of documents will range from regulatory experts and well informed stakeholders through to new customers who may have had little previous knowledge of WPD.

1.9. This document is aimed at readers who require a more detailed understanding. A less detailed description can be found in the main Business Plan Overview document.

1.10. This document is subdivided into the following sections:

Section	Title	Content
Section 2	**A summary of total expenditure (Totex)**	The Totex summary for our Business Plan
Section 3	**Cost and workload forecast considerations**	A summary of the key themes and approaches that underpin the development of our plan
Section 4	**Reinforcement of the network**	Expenditure requirements for reinforcing the network.
Section 5	**Non load-related investment**	Expenditure for replacing and refurbishing assets, improving safety, reducing environmental impact and making improvements to network performance.
Section 6	**Network operating costs**	Expenditure on inspection and maintenance, responding to and repairing faults, tree clearance and other network operating costs.
Section 7	**High value projects (HVPs)**	Expenditure on schemes specified over a £25m threshold.
Section 8	**Engineering management**	Expenditure to support the physical work on the network; this encompasses a range of indirect activities such as planning, project management, system records, stores and wayleaves.
Section 9	**Corporate activities**	Corporate activities, including HR, finance and regulation, procurement, corporate communications, legal services and executive functions.
Section 10	**Workforce resilience**	Expenditure to ensure WPD staff are fully trained and competent in undertaking existing and new activities safely. Expenditure includes the recruitment of new operational staff, upskilling and refresher training of our staff, alongside the cost of delivering in-house training facilities and trainers.
Section 11	**Information technology and telecoms overview**	Expenditure on all capital investment and running costs for IT and Telecoms (operational and non-operational), including cyber resilience.
Section 12	**Vehicles, property and engineering equipment**	The capital purchase of non-network assets and associated running costs to support these assets
Section 13	**Other costs within the price control**	Expenditure associated with: Innovation funded through Ofgem led schemes; Atypicals; and Street works
Section 14	**Activity costs outside the price control**	Expenditure incurred by carrying out distribution network related activities that operate outside the regulatory price control including activities where the costs are recharged to third parties. These costs are excluded from Totex.
Section 15	**Non activity based costs**	Expenditure which can vary annual revenue in line with the actual cost, either because it is outside the DNO's control or because it is subject to separate price control measures. These costs are excluded from Totex.
Section 16	**Our RIIO-ED2 efficiency story**	Our efficiency position for RIIO-ED2 and important considerations for cost assessment
Section 17	**Ongoing efficiency**	Our position on ongoing efficiency for this business plan
Section 18	**Real price effects**	Our position on real price effects for this business plan
Section 19	**Bill impact**	The impact of our RIIO-ED2 plan on the average customer bill

Section 20	Appendices	Supporting appendices referenced in this annex

Figure SA-06. 3: Structure of Supplementary Annex SA06 - Expenditure

Costs included in our plan

1.11. The expenditure included in this document:

- Is stated in 2020/21 prices (current day prices, so cost forecasts exclude general inflation).
- Is our baseline view, i.e. expenditure that we consider should be funded through ex-ante allowances, and excluding expenditure which we consider is more appropriately funded under uncertainty mechanisms.
- Includes pensions costs (excluding established pension deficit repair payments), based on current actuarial projections.
- Includes Real Price Effects (RPEs) and Ongoing Efficiency (OE) at Totex level only (RPEs and OE are excluded from activity level forecasts as these are presented separately in Ofgem data templates).

1.12. Through this annex, we focus on the costs referred to as Totex. This means the licensee's total expenditure (with limited exceptions) on regulated business activities. Totex includes both capital and operating expenditure items over which we have control and which are funded through the price control. The information is presented in alignment with the cost categories we report to Ofgem.

1.13. There are some costs which we incur outside Totex. These are either funded directly by customers or have specific 'pass through' arrangements because we don't have direct control over them. We are required to provide forecasts on these costs to Ofgem as part of the Business Plan submission, and so later sections in this annex detail our approach to these costs.

1.14. There are some areas of our plan where the requirement is yet to be decided through government and regulatory policy. Since the requirements are largely unknown, no cost forecast has been included. For example, this applies to areas including the requirement for enhanced restoration (also referred to as Electricity System Resolution or Black Start) capability and diversions associated with railway electrification. These areas are further discussed in Supplementary Annex SA-07 'Managing Uncertainty' of our Business Plan.

2. A summary of total expenditure (Totex)

2.1. The following tables present the required expenditure by DNO to deliver WPD's RIIO-ED2 baseline plan. Note that in the tables presented through this annex, totals shown may not quite match the sum of individual rows or columns due to rounding to the nearest million.

2.2. Figure SA-06. 4 compares our forecast annual average and total base view Totex costs for RIIO-ED2 against our annual average costs for RIIO-ED1.

2.3. We propose to spend £6.7 billion during the five years of RIIO-ED2.

2.4. This is a 27% increase on the annual average expenditure in RIIO-ED1 and increases are seen in all four licence areas.

Totex					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	320	318	158	254	1,050
RIIO-ED2 Annual Average (forecast)	373	392	223	347	1,336
RIIO-ED2 Total (5 years)	1,864	1,962	1,116	1,737	6,679

Figure SA-06. 4: Our Totex expenditure

2.5. During RIIO-ED1 we delivered on our promises, while also addressing new requirements. We are expecting to end RIIO-ED1 with expenditure in line with RIIO-ED1 allowances. We have achieved this despite needing to deliver activities outside of our RIIO-ED1 Business Plan proposals, which were not foreseen at the time of developing that plan. These have included dealing with significant growth in distributed generation, establishing a Distribution System Operator (DSO) capability, producing the Distribution Future Energy Scenarios, adopting flexibility as an alternative to conventional reinforcement and developing projects to contribute towards a green recovery'.

2.6. Our investment proposals for RIIO-ED2 continue to cover the delivery of essential core activities (including asset replacement and resolution of faults), while also providing more network capacity to accommodate growth in low carbon technologies and establishing enhanced DSO functions. Expenditure plans incorporate the utilisation of flexibility to minimise the need for higher cost reinforcement and an overall clear focus on business efficiency to keep bills as low as possible. The costs forecast also reflect the delivery of commitments developed through extensive stakeholder engagement.

2.7. Figure SA-06. 5 compares our average annual spend in RIIO-ED1 to our current base view forecast for RIIO-ED2. Our total annual spend is forecast to increase, driven primarily by:

- An increase in reinforcement of the network, which is absolutely essential to facilitate the move to net zero carbon emissions,
- An increase in information technology and telecoms investment in order to enhance our DSO functions and manage the cyber risk in our business.

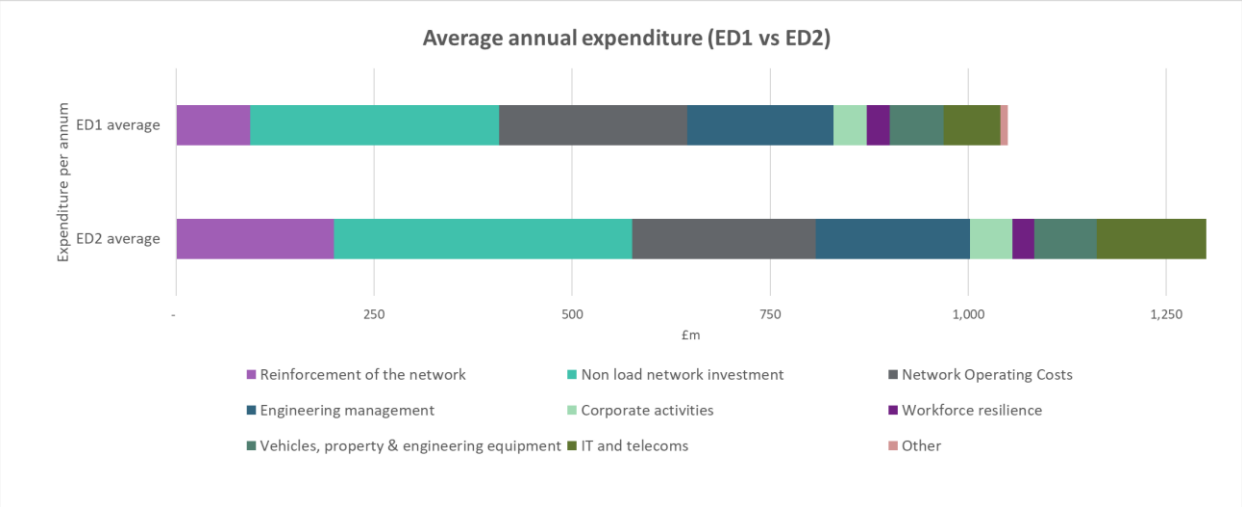


Figure SA-06. 5: Average annual expenditure (RIIO-ED1 vs RIIO-ED2)

2.8. The scale of this investment required during RIIO-ED2 may change, due to substantial shifts in government policy or changes to volumes being delivered due to consumer take-up levels, and our proposals for a mechanism for funding these are included in Supplementary Annex SA-06a 'Load related expenditure' and Supplementary Annex SA-07 'Managing Uncertainty'.

2.9. WPD has a proven record of cost efficient delivery. The RIIO-ED2 Business Plan builds upon these existing efficiencies by factoring in further productivity and unit cost improvements.

Cost allocations

2.10. Cost accounting uses both direct booking of time and materials to specific activities for staff who work directly on delivery of projects and cost allocations for salaried staff. As salaried staff do not complete time sheets, but can work on activities outside of Totex, part of their costs are reallocated outside the price control.

2.11. Work on the network is delivered using a geographical team structure. This means that a team has responsibility for all the main activities in its local area, such as connections, maintenance, network investment and non-price control work including activities that are charged directly to customers. Each team member carrying out physical work on the network completes a timesheet so that the reason for the costs can be separately and accurately identified. This also applies to the cost of materials and the cost of using external contractors. This allows these costs to be directly attributed to a specific activity.

2.12. There are certain staff, covering engineering and corporate functions, who do not complete timesheets. This comprises: engineering management, including project management and clerical support; centralised engineering teams carrying out studies for the development of the network; and corporate activities including human resources. Some of these indirect staff support activities that relate to Totex, as well as activities classified as being outside the price control. To ensure that the appropriate costs are included in Totex and that the areas of work outside the price control are fully costed (including all indirect activities related to delivering this work), we allocate part of our indirect costs to this work outside the price control. This allocation is subject to an internal methodology, which has been fully reviewed and updated for RIIO-ED2.

2.13. All Totex costs shown in this document follow the allocation of indirect activities to non-price control activities. However, where expenditure is presented by activity areas, this expenditure is shown before the impact of these indirect allocations (for example all corporate costs are included before a part of these is allocated outside the price control). Corporate activities

including finance, IT and other activities including the Control Centre and Contact Centre, are operated as shared activities across WPD licence areas, in order to be as cost effective as possible. Shared costs have been allocated across the four licensees using an approach that is consistent with our processes in RIIO-ED1. This allocates the shared costs using the following proportions:

- 30% West Midlands.
- 30% East Midlands.
- 15% South Wales.
- 25% South West.

WPD total core expenditure forecast

2.14. Figure SA-06. 6 to Figure SA-06. 10 show the high level activity breakdown of the expenditure forecast to deliver our proposed Business Plan commitments and activities in our base view. The activity costs are shown before allocations to activities outside the price control. Allocations and adjustments, as well as the values of Ongoing Efficiency (OE) and Real Price Effects (RPEs), are shown separately to determine the Totex values. The presentation shown in this annex is consistent with regulatory reporting to aid read-across with our BPDTs.

2.15. Indirect allocations are described above.

2.16. Totex adjustments are adjustments made in line with regulatory reporting requirements to remove costs that are not funded through Totex allowances. These adjustments include an element of charges from related party businesses which reflect margin, and NIA innovation funded by DNOs, as well as adjusting for income that we receive on disposal of assets and scrap and through commercial arrangements with third parties to utilise our assets.

2.17. OE and RPEs are discussed in chapters 17 and 18 respectively.

2.18. The information is shown for WPD in total, as well providing details for each of the four licence areas.

WPD: Core expenditure forecast

WPD Total Expenditure								
£m at 2020/21 prices	Average per year in RIIO-ED1	Average per year in RIIO-ED2	Spend profile in RIIO ED2					Total RIIO-ED2
			2023/24	2024/25	2025/26	2026/27	2027/28	
Connections requiring reinforcement	25	47	41	45	48	54	47	235
Primary reinforcement	33	52	76	42	56	54	33	261
Secondary reinforcement	28	75	56	68	83	81	86	374
Fault level reinforcement	6	12	18	16	16	5	4	59
New transmission capacity charges	0	3	1	2	2	3	10	17
Reinforcement of the network	**91**	**189**	**193**	**171**	**206**	**197**	**180**	**946**
Diversions	39	49	49	50	49	48	48	244
Diversions (rail electrification)	2	0	0	0	0	0	0	0
Asset Replacement and refurbishment	222	256	240	252	268	250	268	1,279
Civil works driven by condition of civil items	15	14	14	14	14	14	14	69
Black Start	4	0	0	0	0	0	0	0
Legal and Safety	5	9	8	9	9	10	9	45
Quality of supply	6	5	5	5	5	5	5	25
Flood mitigation	1	2	2	3	3	2	2	12
Physical security	0	0	0	0	0	0	0	0
Rising and lateral mains	0	0	0	0	0	0	0	2
Overhead line clearances	18	24	25	25	28	24	20	122
Worst served customers	1	1	1	1	1	1	1	4
Visual amenity and undergrounding in National Parks and Areas of Natural Beauty	1	1	1	1	1	1	1	7
Losses	1	1	1	1	1	1	1	5
Environmental activities	4	6	9	9	8	1	1	29
Non Load network investment	**320**	**368**	**356**	**370**	**388**	**358**	**371**	**1,842**
Faults	103	86	87	86	85	85	84	428
Severe weather: 1 in 20	2	6	6	6	6	6	6	31
Occurrences Not Incentivised (ONIs)	24	25	24	24	24	25	25	123
Tree cutting	51	49	49	51	50	48	48	246
Inspections, Repairs and Maintenance	44	47	48	47	47	47	47	236
Supporting the UK Smart Meter roll out	7	3	10	7	0	0	0	17
Other network operating costs	9	11	11	11	11	10	9	53
Network operating costs	**241**	**227**	**235**	**233**	**224**	**222**	**220**	**1,134**
High value projects	**0**	**6**	**0**	**0**	**10**	**10**	**10**	**30**
Engineering management	**232**	**251**	**252**	**251**	**249**	**251**	**250**	**1,253**
Corporate activities	**50**	**60**	**59**	**59**	**60**	**61**	**61**	**300**
Workforce resilience	**30**	**31**	**30**	**30**	**31**	**32**	**31**	**154**
Information Technology (IT) and Telecoms costs	**79**	**171**	**173**	**165**	**185**	**165**	**168**	**856**
Vehicles, property & engineering equipment	**81**	**90**	**103**	**112**	**97**	**74**	**63**	**448**
Other costs within the price control	**9**	**1**	**0**	**1**	**1**	**1**	**1**	**3**
TOTAL EXPENDITURE	**1,133**	**1,394**	**1,400**	**1,393**	**1,451**	**1,370**	**1,355**	**6,968**
Indirect allocations	**-66**	**-86**	**-89**	**-90**	**-84**	**-84**	**-83**	**-429**
Totex adjustments	**-17**	**-15**	**-15**	**-16**	**-15**	**-15**	**-14**	**-74**
TOTEX (Excluding RPE & OE)	**1,050**	**1,293**	**1,296**	**1,288**	**1,352**	**1,271**	**1,258**	**6,465**
Ongoing efficiency (OE)	**0**	**-19**	**-6**	**-13**	**-20**	**-25**	**-31**	**-95**
Real Price Effects (RPE)	**0**	**62**	**38**	**49**	**65**	**73**	**84**	**309**
TOTEX (Including RPE & OE)	**1,050**	**1,336**	**1,327**	**1,324**	**1,397**	**1,319**	**1,311**	**6,679**

Figure SA-06. 6: RIIO-ED2 forecast total expenditure - WPD

West Midlands: Core expenditure forecast

West Midlands Total Expenditure								
£m at 2020/21 prices	Average per year in RIIO-ED1	Average per year in RIIO-ED2	Spend profile in RIIO ED2					Total RIIO-ED2
			2023/24	2024/25	2025/26	2026/27	2027/28	
Connections requiring reinforcement	4	9	7	8	9	9	9	44
Primary reinforcement	14	13	27	12	9	8	10	66
Secondary reinforcement	11	24	20	23	28	25	24	120
Fault level reinforcement	2	2	2	1	1	2	3	10
New transmission capacity charges	0	1	0	0	0	1	1	3
Reinforcement of the network	**31**	**48**	**57**	**45**	**48**	**46**	**47**	**242**
Diversions	10	13	13	13	13	12	12	64
Diversions (rail electrification)	0	0	0	0	0	0	0	0
Asset Replacement and refurbishment	65	74	61	77	80	63	89	370
Civil works driven by condition of civil items	6	5	5	5	5	5	5	27
Black Start	1	0	0	0	0	0	0	0
Legal and Safety	2	2	2	2	2	3	1	9
Quality of supply	2	1	1	1	1	1	1	5
Flood mitigation	0	0	0	0	0	0	0	1
Physical security	0	0	0	0	0	0	0	0
Rising and lateral mains	0	0	0	0	0	0	0	1
Overhead line clearances	4	6	6	6	7	5	5	29
Worst served customers	0	0	0	0	0	0	0	2
Visual amenity and undergrounding in National Parks and Areas of Natural Beauty	0	0	0	0	0	0	0	2
Losses	1	0	0	0	0	0	0	1
Environmental activities	1	2	3	3	2	0	0	9
Non Load network investment	**92**	**104**	**93**	**108**	**111**	**93**	**116**	**521**
Faults	33	25	25	25	25	24	24	123
Severe weather: 1 in 20	1	2	2	2	2	2	2	9
Occurrences Not Incentivised (ONIs)	9	9	9	9	9	9	9	45
Tree cutting	15	12	12	13	13	12	12	61
Inspections, Repairs and Maintenance	14	14	14	14	14	14	14	68
Supporting the UK Smart Meter roll out	2	1	3	2	0	0	0	5
Other network operating costs	2	2	2	2	2	2	2	11
Network operating costs	**75**	**65**	**67**	**67**	**64**	**63**	**63**	**324**
High value projects	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Engineering management	**73**	**78**	**82**	**78**	**77**	**77**	**76**	**390**
Corporate activities	**15**	**18**	**18**	**18**	**18**	**18**	**18**	**90**
Workforce resilience	**8**	**8**	**8**	**8**	**8**	**8**	**7**	**38**
Information Technology (IT) and Telecoms costs	**24**	**47**	**48**	**45**	**50**	**44**	**45**	**233**
Vehicles, property & engineering equipment	**22**	**23**	**27**	**28**	**22**	**21**	**19**	**115**
Other costs within the price control	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
TOTAL EXPENDITURE	**344**	**391**	**399**	**396**	**398**	**370**	**391**	**1,954**
Indirect allocations	**-20**	**-27**	**-32**	**-27**	**-25**	**-26**	**-24**	**-134**
Totex adjustments	**-4**	**-3**	**-3**	**-3**	**-3**	**-3**	**-3**	**-15**
TOTEX (Excluding RPE & OE)	**320**	**361**	**364**	**366**	**370**	**341**	**364**	**1,804**
Ongoing efficiency (OE)	**0**	**-5**	**-2**	**-4**	**-5**	**-7**	**-9**	**-27**
Real Price Effects (RPE)	**0**	**17**	**11**	**14**	**18**	**20**	**24**	**86**
TOTEX (Including RPE & OE)	**320**	**373**	**373**	**376**	**382**	**354**	**380**	**1,864**

Figure SA-06. 7: RIIO-ED2 forecast total expenditure - WMID

East Midlands: Core expenditure forecast

East Midlands Total Expenditure								
£m at 2020/21 prices	Average per year in RIIO-ED1	Average per year in RIIO-ED2	Spend profile in RIIO ED2					Total RIIO-ED2
			2023/24	2024/25	2025/26	2026/27	2027/28	
Connections requiring reinforcement	17	25	22	24	25	29	22	123
Primary reinforcement	10	11	17	9	9	13	9	57
Secondary reinforcement	10	20	17	20	23	21	20	101
Fault level reinforcement	2	7	10	11	12	3	1	36
New transmission capacity charges	0	1	0	1	1	2	2	6
Reinforcement of the network	**39**	**65**	**66**	**64**	**70**	**69**	**54**	**323**
Diversions	13	16	16	17	17	16	16	82
Diversions (rail electrification)	0	0	0	0	0	0	0	0
Asset Replacement and refurbishment	60	68	68	67	69	71	65	341
Civil works driven by condition of civil items	4	4	4	4	4	4	4	20
Black Start	2	0	0	0	0	0	0	0
Legal and Safety	2	1	1	1	1	1	3	7
Quality of supply	2	2	2	2	2	2	2	8
Flood mitigation	0	1	1	1	1	1	1	6
Physical security	0	0	0	0	0	0	0	0
Rising and lateral mains	0	0	0	0	0	0	0	1
Overhead line clearances	4	3	4	4	4	3	3	17
Worst served customers	0	0	0	0	0	0	0	0
Visual amenity and undergrounding in National Parks and Areas of Natural Beauty	0	0	0	0	0	0	0	1
Losses	0	0	0	0	0	0	0	1
Environmental activities	1	2	2	2	2	0	0	8
Non Load network investment	**88**	**98**	**99**	**98**	**100**	**100**	**95**	**492**
Faults	35	28	29	29	28	28	28	142
Severe weather: 1 in 20	1	2	2	2	2	2	2	9
Occurrences Not Incentivised (ONIs)	7	7	7	7	7	7	7	34
Tree cutting	12	12	12	13	12	12	12	61
Inspections, Repairs and Maintenance	13	14	14	14	14	14	14	71
Supporting the UK Smart Meter roll out	3	1	3	2	0	0	0	5
Other network operating costs	3	4	4	4	4	4	4	19
Network operating costs	**73**	**68**	**71**	**71**	**67**	**67**	**67**	**342**
High value projects	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Engineering management	**72**	**79**	**76**	**80**	**79**	**80**	**81**	**397**
Corporate activities	**15**	**18**	**18**	**18**	**18**	**18**	**18**	**89**
Workforce resilience	**9**	**10**	**9**	**10**	**10**	**11**	**11**	**51**
Information Technology (IT) and Telecoms costs	**23**	**52**	**52**	**49**	**56**	**50**	**51**	**258**
Vehicles, property & engineering equipment	**22**	**26**	**28**	**31**	**27**	**23**	**20**	**128**
Other costs within the price control	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
TOTAL EXPENDITURE	**343**	**416**	**419**	**420**	**427**	**418**	**397**	**2,080**
Indirect allocations	**-20**	**-32**	**-27**	**-33**	**-32**	**-32**	**-34**	**-159**
Totex adjustments	**-5**	**-5**	**-5**	**-5**	**-5**	**-5**	**-4**	**-23**
TOTEX (Excluding RPE & OE)	**318**	**380**	**386**	**382**	**391**	**381**	**359**	**1,899**
Ongoing efficiency (OE)	**0**	**-6**	**-2**	**-4**	**-6**	**-8**	**-9**	**-28**
Real Price Effects (RPE)	**0**	**18**	**11**	**15**	**19**	**22**	**24**	**91**
TOTEX (Including RPE & OE)	**318**	**392**	**396**	**393**	**404**	**395**	**374**	**1,962**

Figure SA-06. 8: RIIO-ED2 forecast total expenditure - EMID

South Wales: Core expenditure forecast

South Wales Total Expenditure								
£m at 2020/21 prices	Average per year in RIIO-ED1	Average per year in RIIO-ED2	Spend profile in RIIO ED2					Total RIIO-ED2
			2023/24	2024/25	2025/26	2026/27	2027/28	
Connections requiring reinforcement	1	6	5	5	6	6	6	28
Primary reinforcement	4	12	14	11	14	16	4	59
Secondary reinforcement	3	14	9	11	15	15	21	70
Fault level reinforcement	0	1	2	0	0	0	0	3
New transmission capacity charges	0	1	0	0	0	0	4	5
Reinforcement of the network	**8**	**33**	**30**	**28**	**35**	**36**	**35**	**164**
Diversions	5	6	6	7	6	6	6	31
Diversions (rail electrification)	0	0	0	0	0	0	0	0
Asset Replacement and refurbishment	37	41	42	40	47	38	37	204
Civil works driven by condition of civil items	2	2	2	2	2	2	2	11
Black Start	1	0	0	0	0	0	0	0
Legal and Safety	1	2	2	3	2	2	2	12
Quality of supply	1	0	0	0	0	0	0	1
Flood mitigation	0	0	0	0	1	0	1	2
Physical security	0	0	0	0	0	0	0	0
Rising and lateral mains	0	0	0	0	0	0	0	1
Overhead line clearances	3	4	4	4	4	3	3	18
Worst served customers	0	0	0	0	0	0	0	2
Visual amenity and undergrounding in National Parks and Areas of Natural Beauty	0	0	0	0	0	0	0	1
Losses	0	0	0	0	0	0	0	1
Environmental activities	1	1	1	1	1	0	0	4
Non Load network investment	**52**	**58**	**60**	**59**	**64**	**53**	**52**	**288**
Faults	12	11	11	11	11	11	11	54
Severe weather: 1 in 20	0	1	1	1	1	1	1	5
Occurrences Not Incentivised (ONIs)	3	3	3	3	3	3	3	17
Tree cutting	9	10	10	10	11	10	10	50
Inspections, Repairs and Maintenance	8	8	9	9	8	8	8	42
Supporting the UK Smart Meter roll out	1	1	2	1	0	0	0	3
Other network operating costs	1	2	2	2	1	1	1	8
Network operating costs	**35**	**36**	**37**	**37**	**36**	**35**	**35**	**179**
High value projects	**0**	**6**	**0**	**0**	**10**	**10**	**10**	**30**
Engineering management	**34**	**38**	**38**	**38**	**37**	**38**	**38**	**188**
Corporate activities	**8**	**9**	**9**	**9**	**9**	**9**	**9**	**45**
Workforce resilience	**6**	**5**	**5**	**5**	**5**	**5**	**5**	**27**
Information Technology (IT) and Telecoms costs	**12**	**30**	**30**	**29**	**33**	**29**	**30**	**151**
Vehicles, property & engineering equipment	**16**	**16**	**21**	**20**	**17**	**11**	**9**	**78**
Other costs within the price control	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL EXPENDITURE	**172**	**230**	**230**	**225**	**247**	**227**	**224**	**1,151**
Indirect allocations	**-11**	**-11**	**-12**	**-12**	**-11**	**-11**	**-11**	**-57**
Totex adjustments	**-3**	**-3**	**-3**	**-3**	**-3**	**-3**	**-3**	**-14**
TOTEX (Excluding RPE & OE)	**158**	**216**	**215**	**210**	**233**	**213**	**210**	**1,080**
Ongoing efficiency (OE)	**0**	**-3**	**-1**	**-2**	**-3**	**-4**	**-5**	**-16**
Real Price Effects (RPE)	**0**	**10**	**6**	**8**	**11**	**12**	**14**	**52**
TOTEX (Including RPE & OE)	**158**	**223**	**220**	**216**	**240**	**221**	**219**	**1,116**

Figure SA-06. 9: RIIO-ED2 forecast total expenditure – SWALES

South West: Core expenditure forecast

South West Total Expenditure								
£m at 2020/21 prices	Average per year in RIIO-ED1	Average per year in RIIO-ED2	Spend profile in RIIO ED2					Total RIIO-ED2
			2023/24	2024/25	2025/26	2026/27	2027/28	
Connections requiring reinforcement	3	8	7	7	8	9	9	41
Primary reinforcement	6	16	17	10	24	17	10	79
Secondary reinforcement	3	17	11	14	18	20	21	83
Fault level reinforcement	1	2	4	3	3	0	0	11
New transmission capacity charges	0	1	0	0	0	0	4	4
Reinforcement of the network	**13**	**43**	**39**	**34**	**54**	**46**	**44**	**217**
Diversions	11	14	14	14	14	14	14	68
Diversions (rail electrification)	1	0	0	0	0	0	0	0
Asset Replacement and refurbishment	60	73	69	68	72	78	76	363
Civil works driven by condition of civil items	2	2	2	2	2	2	2	10
Black Start	1	0	0	0	0	0	0	0
Legal and Safety	1	3	3	3	4	3	3	16
Quality of supply	1	2	2	2	2	2	2	12
Flood mitigation	0	0	0	0	1	0	0	2
Physical security	0	0	0	0	0	0	0	0
Rising and lateral mains	0	0	0	0	0	0	0	0
Overhead line clearances	8	12	11	11	14	12	10	58
Worst served customers	0	0	0	0	0	0	0	1
Visual amenity and undergrounding in National Parks and Areas of Natural Beauty	0	0	0	0	0	0	0	2
Losses	0	0	0	0	0	0	0	1
Environmental activities	1	2	3	3	2	0	0	8
Non Load network investment	**88**	**108**	**104**	**105**	**112**	**112**	**108**	**541**
Faults	24	22	22	22	22	21	21	108
Severe weather: 1 in 20	0	2	2	2	2	2	2	8
Occurrences Not Incentivised (ONIs)	5	5	5	5	5	5	5	27
Tree cutting	14	15	15	15	15	15	15	74
Inspections, Repairs and Maintenance	10	11	11	11	11	11	11	54
Supporting the UK Smart Meter roll out	1	1	2	1	0	0	0	3
Other network operating costs	3	3	3	3	3	3	2	15
Network operating costs	**58**	**58**	**60**	**59**	**57**	**57**	**56**	**289**
High value projects	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Engineering management	**52**	**56**	**56**	**56**	**55**	**56**	**55**	**278**
Corporate activities	**12**	**15**	**15**	**15**	**15**	**15**	**15**	**76**
Workforce resilience	**7**	**8**	**8**	**8**	**8**	**8**	**8**	**39**
Information Technology (IT) and Telecoms costs	**20**	**43**	**43**	**41**	**46**	**41**	**42**	**214**
Vehicles, property & engineering equipment	**21**	**25**	**28**	**34**	**32**	**20**	**15**	**127**
Other costs within the price control	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
TOTAL EXPENDITURE	**274**	**356**	**353**	**352**	**379**	**356**	**343**	**1,782**
Indirect allocations	**-15**	**-16**	**-18**	**-17**	**-16**	**-15**	**-15**	**-79**
Totex adjustments	**-5**	**-4**	**-4**	**-5**	**-4**	**-4**	**-4**	**-21**
TOTEX (Excluding RPE & OE)	**254**	**336**	**331**	**330**	**359**	**337**	**325**	**1,682**
Ongoing efficiency (OE)	**0**	**-5**	**-2**	**-3**	**-5**	**-7**	**-8**	**-25**
Real Price Effects (RPE)	**0**	**16**	**10**	**13**	**17**	**19**	**22**	**80**
TOTEX (Including RPE & OE)	**254**	**347**	**339**	**339**	**371**	**349**	**338**	**1,737**

Figure SA-06. 10: RIIO-ED2 forecast total expenditure - SWEST

3. Cost and workload forecast considerations

3.1. WPD has consistently led the way in the electricity distribution sector with a proven business model that delivers effective, efficient and reliable services for our communities. We will continue to develop and change in line with the shifting environment, most pressingly the UK's drive towards net zero. Other developments, including the move towards greater digitalisation, and the increased importance of cyber security, have also heavily influenced our plan.

3.2. Our strong business model provides the foundation for the efficient, agile and adaptive delivery of our plan.

3.3. Our expenditure plans have been developed to embed our Business Plan commitments, which are built to meet four distinct, but inter-dependent challenges for RIIO-ED2, shown in paragraph 1.4.

WPD's Best View for future network capacity requirements

3.4. We have used a wide range of sources to inform our projections for reinforcement activities. These include:

- UK government net zero aspirations and legislation, including the government's Ten Point Plan and Energy White Paper.
- Committee on Climate Change's 6th Carbon Budget.
- Welsh government net zero aspirations. – Net Zero Wales.
- Electricity System Operator – Future Energy Scenarios (ESO FES).
- Distribution Future Energy Scenarios (DFES).
- Local Area Energy Plans (LAEPs).
- ENA Common Scenario.

3.5. These sources provide a series of scenario projections which have been consolidated to inform our WPD Best View, leading to the development of comprehensive forecasts. The current WPD Best View scenario indicates that there will be significant increases in demand due to the accelerated use of low carbon technologies (LCTs). This will call for increased levels of network reinforcement in comparison to previous levels of expenditure.

3.6. Our Best View and associated costs are based on the DFES published in 2020. Our forecasting models have been compared to the scenarios Ofgem asked us to consider in the Business Plan Guidance and are favourably aligned, recognising there is a wide range of potential pathways which need to be covered by our investment plans. Within this Business Plan, the WPD Best View covers the total costs and volumes of investment we expect to be required on the network to fully deliver on government and local authority objectives. Our Best View represents the investment requirements that we propose should be funded ex-ante.

3.7. We recognise that there are numerous paths that could lead to different network reinforcement requirements and therefore we have proposed a comprehensive, but simple, set of uncertainty arrangements which span across different network reinforcement activities. These mechanisms are intended to protect customers where investment is no longer required and provide additional allowances where circumstances require more network investment to enable decarbonisation.

3.8. We acknowledge that DNOs and Ofgem have proposed a wide range of different uncertainty mechanism proposals which are being considered as part of the assessment of business plans. Our preference would be that uncertainty mechanisms are based on automatic mechanistic processes such as volume drivers wherever possible, reducing the amount of regulatory burden for both Ofgem and licensees. The uncertainty mechanisms should also recognise that the amount of reinforcement work required may differ from the WPD Best View, should government policy and customer demand lead to greater or lesser demands on the electricity network. The range in the potential levels of investment required between different future energy scenarios is too wide to be simply covered by an upfront allowance and instead will need agile symmetric uncertainty mechanisms to be set out within the price control.

3.9. This Business Plan presents the high level costs which we consider should be funded through the ex-ante allowances. It is this base Best View that is presented in all expenditure tables throughout this chapter. Comparisons between WPD's Best View and other industry scenarios can be found in Supplementary Annex SA-06a 'Load related expenditure'.

3.10. Where there is a need for uncertainty mechanisms, WPD has identified a portfolio of approaches which will enable different levels of investment to be funded when required and evidenced through measured outputs, resulting in an agile price control that can adapt to deliver the full range of forecast futures. These are discussed in Supplementary Annex SA.07 'Managing uncertainty'.

Access Significant Code Review

3.11. Ofgem is working on ongoing refinement of the charging methodology policy for connections, as part of the Access and Forward-Looking Charges Significant Code Review (Access SCR).

3.12. Following the government's legally binding decision to deliver net zero by 2050, WPD shares the ambition to deliver this at the lowest cost to customers and as early as possible. This was identified as a priority by our stakeholders during the development of our RIIO-ED2 plan. We welcome clarification on Ofgem's latest position set out in their minded-to position on the Access SCR, but recognise that a final decision is yet to be made.

3.13. Given that the final decision on Access SCR is yet to be made, Ofgem has provided a series of assumptions for identification of the cost impact of implementing the minded to position. These have been separately costed and are not included in the Totex forecasts. These costings are shown in Supplementary Annex SA-06a: Load Related Expenditure. The final cost impacts will not be known until Ofgem makes the final decision on the Access SCR. This will lead to adjustments to allowances and will be the subject of future discussions with Ofgem.

3.14. Given the significance of the potential changes, along with the timing of Ofgem's final policy decision, we are proposing an Access SCR uncertainty mechanism for RIIO-ED2 to enable us to update our Business Plan, once we have further clarity on the final Access SCR decision. WPD will work with Ofgem to develop an effective uncertainty mechanism to facilitate the inclusion of any additional outputs and recovery of any additional associated revenue in RIIO-ED2 once we have further clarity on Ofgem's final decision which is expected in 2022. Therefore, at this time, our RIIO-ED2 Totex cost forecasts have been prepared on the basis of no change.

DSO and digitisation

3.15. To meet the demands of a rapidly changing environment, we are building upon our traditional role of Distribution Network Operator (DNO) to develop Distribution System Operator (DSO)

roles and functions. The adoption of DSO functions will be essential to drive performance and efficiency from our network and ensure we can meet the future energy demands of all our customers.

3.16. Ofgem has identified three core DSO roles for RIIO-ED2: planning and network development; network operation; and market development. WPD has been developing DSO functionality in all three areas during RIIO-ED1 and we will continue to expand our capabilities further during RIIO-ED2. We commit to increase data acquisition from the network, enhance established DSO processes, develop new systems and share more data. These changes must be underpinned by greater data visibility and digitalisation of our processes and systems.

3.17. The costs and implications of carrying out DSO functions and increasing digitalisation are fully embedded across all relevant activities in this plan. These changes are a natural extension of the essential functions we already perform successfully, putting us in a strong position to fulfil the role of Distribution System Operator. The main cost impacts fall into the following areas:

- A separate management structure for DSO within WPD's existing organisational structure. This separation will allow network strategy, system operation and market development teams to make independent recommendations for network investment and create a neutral marketplace for flexibility. This functional structure is already in place, with external audit and establishment of an independent DSO scrutiny panel being implemented before RIIO-ED2 begins. The costs of this are embedded in our plan.
- More comprehensive network strategy planning processes. WPD has already committed to produce a full suite of DFES analysis each year and has been working with local authorities to understand and support Local Area Energy Plans.
- Continuation of a flexibility first approach to network reinforcement, expanding the flexibility market and supporting the provision of flexibility services.
- Enhanced data collection and greater data visibility to allow better decision making. Investment is included to ensure we have the right systems and infrastructure in place.
- Development of operational systems to meet our DSO and digitalisation objectives, which will include both enhancements to the existing applications and development of new systems to interact with the existing control systems. The main focus will be on higher network voltages, along with increased amounts of data and visibility of network operation implemented for lower voltages.
- Establishment of an Energy Management Centre to transparently and independently operate the provision of network capacity through flexibility services.
- Investment in cyber resilience and security to prevent future security breaches to the electricity distribution network through IT and OT systems, especially where these systems are expanded to increase network monitoring and control. Focus will be on updating old legacy IT and OT systems and ensuring that all systems and technologies are designed and implemented with the relevant level of cyber security controls.

Risk and asset strategy

3.18. We have an extensive network of assets across a large geographical area, providing essential supplies to 8 million customers. We are committed to keeping the network in good working order to prevent the assets failing and to ensure uninterrupted service to our customers. We regularly inspect and maintain our assets, gathering information about their condition. Where necessary, assets in poorest condition are replaced to reduce the risk of network failure.

3.19. Asset based risk considers the probability that an asset will fail (based on its condition) alongside the consequences of that failure (taking into account safety, the environment, impact on customer service and cost of rectification). The industry uses risk measures to gauge asset

health and criticality. For RIIO-ED2, these are based upon Network Asset Risk Metrics (NARMs) which allow assets to be classified into different levels of health and criticality. Those with the poorest health and highest criticality carry the greatest risk. Because every asset has its own risk value, NARMs enables us to generate an overall risk measure for all the assessed assets.

3.20. Without intervention, the overall risk to the network will increase as the network deteriorates over time. Our asset replacement actions remove higher risk assets. The resultant level of risk depends on the overall age and condition of the network. For example, a network with a lot of new assets requires less replacement activity and therefore it is acceptable to allow the risk to increase, while a network with many older poor condition assets requires more work, which could lead to a lower resultant risk. Our strategy for managing condition based risk is not about targeting a specific reduction or increase in network risk; it is about doing what is necessary to remove poor condition assets. The resultant network risk will reflect this programme and our proposals will result in network risk at the end of RIIO-ED2 being at similar levels to the start of RIIO-ED2. The NARM risk values are summarised in Figure SA-06. 11.

NARM Risk Change in RIIO-ED2					
	Start of RIIO-ED2	End of RIIO-ED2 (no interventions)	End of RIIO-ED2 (with interventions)	Risk Reduction	% age improvement
WMID	2,026,474,871	2,634,322,209	2,114,534,650	-519,787,560	20%
EMID	1,568,323,792	2,107,546,842	1,702,892,504	-404,654,338	19%
SWALES	1,070,970,887	1,417,980,616	1,055,269,033	-362,711,582	26%
SWEST	1,895,450,847	2,510,056,203	1,882,884,992	-627,171,211	25%
WPD	**6,561,220,396**	**8,669,905,870**	**6,755,581,178**	**-1,914,324,691**	**22%**

Figure SA-06. 11: NARM risk change in RIIO-ED2

3.21. To derive the NARM data, WPD has implemented and used the latest version of the industry's Common Network Asset Indices Methodology (CNAIM v2.1) and has used condition information available at 31 March 2021. This means that the latest data and most up to date methodology have been used.

Our proven delivery record

3.22. WPD's established and effective organisational structure has proven to be key to the successful delivery of excellent customer service and our work programme commitments. This in-sourced team based structure provides a great foundation for the successful delivery of our investment programmes for RIIO-ED2.

3.23. In-house regional resources is crucial to cost effective, efficient delivery. Our local staff know the area, the local network and local developments, enabling us to provide efficient, high quality customer service based on in-depth knowledge. Our organisational structure is flat, with devolved decision making and minimal bureaucracy, powering a culture that delivers innovative thinking and collaborative working. Continuing this structure and ethos is integral to our delivery model for RIIO-ED2.

Resourcing strategy

3.24. We recognise that an increased amount of activity requires increases in resources to deliver the work. Where appropriate we will seek to do so via internal resources, thus retaining knowledge and expertise. Our experience shows that having in-house specialists enables fast resolution of issues and encourages greater ownership and enthusiasm for innovative developments. As we enhance and develop our DSO functions we will require additional specialist resources to create new systems, processes and better ways of interacting with customers and flexibility providers.

3.25. There are, however, certain aspects of the increased workload where alternative approaches may be more appropriate for delivery of the work. For example, we propose to use contractor resources where there is a cost benefit for doing so, where there is some uncertainty about the volumes of activity or where different working arrangements are required. This will allow us to deal with short term increases, while determining a sustainable level of ongoing resource requirement. It will also allow us to look at alternative ways of working (e.g. weekend and out of hours working) for high volume low cost activities such as cut-out inspections and unbundling of services. More details on our plans to meet future workforce requirement can be found in our Workforce Resilience Strategy (see www.westernpower.co.uk/RIIO-ED2/workforce-resilience-strategy).

Innovation

3.26. Innovation runs through everything we do, allowing us to introduce new techniques, improve the way we operate the network and develop new services for vulnerable customers. We are continually harnessing innovative thinking to identify efficiencies and provide value for money to our customers. One of the ways we continue to innovate is to champion widespread digitalisation across our business, utilising new technology to connect customers and deliver the timely, new services.

3.27. We will continue to collaborate with third parties and will fully participate in Ofgem's Strategic Innovation Fund and Ofgem's Network Innovation Allowance. We will also support other research, development and demonstration projects, which fall outside the scope of these innovation mechanisms.

Purchasing strategy

3.28. Contract and material tendering is the most frequently used method of purchasing goods and services throughout WPD. Tenders are conducted in line with appropriate legislation by our purchasing team, which is fully embedded within the business.

3.29. Our purchasing strategy is to multi-source goods and services, not only to protect the business from the failure of a single point of supply but also to encourage competition. Where appropriate, we tender goods and services through lots which are applied across all four licence areas or split into smaller geographical areas. By using this approach, we can procure the most economically advantageous contracts that deliver best value for customers.

Regional factors

3.30. Our expenditure plans recognise regional variations in our plan where these exist and we detail these in this annex on an activity-by-activity basis.

3.31. Our approach to regional factors and the way in which they interact with cost assessment is discussed in chapter 16 of this annex (see section Regional Factors). We would expect Ofgem to recognise these differences in cost assessment, which is inherently conducted at a DNO level (not group), and make cost exclusions or adjustments as required to ensure high quality comparative assessment.

Pensions

3.32. All costs stated in this Business Plan include pension costs.

3.33. Our pensions expenditure forecasts have been prepared by AON, WPD's Actuarial adviser, based on current expectations of the outcome of the 2022 Actuarial Valuations. The distribution-related costs forecast to be incurred on ongoing pensions contributions and incremental pension deficit repair payments are allocated across all activities in Totex where labour costs are incurred. Established pension deficit repair payments are reported in the BPDT as "Other Non Activity Based Costs" (which is outside Totex). Although these total £52 million, based upon current market conditions we are not currently anticipating the requirement for any further allowances in RIIO-ED2 to cover these. This will be reviewed again as part of the 2023 Reasonableness Review. The total pension costs forecast in this Business Plan reconcile back to those provided by AON. It should be noted that the different pension schemes have scheme-specific characteristics which result in differences in the level of costs reported across our 4 DNOs. We would expect Ofgem to recognise these differences in the overall cost assessment.

3.34. Further explanation of our pensions costs are also included in Supplementary Annex SA-09 'Financing our Plan'.

Investment appraisal

3.35. Significant investments of more than £1 million in our RIIO-ED2 Business Plan have an accompanying Engineering Justification Paper (EJP) and Cost Benefit Analysis (CBA), whenever applicable. The papers outline and justify the investment need, and also provide analysis of alternative solutions that have been discounted in favour of the preferred option.

3.36. Further detail is included in Supplementary Annex SA-11 'Investment Appraisal'.

3.37. We also reference individual EJPs where applicable throughout this annex.

4. Reinforcement of the network

4.1. Load related investment is expenditure incurred when providing additional capacity on the network to facilitate new connections as well as generic load growth. This covers both demand and generation. Load-related reinforcement investment falls into four categories: connections, general reinforcement, fault level reinforcement and new transmission capacity charges.

4.2. The largest element in general reinforcement is the investment required to provide adequate capacity on the network for generic load growth (this does not relate to any individual customer or new connection).

4.3. General reinforcement enables WPD to fulfil its obligation to provide adequate network capacity to meet network security standards and ensure that the voltage of the network remains within statutory limits. These obligations are found in the Electricity Networks Association Engineering Recommendation for Security of Supply P2/7, which specifies the expected capability of the network to meet demands under defined outage conditions, and the Electricity Supply Quality and Continuity Regulations (ESQCR), which defines voltage limits.

4.4. General reinforcement is split into two categories: primary network reinforcement, which covers the EHV (33kV and 66kV) and 132kV networks; and secondary network reinforcement which covers the low voltage (LV) and high voltage (HV) networks

4.5. The annual expenditure in all categories is forecast to increase during RIIO-ED2, as summarised in Figure SA-06. 12, despite a significant increase in the use of flexibility to offset traditional reinforcement.

4.6. Reinforcement in our Best View scenario will increase from 8% of Totex (average in RIIO-ED1) to 14% in RIIO-ED2.

Reinforcement of the network					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	31	39	8	13	91
RIIO-ED2 Annual Average (forecast)	48	65	33	43	189
RIIO-ED2 Total (5 years)	242	323	164	217	946

Figure SA-06. 12: RIIO-ED2 forecast expenditure – reinforcement of the network

4.7. The main driver for higher load-related expenditure is the government's 2050 net zero target, which is powering significant growth in low carbon technologies, including electric vehicles, heat pumps, storage and distributed generation. This is exacerbated by the ambitious local development plans of many local authorities in our regions which feature commercial, industrial and housing developments.

4.8. To ensure we meet these demands, we have used numerous data sources, including national forecasts of growth by the Electricity System Operator and local information about regional aspirations, to establish our WPD Best View of anticipated future network loads and constraints.

4.9. Our expenditure forecasts also include agreed costs for green recovery investment, most of which falls in the last two years of RIIO-ED1, with a proportion falling into the early part of RIIO-ED2.

4.10. Supplementary Annex SA-06a 'Load Related Expenditure' provides more detail on our primary network and secondary network reinforcement plans.

Our forecasting approach

4.11. The WPD Best View was created using the Distribution Future Energy Scenarios (DFES) for each licence area, which capture the growth projections for different technologies in the next 15 years. The DFES framework follows four scenarios aligned to the National Grid Future Energy Scenarios framework. This accounts for the growth of:

- Low carbon technologies including electric vehicles and heat pumps.
- Distributed generation and storage technologies to further exploit the UK's renewable energy potential.
- 'Conventional' demand, including new domestic, industrial and commercial developments as outlined in local plans.

4.12. Each technology type has been given an electrical profile to plot the expected impact on the WPD network. The profiles were compiled using metering data for existing customers and synthesised data from innovation project trials, led by various DNOs. This data is published in our Distribution Future Energy Scenarios – Customer Behaviour report.

4.13. The forecasting process produces a set of growth rates, which are overlaid on to a power system model of the primary network to identify which areas of the network need reinforcement during RIIO-ED2, and when this would need to happen. The growth data is then disaggregated down to the LV and HV network level and loaded into a network modelling tool, known as the Network Investment Forecasting Tool (NIFT), specifically developed for WPD by EATL to identify the LV and HV network reinforcement requirements. NIFT incorporates a model of WPD's LV feeders and HV transformers using WPD asset and geographic data. It maps the forecast localised demand and distributed energy resource growth from the WPD Best View scenario on to these simulated networks to identify where and when additional capacity will be required.

4.14. The WPD Best View covers the total costs and volumes of investment we expect to be required on the network to fully deliver on government and local authority objectives. This investment has informed the baseline Totex forecast that is presented throughout this annex.

Flexibility

4.15. We have made significant progress to make use of flexibility services to manage demand in real time to avoid the need for costly reinforcement, where possible. This includes local management of generation output, load and power flows.

4.16. We anticipate that the use of flexibility will further increase during RIIO-ED2 although it is not expected that the market will be able to provide services to match all constraints. Our flexibility first approach means that, for all reinforcement issues, we consider whether flexibility is a credible option to address network issues and avoid or defer reinforcement.

4.17. We have identified 58 potential schemes (of 192 on the initial reinforcement list, and including connections driven reinforcement) where we anticipate that flexibility will defer the conventional reinforcement beyond the RIIO-ED2 period. We will deliver savings of £94 million through flexibility by avoiding load related expenditure otherwise anticipated within the Best View. Additional flexibility will be sought from the market to increase these savings if they become economic in the price control.

Provision of connections

Introduction

4.18. Customers who require a new or increased (augmented) electricity supply need to obtain a new or larger connection to the network. This may require new assets that will be exclusively used by the customer (sole use assets) and may also require the capacity of the existing network to be increased (reinforcement).

4.19. When a customer requests a connection, WPD carries out the network design, calculates the associated costs and provides a connection quotation. Once the customer accepts the quotation, the work is organised and dates are agreed with the customer. All aspects of the process are subject to Ofgem Guaranteed Standards of Performance and WPD strives to achieve zero failures against these guarantees.

Connections categories

4.20. There are three main types of connections:

- demand;
- distributed generation (DG);
- unmetered

4.21. Demand connections are provided for customers who consume electricity.

4.22. Distributed generation connections are provided where the predominant use of the connection is the export of electricity or where an existing connection has to be augmented to enable the export of electricity. This category does not include new demand connections that also have an element of generation export, e.g. a new property fitted with a PV installation is a demand connection, not a DG connection.

4.23. Unmetered connections are provided to local authorities and developers for low power consumption equipment of a predictable nature such as street lights and traffic lights.

Competition in connections

4.24. Historically, DNOs were the only organisations that could provide a connection but the opening up of the connections market to third party providers has led to increased competition in the provision of connections.

4.25. Over the last 20 years, there has been an increase in the number of third party providers carrying out connections work, with customers now able to appoint an Independent Connection Provider to either construct the network and:

- pass on ownership of that network to DNOs; or
- pass on ownership of that network to Independent Distribution Network Operators (IDNOs) who take on responsibility for the maintenance and operation of the networks.

4.26. Third party providers have the freedom to elect whether or not to accept connections work, but under the Electricity Act 1989, DNOs are obliged to provide a connection if asked to do so. This has resulted in competition for larger developments but negligible competitive activity for smaller schemes or one-off small value connections.

4.27. Third parties can only carry out work that is deemed to be contestable (open to competition).

4.28. The majority of works at all voltages is now contestable. An area we might see a change is in the level of contestable design. With the proposal to increase open data, we may see ICPs looking to determine PoC at EHV for both demand and generation. WPD will continue to co-operate with third parties and develop processes to facilitate any future changes to contestability.

Expenditure summary

4.29. Figure SA-06. 13 provides a summary of the costs for each type of connection:

Connections expenditure (by connection type) - Total RIIO-ED2 (£m)					
	West Midlands	East Midlands	South Wales	South West	WPD Total
Demand connections	184	294	74	135	687
DG connections	34	40	46	30	150
Unmetered connections	4	3	3	3	12
Total connections expenditure	**222**	**336**	**123**	**168**	**849**

Figure SA-06. 13: RIIO-ED2 forecast expenditure – connections

4.30. The cost for each category can be subdivided into sole use costs and costs for network reinforcement.

4.31. Sole use costs are treated as being outside the price control (i.e. outside Totex) as they are fully funded by the customer requesting the connection.

4.32. Reinforcement costs are considered as part as the price control because a proportion of the costs are funded through DUoS. The part of reinforcement funded by connection customers is determined by comparing the capacity required specifically for the customer against the overall capacity provided by the reinforcement. The methods for calculating this proportion, which is called the Cost Apportionment Factor (CAF), are defined within Connections Charging Statements published by each DNO. The remainder of the costs for reinforcement are funded through DUoS.

4.33. This treatment of costs create three main cost categories:

- Sole use costs.
- Customer funded reinforcement.
- DUoS funded reinforcement.

4.34. Figure SA-06. 14 and Figure SA-06. 15 and show how the costs for demand connections and DG connections are split across these cost categories. All unmetered connections are sole use connections only.

Demand connections expenditure - Total RIIO-ED2 (£m)					
	West Midlands	East Midlands	South Wales	South West	WPD Total
Sole use	123	146	57	88	414
Customer funded reinforcement	20	25	5	14	64
DUoS funded reinforcement	41	122	12	33	208
Total demand connections expenditure	**184**	**294**	**74**	**135**	**687**

Figure SA-06. 14: RIIO-ED2 forecast expenditure – demand connections

DG connections expenditure - Total RIIO-ED2 (£m)					
	West Midlands	East Midlands	South Wales	South West	WPD Total
Sole use	16	28	15	11	69
Customer funded reinforcement	4	1	10	4	20
DUoS funded reinforcement	15	11	21	15	62
Total DG connections expenditure	**34**	**40**	**46**	**30**	**150**

Figure SA-06. 15: RIIO-ED2 forecast expenditure – DG connections

4.35. Figure SA-06. 16 summarises the DUoS funded expenditure (for demand connections and DG connections) and illustrates that this equates to approximately 32% of total connection costs across WPD.

DUoS expenditure - Total RIIO-ED2 (£m)					
	West Midlands	East Midlands	South Wales	South West	WPD Total
Total DUoS funded expenditure	56	133	33	49	270
%age of total connections expenditure	25%	40%	27%	29%	32%

Figure SA-06. 16: RIIO-ED2 forecast DUoS funded expenditure

4.36. Figure SA-06. 17 reconciles the connections costs presented in this section to the Connections costs inside the price control presented in section 2 of this annex. Connections inside the price control is the total of DUoS funded reinforcement and customer funded reinforcement (net of contributions, but before indirect allocations) for both DG connections and demand connections.

Connections inside the price control - Total RIIO-Ed2 (£m)					
	West Midlands	East Midlands	South Wales	South West	WPD Total
Duos funded expenditure	56	133	33	49	270
Customer funded expenditure - direct cost	24	27	16	18	84
Customer funded expenditure - contributions	-37	-37	-21	-25	-120
Connections inside the price control	44	123	28	41	235

Figure SA-06. 17: Connections inside the price control

4.37. Our IT plans include investment in LV Monitoring and smart meter data. We forecast that this will defer over £28 million of connections reinforcement investment, which is therefore excluded from this forecast. More detail on this investment is provided in EJP 109.

4.38. We expect that the proposed changes under the Significant Code Review will impact Connections costs. However, at this time Connections has currently been forecast on the basis of no change to charging arrangements in our baseline forecast.

Forecasts

4.39. The forecast of future expenditure has been carried out by assessing requirements within different market segments and built up from our DFES data. For each market segment we have considered:

- The volumes of connections;
- The growth in work that is contestable;
- The proportion of projects delivered by third party providers;
- The proportion of projects that require reinforcement;
- The impact of LCTs on connection costs.

Market segments used in the forecast

4.40. Connections have been categorised into segments that are dependent on the voltage of the connection, the highest voltage being worked on, the size of the development and whether it is for demand, generation or an unmetered supply. The segments used are based on regulatory reporting segments, which are more disaggregated than the market segments used for the regulatory Competition Test.

4.41. The segments used for demand connections align with regulatory reporting categories and are:

- LVSSA – Single domestic connections with no mains work at low voltage (LV).
- LVSSB – 2 to 4 domestic connections or one-off 3ph commercial connections at LV.
- LVAL - All other LV (with only LV work).
- LVHV - LV end connections involving high voltage (HV) work.
- HVHV - HV end connections involving only HV work.
- LVEHV - LV end connections involving extra high voltage (EHV) work.
- HVEHV - HV end connections involving EHV work.
- EHV - EHV end connections involving only EHV work.
- HV132 - HV or EHV connections involving 132kV work.
- 132kV - 132kV end connections involving only 132kV work.
- SOCREF – Socialised Reinforcement.

4.42. The total project costs for each demand segments are shown in Figure SA-06. 18, illustrating that the majority of expenditure is on LVAL, LVHV and HVHV connections.

Demand connections expenditure in RIIO-ED2 (£m)					
	West Midlands	East Midlands	South Wales	South West	WPD Total
LVSSA	8	8	4	8	28
LVSSB	13	17	5	11	46
LVAL	41	52	22	26	141
LVHV	68	100	29	61	258
HVHV	35	47	11	16	109
LVEHV	0	0	0	0	0
HVEHV	6	22	0	8	36
EHVEHV	3	2	0	1	6
HV132	0	35	0	0	35
132kV	0	0	0	0	0
SOCREF	10	11	3	5	28
TOTAL	**184**	**294**	**74**	**135**	**687**

Figure SA-06. 18: RIIO-ED2 forecast expenditure – demand connections by segment

4.43. The segments used for DG connections are based on regulatory reporting requirements, but the category for HV work has been subdivided further to differentiate between LV DG connections with HV work and HV DG connections with HV work. The full list of categories used for DG connections is:

- DGLV – DG connections involving LV work only.
- DGHV – DG connections requiring work at HV.
- DGEHV – DG connections requiring EHV work.
- DG132 – DG connections requiring 132kV work.

4.44. The total project costs for each DG segment are shown in Figure SA-06. 19, illustrating that the majority of expenditure is on HV, EHV & 132kV connections.

DG connections expenditure in RIIO-ED2 (£m)					
	West Midlands	East Midlands	South Wales	South West	WPD Total
DGLV	0	0	0	0	0
DGHV	3	3	1	2	9
DGEHV	12	12	10	5	39
DG132	18	25	35	24	102
TOTAL	**34**	**40**	**46**	**30**	**150**

Figure SA-06. 19: RIIO-ED2 forecast expenditure – DG connections by segment

4.45. The segments used for unmetered connections are:

- UMLA – unmetered local authority;
- PFI – unmetered connections for private finance initiatives;
- OUMC – other unmetered connections.

4.46. The total project costs for each unmetered segment are shown in Figure SA-06. 20, illustrating that the expenditure is evenly spread between unmetered local authority connections and other unmetered connections.

Unmetered connections expenditure in RIIO-ED2 (£m)					
	West Midlands	East Midlands	South Wales	South West	WPD Total
UMLA	2	1	1	1	5
PFI	0	0	0	0	0
OUMC	2	2	1	1	6
TOTAL	**4**	**3**	**3**	**3**	**12**

Figure SA-06. 20: RIIO-ED2 forecast expenditure – unmetered connections by segment

Future connections activity

Demand connections

4.47. The volume of connections varies each year and is dependent upon various factors including economic strength, attitude of developers and government incentives.

4.48. The connections volume forecasting has been informed by the Distribution Future Energy Scenarios studies and the WPD Best View analysis which was undertaken for RIIO-ED2. The projections for the number of domestic and non-domestic connections have been mapped to an expected number of connections on the WPD network, using historical data to account for competition in connections. The projections for the number of connected distributed generation customers by connections voltage and market segment has been inferred using information about existing customers connected to the WPD network. LCT projections align with the Regulatory Reporting submissions for RIIO-ED1, and project a number of expected connections as a result of the installation of electric vehicle chargers which require a modification to a customer's existing connection.

4.49. The charts in Figure SA-06. 21 show the market volumes relative to 2020 for segments involving LV and HV work. These growths are based upon the following assumptions:

- Housing development is forecast is to reduce slightly during the RIIO-ED2 period. This reduction is likely to impact LVAL and LVHV market segments primarily. There will be a lesser reduction in LVSSB. LVSSA is forecast to remain reasonably unaffected.
- Commercial and industrial connections at HV requiring HV work (HVHV) will be constant until 2028.
- The number of connections relating to electric vehicle charge points will greatly increase through the RIIO-ED2 period as the number of electric vehicles grows each year. This increase can been seen in market segments LVSSB, LVAL, LVHV and HVHV. The larger increases will be seen in West Midlands, East Midlands and South West. South Wales will also see an increase but at a lower rate.
- The increase in LVSSB market segment will be a mixture of new and augmented supplies comprising mainly of service upgrades.
- The increase in LVAL and HVHV will mainly be due to new connections and larger charge point installations. The increase in LVAL due to electric vehicle charge points will be partly offset by increased competition from third parties.
- The reduction in LVHV market segment is driven by increased competition from third parties which will offset the increased number of connections due to electric vehicle charge points.
- We expect that the proposed changes under the Significant Code Review will impact volumes but we have currently forecast on the basis of no change to charging arrangements.

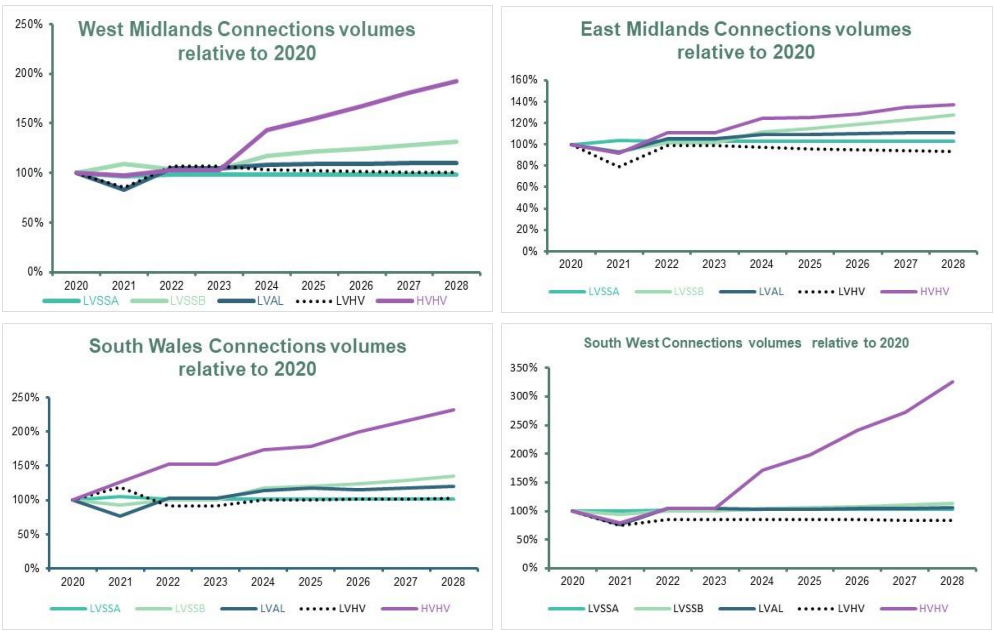


Figure SA-06. 21: Market volumes relative to 2020 for segments involving LV and HV work

4.50. Connection volume growth across the four licence areas will vary slightly in total but individual market segments will vary considerably, mostly due to the increase of EV charge points and heat pumps. Figure SA-06. 22 illustrates the growth in volumes comparing 2028 to 2020.

Growth In Demand Connections Comparing 2028 to 2020 RIIO-ED2				
	West Midlands	East Midlands	South Wales	South West
Demand Connections	10%	8%	16%	1%

Figure SA-06. 22: Market volumes relative to 2020 for segments involving LV and HV work

4.51. Demand connection volumes will be very low on EHV and 132kV networks and the following assumptions have been used for the entire RIIO-ED2 period:

- LVEHV - no volumes are forecast in this segment.
- HVEHV – the majority of connections will be in East and West Midlands.
- EHV – East Midlands is forecast to see the majority of connections spread across the period.
- HV132 - East Midlands is forecast to see the majority of connections.
- 132kV – No connections are forecast at 132kV for demand connections.

4.52. Figure SA-06. 23 shows the total forecast volume of demand connections (exit points) across RIIO-ED2:

Forecast number of demand connections projects in RIIO-ED2					
	West Midlands	East Midlands	South Wales	South West	WPD Total
LVSSA	6,365	6,670	3,525	8,355	24,915
LVSSB	8,556	10,914	4,151	8,044	31,665
LVAL	31,742	36,131	18,219	25,507	111,599
LVHV	13,795	16,677	6,370	13,043	49,885
HVHV	923	780	190	471	2,364
LVEHV	0	0	0	0	0
HVEHV	25	50	0	5	80
HV132	1	10	0	5	16
EHVEHV	0	10	0	0	10
132kV	0	0	0	0	0
TOTAL	**61,407**	**71,242**	**32,455**	**55,430**	**220,534**

Figure SA-06. 23: Forecast number of demand connection projects in RIIO-ED2

Distributed generation connections

4.53. Distribution Future Energy Scenarios studies show a high take-up of domestic PV installations. These will be installed on a 'fit and report' basis; it is assumed that none will require a new DG connection. Domestic PV installations associated with new housing developments will be accommodated within the connection charges for the domestic development.

4.54. The collective effect of connecting these could give rise to the need for network reinforcement or installation of voltage regulation equipment. The costs for this are captured within general network reinforcement expenditure.

4.55. LV DG connection volumes are primarily derived from forecasts of non-domestic PV installations which will show little change during RIIO-ED2 (volumes still remain relatively low). Other technology types make up a very small number of the total DGLV connections forecast.

4.56. Figure SA-06. 24 illustrates the forecast volumes for HV DG connections compared to RIIO-ED1.

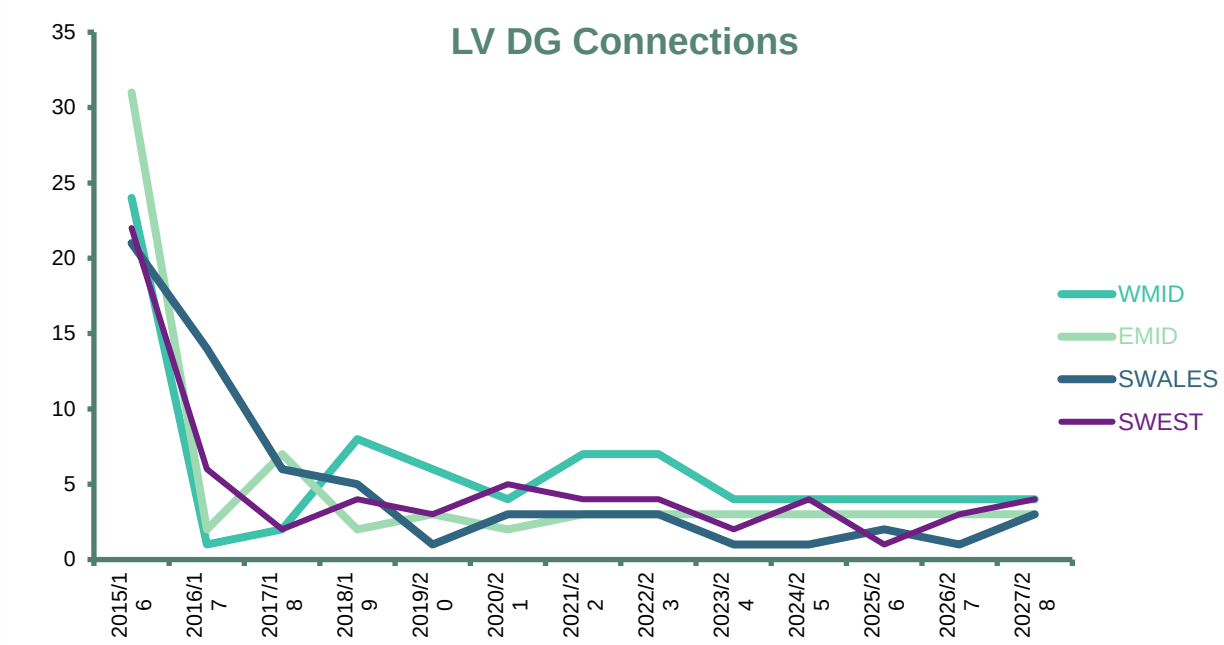


Figure SA-06. 24: LV DG connections RIIO-ED1 and RIIO-ED2

4.57. HV DG connection volumes are derived primarily from forecasts for large scale PV generation and Onshore Wind.

4.58. Figure SA-06. 25 illustrates the forecast volumes for HV DG connections compared to RIIO-ED1.

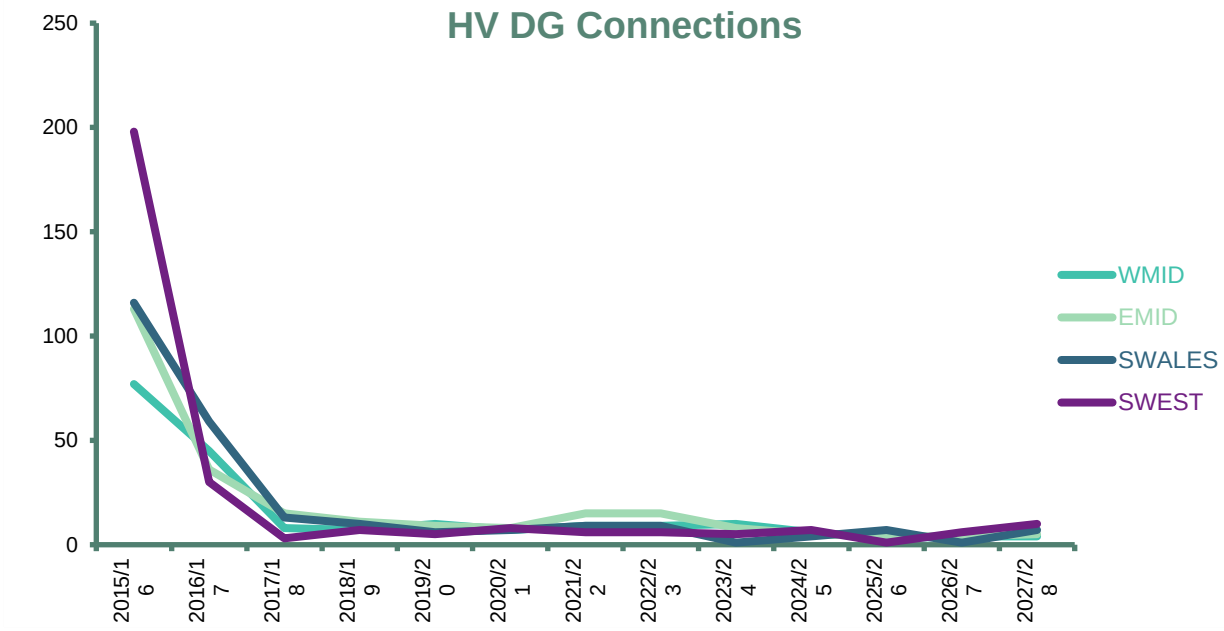


Figure SA-06. 25: HV DG connections RIIO-ED1 and RIIO-ED2

4.59. EHV DG connections are derived from storage (battery) PV generation and Onshore Wind.

4.60. Figure SA-06. 26 illustrates the forecast volumes for EHV DG connections compared to RIIO-ED1.

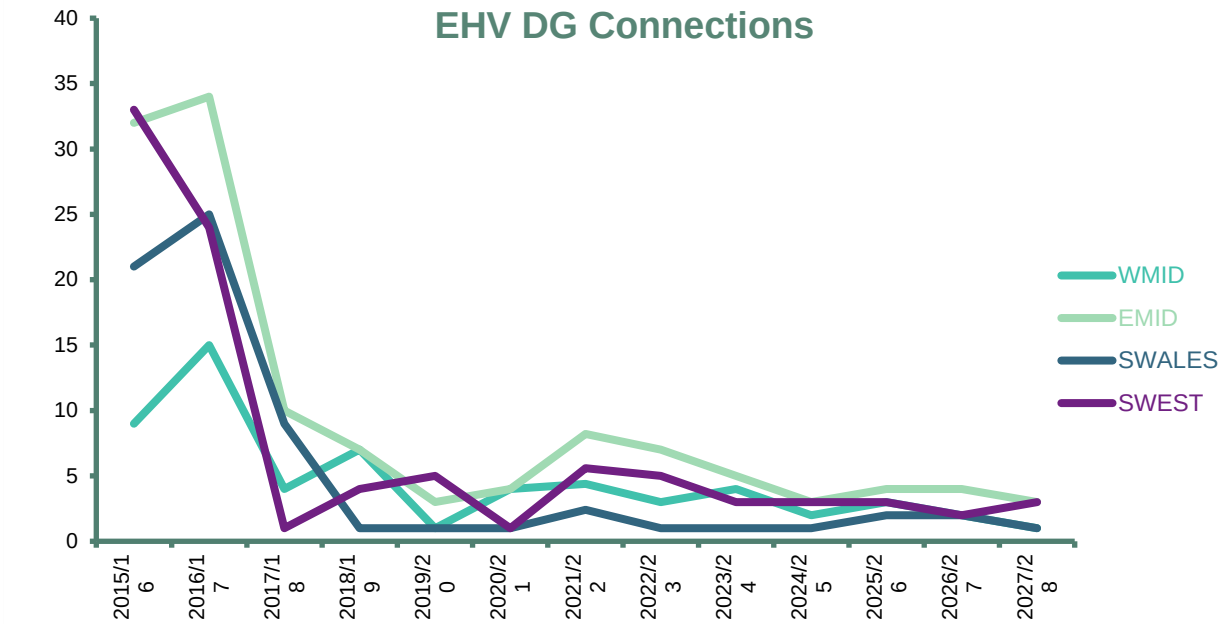


Figure SA-06. 26: EHV DG connections RIIO-ED1 and RIIO-ED2

4.61. There are a relatively low volume of DG connection projects at 132kV although East Midlands will see an increase in volume across the RIIO-ED2 period. This increase is driven by predominantly by large PV installations.

4.62. Figure SA-06. 27 illustrates the forecast volumes for 132kV DG Connections compared to RIIO-ED1.

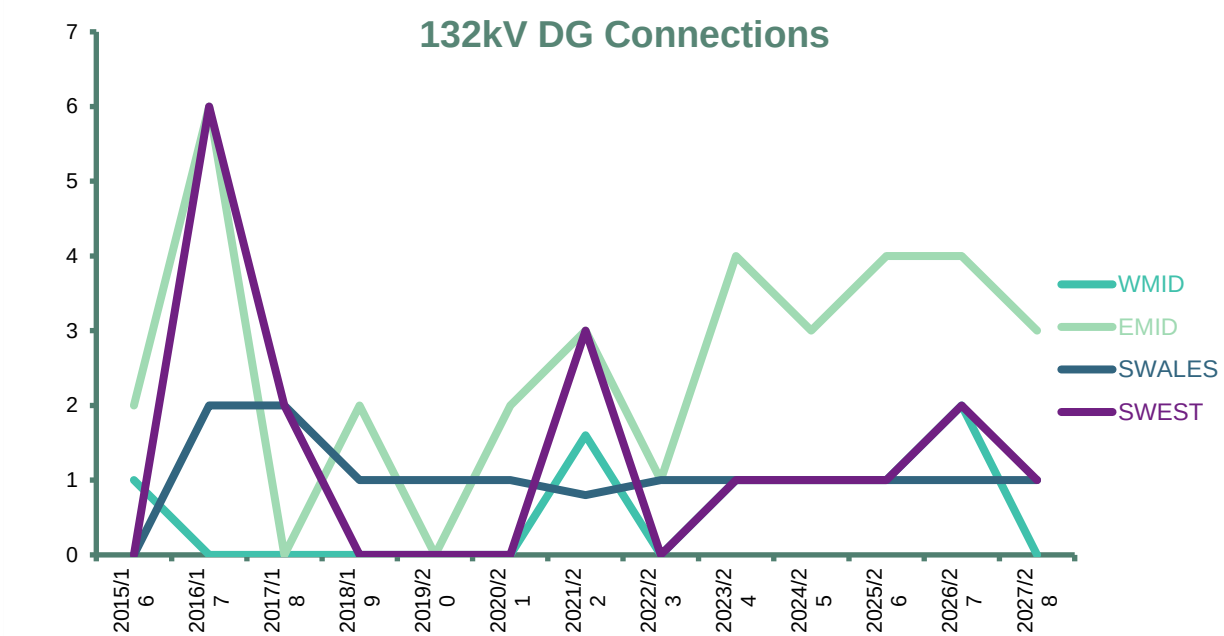


Figure SA-06. 27: 132kV DG connections RIIO-ED1 and RIIO-ED2

Forecast number of DG connections projects in RIIO-ED2					
	West Midlands	East Midlands	South Wales	South West	WPD Total
DGLV	20	15	8	14	57
DGHV	27	26	20	29	102
DGEHV	12	19	7	14	52
DG132	5	18	5	6	34
TOTAL	**64**	**78**	**40**	**63**	**245**

Figure SA-06. 28: shows the forecast volume of DG connections in RIIO-ED2

Market share lost to third parties

4.63. Third parties are most active in the LVAL, LVHV and HVHV segments providing connections for medium to large domestic estates and commercial/industrial developments. Competition has been well established in the Midlands areas for a number of years. Consequently, this is where there is the most competitive activity. Third parties have expanded into South West and to a lesser degree in South Wales more recently.

4.64. It has been assumed that third party providers will continue to increase or retain their market share in the segments where they are active, albeit it at a slower rate in the Midlands.

4.65. Market share changes for demand connection projects carried out by third party providers at 2020 and projected to 2028 are summarised in Figure SA-06. 29. For all other market segments, we have assumed no significant change to market share.

Proportion of demand end connections provided by third parties (RIIO-ED2)				
	West Midlands	East Midlands	South Wales	South West
	Increase from 60% to 70%	Increase from 63% to 70%	Increase from 26% to 30%	Increase from 44% to 50%

Figure SA-06. 29: Proportion of demand end connections provided by third parties, RIIO-ED2

4.66. Third parties providers have been very active in the DG connections market for connections involving EHV and 132kV work and our forecasts suggest that their market share will remain high. Whilst there are reasonable % changes both up and down the volumes are low so a small change in volumes results in what seems like a large % change. The proportions carried out by third parties during RIIO-ED1 and for forecast for RIIO-ED2 are shown in Figure SA-06. 30.

Proportion of DG end connection market share carried out by third parties (RIIO-ED2)				
	West Midlands	East Midlands	South Wales	South West
DGLV	No change Remains at 0%	No change Remains at 0%	No change Remains at 0%	No change Remains at 0%
DGHV	Reduce from From 11% to 0%	Reduce from From 13% to 0%	Reduce from From 6% to 0%	No change Remains at 0%
DGEHV	Minimal change around 50%	Increase from 64% to 74%	Reduce from from 54% to 42%	Minimal change around 70%
DG132	Minimal Activity but assumed 40%	Increase from 44% to 72%	Minimal Activity but assumed 60%	Increase from 43% to 50%

Figure SA-06. 30: Proportion of DG end connection market share carried out by third parties, RIIO-ED2

4.67. The impact of these changes means that third parties providers will carry out more sole use work. The RIIO-ED2 expenditure forecasts exclude those costs that are expected to migrate to

third party providers because they will become direct transactions between customers and third party providers.

Connections requiring reinforcement

4.68. The majority of connection projects can be carried out as pure network extension work where all the new assets are specifically for the new connections (sole use). In some instances, the existing network will need to be reinforced to provide the necessary upstream capacity.

4.69. During RIIO-ED1, we established flexibility markets that provide a means of addressing network constraints to defer conventional reinforcement. These make use of new technology and the ability for some network users to provide flexibility in their own consumption either by increasing, reducing or shifting their net import or export during peak loading periods. A number of flexibility products are offered to eligible providers in constraint management zones (CMZs) within WPD's licence areas. This procurement is carried out in cycles on a six-monthly basis. Flexibility is most suited for constraints where assets are only slightly overloaded.

4.70. We anticipate that the use of flexibility will increase during RIIO-ED2 although it is not expected that the market will be able to provide services to match all constraints. Our 'flexibility first' approach outlined in our Business Plan core commitment 46 means that, for all constraints, we consider whether flexibility is a viable option to address network issues and defer reinforcement.

4.71. To determine whether the costs of flexibility procurement are less than the benefit of deferring expenditure associated with reinforcement, cost-benefit analysis is carried out for each scheme using the common evaluation methodology (CEM), as part of the DNOA process. Flexibility is not suitable for some types of constraint, such as fault level issues.

4.72. Flexibility has been assumed to apply to connections related reinforcement as it has done for the load related reinforcement captured in our ex-ante proposals.

4.73. The anticipated growth in demand-based LCTs for vehicle charging and heat pumps will lead to less spare capacity on the LV network as more of these LCTs are connected, leading to a greater proportion of connections requiring reinforcement to enable connection. For demand connections, this will mainly impact the LVAL and LVHV connection segments, with limited change in other segments. Figure SA-06. 31 illustrates the change for WPD-provided demand connections.

Percentage of demand connection projects delivered by WPD requiring reinforcement (RIIO-ED2)				
Segment	West Midlands	East Midlands	South Wales	South West
LVAL	Increase from 4% to 14%	Increase from 3% to 8%	Increase from 4% to 8%	Increase from 3% to 4%
LVHV	from 34% to 46%	Reduction from 41% to 38%	Increase from 39% to 48%	Increase from 38% to 48%

Figure SA-06. 31: Percentage of demand connection projects delivered by WPD requiring reinforcement, RIIO-ED2

Impact of low carbon technology on connection costs

4.74. As customers adopt more LCTs and this becomes an integral part of new connections (e.g. vehicle charging points in new properties), the assets used for new connections will need to be of a larger capacity, with associated higher costs. This will impact all demand segments where the end connection is at LV and at HV. The forecast includes additional costs for providing a 3 phase service arrangement as standard for all new domestic sole use connections.

Overlap with forecasts for general reinforcement

4.75. There is no overlap with the forecasts for general reinforcement. The forecast for general reinforcement uses the output from a model that assumes future networks will be built with sufficient capacity to cater for connection of low carbon technology. The model does not include any allowance for increased costs of new connections in its results.

Unmetered connections

4.76. Volumes of unmetered connections in the all DNO areas within WPD are forecast to remain steady over the RIIO-ED2 period since third party activity is established and not forecast to change.

4.77. The volumes of connections forecast to be delivered by WPD in each market segment are shown in Figure SA-06. 32.

Volumes of unmetered connections (RIIO-ED2)					
	West Midlands	East Midlands	South Wales	South West	WPD Total
UMLA	2,030	680	1,250	2,000	5,960
PFI	-	-	-	-	0
OUMC	1,970	2,020	1,540	2,885	8,415
TOTAL	**4,000**	**2,700**	**2,790**	**4,885**	**14,375**

Figure SA-06. 32: Volume of unmetered connections, RIIO-ED2

Primary reinforcement

4.78. General reinforcement is the investment required to provide adequate capacity on the network for generic load growth (i.e. not related to any individual customer or new connections). Primary is the element which covers the EHV (33kV and 66kV) and 132kV networks.

4.79. The WPD Best View has been used within detailed network analysis to identify potential circuit and transformer overloads as well as voltage excursions outside statutory limits at both the EHV and 132kV levels.

4.80. For each network constraint, the optimum reinforcement scheme was then identified after evaluating a range of options and their associated costs which included the assessment of using flexibility as an alternative to conventional reinforcement.

4.81. Figure SA-06. 33 compares our forecast RIIO-ED2 expenditure as an annual average to RIIO-ED1.

Primary reinforcement					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	14	10	4	6	33
RIIO-ED2 Annual Average (forecast)	13	11	12	16	52
RIIO-ED2 Total (5 years)	66	57	59	79	261

Figure SA-06. 33: RIIO-ED2 forecast total expenditure - primary reinforcement

4.82. Supplementary Annex SA-06a ‘Load-related expenditure’ provides more detail on our primary reinforcement plans. We recognise that there is some uncertainty about the scale and impact of decarbonisation activities and therefore we expect to utilise the uncertainty mechanism to make adjustments to ex-ante funding during RIIO-ED2.

4.83. There is one high value project exceeding £25 million, for the provision of a new circuit to provide a new interconnection into the Mid East Wales ring. As this is a high value project it is separately costed and excluded from the costs shown for primary network reinforcement.

Secondary reinforcement

4.84. General reinforcement is the investment required to provide adequate capacity on the network for generic load growth (i.e. not related to any individual customer or new connections). Secondary is the element which covers low voltage (LV) and high voltage (HV) networks.

4.85. WPD's NIFT modelling tool has been used to identify the reinforcement requirement at LV and HV. To produce expenditure forecasts, volumes of interventions from NIFT have been multiplied by average unit costs derived from a number of costed projects based upon assessing the requirements on a representative sample of circuits.

4.86. We have service arrangements where the service cables to properties are looped from property to property. With anticipated load growth for LCTs, these arrangements are no longer appropriate and need to be unbundled. When we identify locations on the network that would benefit from unbundling we will consider proactive unbundling in anticipation of load growth to remove potential constraints and delays for customers. We are proposing investment to do so, but as it is difficult to identify the scale of this activity ahead of need, we propose to use an uncertainty mechanism that adjusts allowances (upwards and downwards) to reflect the volumes of activity during RIIO-ED2.

4.87. Figure SA-06. 34 compares our forecast RIIO-ED2 expenditure as an annual average to RIIO-ED1.

Secondary reinforcement					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	11	10	3	3	28
RIIO-ED2 Annual Average (forecast)	24	20	14	17	75
RIIO-ED2 Total (5 years)	120	101	70	83	374

Figure SA-06. 34: RIIO-ED2 forecast total expenditure - secondary reinforcement

4.88. Our IT plans include investment in LV Monitoring and smart meter data. We forecast that this will defer over £59 million of secondary reinforcement investment, which is therefore excluded from this forecast.

4.89. Supplementary Annex SA-06a 'Load Related Expenditure' provides more detail on our secondary reinforcement plans.

Fault level reinforcement

4.90. Certain faults on the network can cause very high current to flow until the network is switched off automatically by circuit breakers. The network is designed to withstand these fault levels, but the number of generators and large induction motors connected to the network can cause the fault current to exceed the rating of the circuit breakers, overhead line and cables. This can introduce a risk of catastrophic failure to the overhead lines and cables, or when the switchgear is operated.

4.91. It is imperative that we protect our employees and members of the public by applying temporary operational limitations to ensure they is not at risk of injury due to the failure of the company's

assets in high fault level situations. Because these involve sub-optimal running arrangements, these are only used as interim solutions until the equipment can be changed. The implementation of sub-optimal network running arrangements can affect network performance and constrain the capacity of the network, restricting the connection of additional load or generation. Situations like this are typically resolved by replacing switchgear and overhead lines and cables with higher rated assets. In some cases, fault levels can also be reduced by changing transformers for higher impedance models. Smart interventions, including the use of fault current limiters, are also applied where this is an economical solution.

4.92. A significant factor in increased fault levels is the connection of distributed generation. The growth in distributed generation is expected to continue into RIIO-ED2, resulting in an increase in fault levels on parts of the network.

4.93. Twenty-six fault level schemes have been identified during the RIIO-ED2 period across WPD. These have been developed by:

- Identifying all sites which have a current switchgear duty rating of 90-95%.
- Undertaking further analysis of these substations to identify the projected growth in fault levels over the RIIO-ED2 period in line with the WPD Best View scenario.
- Considering whether fault levels could be reduced by altering network running arrangements or whether network investment was the most appropriate solution.

4.94. Figure SA-06. 35 compares our forecast RIIO-ED2 expenditure as an annual average to RIIO-ED1.

Fault level reinforcement					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	2	2	0	1	6
RIIO-ED2 Annual Average (forecast)	2	7	1	2	12
RIIO-ED2 Total (5 years)	10	36	3	11	59

Figure SA-06. 35: RIIO-ED2 forecast total expenditure - fault level reinforcement

New transmission capacity charges

4.95. WPD interconnects to the transmission network, typically at the Grid Supply Points (GSPs) which are 400/132kV or 275/132kV interface substations between the transmission and distribution networks.

4.96. Load growth on the distribution networks may call for extra capacity from the transmission system. This is provided by National Grid which recoups the costs through exit charges. Where these exit charges are linked to load-related requirements, they form part of the costs within the price control Totex.

4.97. We forecast that conventional reinforcement by National Grid Electricity Transmission is required for six GSPs in RIIO-ED2.

4.98. Figure SA-06. 36 compares our forecast RIIO-ED2 expenditure as an annual average to RIIO-ED1.

New transmission capacity charges					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	0	0
RIIO-ED2 Annual Average (forecast)	1	1	1	1	3
RIIO-ED2 Total (5 years)	3	6	5	4	17

Figure SA-06. 36: RIIO-ED2 forecast total expenditure - new transmission capacity charges

5. Non load-related investment

Diversions

5.1. Diversions activity is predominantly driven by third party requirements. While for most activity areas, forecasts are based on historical trends in costs and volumes from RIIO-ED1, increases have been included for LV and HV, due to the emergent issue of wooden poles in gardens. Since the start of RIIO-ED1, WPD has experienced a significant rise in claims activity relating to wooden poles in gardens, largely driven by the marketing activities of compensation agents. This was not foreseen before the start of the RIIO-ED1 and, as a result, has been reported in atypical costs during the period. For the RIIO-ED2 forecast, these costs are now included in diversions as an ongoing activity.

5.2. WPD has statutory rights that allow installation of the distribution network in public land (such as adopted highways) but, where the network passes over or under private land, WPD requires rights from the property owners.

5.3. Diversions expenditure covers all potential outcomes arising from a landowner's ability to serve notice on a DNO and review the arrangements for the apparatus to be relocated or to remain in situ. It includes costs associated with the conversion of existing wayleaves to easements, easements, injurious affection claims, substation lease renewals, diversions due to wayleave terminations and diversions due to highways work, part funded by the DNO in line with the New Roads and Street Works Act (NRSWA). These categories are explained in more detail below.

5.4. During RIIO-ED2, it is anticipated that the expenditure profile for diversions will remain similar in each year of the period.

5.5. Forecasted costs for diversions (excluding those relating to rail electrification) for RIIO-ED2 are shown in Figure SA-06. 37.

Diversions (Excluding rail electrification)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	10	13	5	11	39
RIIO-ED2 Annual Average (forecast)	13	16	6	14	49
RIIO-ED2 Total (5 years)	64	82	31	68	244

Figure SA-06. 37: RIIO-ED2 forecast total expenditure - diversions

Conversions of existing wayleaves to easements

5.6. It is usual for a landowner to be paid for the financial loss arising from the equipment on their land. This may take one of two forms of agreement: a wayleave or an easement.

5.7. A voluntary wayleave is a form of private licence, granted by a landowner, that gives WPD the right to place and maintain its equipment on private land. In return, the landowner receives an annual payment. Wayleaves are routinely entered into with landowners for a fixed term (e.g. 14 years) or on a rolling annual basis and are generally quick and simple to agree. Wayleave costs are covered under closely associated indirect expenditure and not included in diversions.

5.8. There are two potential disadvantages of wayleave agreements:

- A wayleave is a personal contract with the landowner and does not automatically bind their successor in title, which can cause issues when land is sold;
- Wayleaves can, in many cases, be terminated by giving notice.

5.9. An easement is the granting of a permanent right for equipment to be installed and/or retained on private land that remains on the title of the property even if the land is sold. A lump sum payment (rather than an annual rental) is paid for a permanent or long term agreement to cross the land. The process to acquire an easement is more complicated, requiring a legal conveyance and therefore incurs higher costs. As a result, easements are used most frequently for strategically important apparatus.

5.10. The presence or construction of the distribution network can lead to landowners claiming for injurious affection (loss in value associated with the detrimental effect upon property as a result of the location of distribution network assets). Where landowners believe they have an injurious affection claim and they terminate their wayleave, WPD seeks to negotiate with the landowner in order to reach an agreement to allow the equipment to remain.

5.11. A landowner may also trigger the statutory process by serving formal notice to remove the equipment. Under its licence obligations, WPD would then seek to protect its position and apply for either a statutory wayleave for a fixed term or acquire permanent rights in the form of a compulsory purchase order.

5.12. Where new rights are acquired by WPD, the landowner is entitled to payment of compensation. Since the use of statutory powers is expensive and often takes a long time, these are used as a last resort, with WPD using a range of approaches to minimise the potential costs of keeping assets on land.

Forecast approach

5.13. During the course of RIIO-ED1, WPD has received significant volumes of claims, particularly in relation to residential properties, driven by a number of compensation agents acting for landowners.

5.14. WPD considers the merits of every claim received and has established a set of principles for calculating the injurious affection in order to retain the existing equipment.

5.15. WPD will assess the operational impact of diverting the equipment, together with the cost implications, and compare this with the cost and impacts of seeking to acquire rights to retain. Where it is established that it is preferable to retain the equipment, WPD will consider whether to proceed with negotiations for new rights by agreement with an individual landowner or whether to use its statutory powers.

5.16. Generally RIIO-ED2 forecasts have been made on a consistent basis with levels of activity incurred during RIIO-ED1.

Wooden poles in gardens

5.17. In contrast to the DPCR5 period (when claim volumes were minimal), WPD has experienced a significant rise in wooden pole claim activity since the start of RIIO-ED1, largely driven by the marketing activities of compensation agents. These agents take a fee from claimants which is based on a percentage of the value of each settlement.

5.18. The scale of the increase in claims seen at the start of RIIO-ED1 was unsustainable. For example, WPD received an average of 18 claims a year from 2011-14, compared to more than

16,750 claims in 2016. This resulted in prolonged turn-around times for dealing with claims. In order to manage the volume of claims and to improve claim turn-around times, WPD implemented changes to the claim settlement strategy in April 2017.

5.19. As a result, termed wayleaves are offered on low voltage (LV) and high voltage (HV) wooden pole claims. Easements continue to be acquired on strategically critical wooden pole lines at 33kV (EHV) and above. Additionally, WPD stopped making voluntary contributions towards agents' fees where it was not obliged to do so.

5.20. These changes resulted in a reduction in submitted claim volumes and also an acceleration in the rate of settling claims. Currently, incoming claim volumes are relatively stable.

5.21. In response to feedback from the agents during the stakeholder process, WPD has undertaken a review of its termed wayleave-based settlement strategy for RIIO-ED2. WPD's settlement strategy was challenged under three primary headings and WPD's response can be summarised as presented in Figure SA-06. 38.

Challenge	WPD's response
Easements should be offered instead of termed wayleaves	Because of its finite duration and limited security, a termed wayleave justifies a lower payment than a permanent easement. WPD has received approximately 44,000 agent-driven claims for wood poles in gardens and 13,000 claims direct from landowners. The cost of settling this number of claims by offering easements is estimated to be significantly in excess of £300m. By screening eligible claims and offering termed wayleaves WPD's liability from wood pole claims during RIIO-ED1 has amounted to £52.6m. Cost benefit analysis shows that our current policy of offering termed wayleaves is more cost effective than the purchase of permanent easements. Wayleaves also provide both WPD and the landowner with the ability to review their options after the expiry of each wayleave period. There is a risk that future changes in network load could result in equipment detailed on the permanent easement requiring either alteration (causing an additional liability) or removal, thereby reducing the benefit of the initial purchase. Our conclusion is that wayleaves offer better value for money while providing greater flexibility to both the landowner and WPD concerning future requirements for use of land and apparatus.
Offers made for termed wayleaves should be more generous	WPD applies a consistent approach to all claims by offering a fixed price settlement which ensures a quick response to all claims. During RIIO-ED1, 87% of our termed wayleave settlement offers for high voltage apparatus were accepted by landowners, along with 78% for LV apparatus. The high volume of uptake suggests that our approach to addressing the increased volume of claims, while providing landowners with a fast and efficient process, is well received. We regard this volume of settlements as reassuring evidence that landowners regard our offers as fair and reasonable. The settlements process that we have adopted is consistent with our statutory duty to operate our network economically.
WPD should reinstate	Where a settlement is reached by agreement, WPD has no obligation to make a fee payment to landowners' agents.

making a contribution towards agent's fees	The settlement offers which we make on agent-led claims and those with no agent involvement are calculated on the same basis and are therefore equitable for all customers while maintaining our statutory duty to operate our network economically.

Figure SA-06. 38: Key stakeholder challenges and our responses to our termed wayleave-based settlement strategy for RIIO-ED2

5.22. As a result, WPD has not proposed a change of approach to settlement strategy for wooden poles in gardens. We anticipate that claim volumes during RIIO-ED2 will remain stable and have therefore based forecasts on the costs and volumes identified from April 2017 to date. The volumes and costs included in our RIIO-ED2 forecasts are therefore much lower than they would be should we not have adopted this strategy.

Substation purchases

5.23. Purchases under this heading relate to WPD's existing substation sites. Acquisitions which relate to the construction of new substations for the purposes of network growth are covered in the reinforcement and connections forecasts.

5.24. WPD seeks to negotiate settlements with third parties when substation leases expire or when there is a requirement to modify legal rights for an existing substation. Sometimes WPD's position is strengthened by pre-existing legal rights but, in other cases where no such options are available, settlements are negotiated according to the circumstances of the case. In all instances, WPD seeks to agree optimal terms which are consistent with its statutory obligation to operate its network in an efficient, co-ordinated and economical manner. In keeping with this objective, WPD will continue to consider using its statutory powers of compulsory purchase when justified, where an unreasonable ransom demand is being made.

5.25. The acquisition of land and rights over land is a relatively routine operation for WPD and so, in considering the spend profile under this heading in RIIO-ED2, WPD has related these to similar costs through RIIO-ED1 to date.

Expenditure summary

5.26. Figure SA-06. 39 shows our forecast expenditure summary for all parts of the activity of conversions of existing wayleaves to easements.

Conversions of existing wayleaves to easements					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	2	5	2	6	14
RIIO-ED2 Annual Average (forecast)	4	6	3	8	22
RIIO-ED2 Total (5 years)	22	32	14	41	109

Figure SA-06. 39: RIIO-ED2 forecast total expenditure - conversions of existing wayleaves to easements

Diversions due to wayleave terminations

5.27. Diversions arise when landowners request that assets are moved, often through a wayleave termination or the threat of one. This may be for reasons such as facilitating a house extension or the development of land.

5.28. Diversions may also be carried out where the cost of purchasing an easement or using statutory powers to retain assets in situ exceeds the cost of moving the equipment.

5.29. For EHV or 132kV overhead lines, a diversion can sometimes be a cheaper alternative to high value injurious affection claims. The factors affecting this are complex, but can be due to the value of land or local authority planning policies, as well as political and public pressure against retaining overhead lines on developments.

5.30. WPD aims to minimise expenditure on diversions due to wayleave terminations by using a variety of different approaches including:

- Developing landowner relationships locally through a staff structure that gives wayleave officers a geographical area to cover. (Face to face negotiations are normally a very effective way of resolving a termination and can avoid a diversion altogether or lead to an outcome where both sides contribute to the costs);
- Negotiating an agreement to retain the equipment instead of carrying out a more expensive diversion. The option to use statutory powers will also mean negotiations are carried out against this formal alternative;
- Central support and co-ordination of complex or higher value cases, ensuring consistent approach to minimise costs;
- Making representations to local authorities regarding planning policies which can lead to a requirement for diversion of overhead lines, especially those involving towers (pylons) where a cost burden is placed on WPD and its customers rather than on the developer who benefits financially from the development.

5.31. No significant changes to the volumes of diversions are anticipated during RIIO-ED2, and therefore the forecasts are generally in line with the levels of activity experienced during the first years of RIIO-ED1.

5.32. Figure SA-06. 40 shows the expenditure summary for this activity.

Diversions due to wayleave terminations					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	7	9	3	6	25
RIIO-ED2 Annual Average (forecast)	8	9	3	5	26
RIIO-ED2 Total (5 years)	41	46	17	27	131

Figure SA-06. 40: RIIO-ED2 forecast total expenditure - diversions due to wayleave terminations

Diversions for highways

5.33. Highways work, such as large scale development of new motorways and road widening, may require the diversion of WPD equipment. While the majority of the cost of these diversions are rechargeable to the local authorities or Highways, Regulation 4 of The New Roads and Street Works Act (NRSWA) requires WPD to contribute 18% to the costs. These projects are managed in a co-ordinated manner to minimise the cost impact.

5.34. WPD forecast costs are for the proportion that is not funded by the authorities. Additional costs of £7 million have been forecast in RIIO-ED2, because there are a number of highway diversions that are required to enable the construction of the HS2 railway. Otherwise, forecasts for RIIO-ED2 are in line with previous levels of expenditure and are only a small element of overall Diversions costs.

Diversions (rail electrification)

5.35. The electrification of railway lines arises from Network Rail's programme to replace older diesel trains with electric trains. Network Rail intends to progressively electrify significant sections of its existing rail network.

5.36. WPD has a number of overhead lines and cables across Network Rail land. (These works are to move and divert overhead lines and cables to enable the electrification; they are not for the provision of power to the electrified railway).

5.37. WPD and Network Rail have a number of Master Wayleave Agreements (MWAs) which provide rights for WPD's overhead lines and cables across railway property. There will be similar MWAs in place between Network Rail and the other DNOs. These agreements date from the 1950s and 1960s and were entered into by the regional electricity boards and the Central Electricity Generating Board with Network Rail's predecessors. Like most wayleave agreements, they are terminable and, when terminated, result in costs for WPD for diverting the route of WPD assets.

Legal interpretation of MWA

5.38. Network Rail has informed WPD that it intends to use the MWA to make WPD pay for all diversions to facilitate its electrification works. WPD disagrees with Network Rail's interpretation of the MWA.

5.39. The MWA contains arbitration provisions which we expect Network Rail to use (alternatively they might commence proceedings in the High Court) as one way of determining the liability for compensation/costs in the event of a dispute relating to the nature of diversions required or where the costs fall.

5.40. In the event of a dispute, WPD could also use its statutory powers under the Electricity Act 1989. This would secure WPD's existing rights, although Network Rail may seek statutory compensation for any losses which rightfully flow from the exercise of WPD's statutory powers. Should this occur and in the absence of an agreement, Network Rail may refer a statutory compensation dispute to the Lands Chamber for determination.

5.41. In addition, Network Rail may seek to counter WPD's exercise of compulsory powers by using its own compulsory powers to either negate or reverse any compulsory acquisition by WPD.

5.42. The outcome of an arbitration, court proceedings, the exercise of compulsory powers, or any Lands Chamber decision on statutory compensation is at present unknown but WPD must work on the basis that it could be required to meet all the costs of diversion, or be required to pay an unknown level of compensation. The most likely outcome would be the diversion of WPD's equipment (although it is less certain how the costs would be apportioned) to enable electrification of the railway lines.

5.43. WPD is currently engaged in discussions with Network Rail about diversions which have taken place in RIIO-ED1 as a result of electrification of the Midland Main Line railways. By the end of RIIO-ED1, WPD expects that a settlement will have been reached over the apportionment of WPD's network diversion costs.

RIIO-ED2 railway electrification

5.44. The Midland Main Line runs from London to Sheffield and is scheduled to be fully electrified. In 2015, the Transport Secretary reduced the scope of the Midland Main Line electrification project to approximately one third of the total route length by ending the electrification project at Kettering, with a subsequent extension to Market Harborough.

5.45. WPD anticipates that the remaining two thirds of the Midland Main Line railway will be electrified during the RIIO-ED2 period, but we recognise that this has not been confirmed by the government and therefore are proposing the use of an uncertainty mechanism. We await further developments after the government's announcement on 18th November 2021 that it intends to review its proposals for the Midland Main Line and we will reconsider the cost impact of any changes that affect our network.

5.46. WPD's diversion works for the completed, first (one third) component of the whole project are now substantively complete. WPD regards the cost of these works as a benchmark which will inform an estimate of network diversion costs for the remaining sections of track. On this basis, we are estimating expenditure of £3 million as a future uncertainty mechanism reopener claim in our East Midlands Business Plan. This has been included in BPDT table M13 Uncertainty Mechanisms only and is excluded from our baseline expenditure. The work required will need to be fully costed once the requirements are clearer

5.47. No other expenditure has been identified and included in our baseline expenditure, or in our other DNO uncertainty mechanisms, at this time. However, because the uncertainty does exist, and in light of the discussions that will follow the government announcement in November 2021, we propose that the uncertainty mechanism for this activity should be available to all our DNOs, should future expenditure arise when government policy becomes clearer.

5.48. Figure SA-06. 41 compares our forecast RIIO-ED2 baseline expenditure as an annual average to RIIO-ED1.

Diversions (Rail Electrification)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	1	2
RIIO-ED2 Annual Average (forecast)	0	0	0	0	0
RIIO-ED2 Total (5 years)	0	0	0	0	0

Figure SA-06. 41: RIIO-ED2 forecast total expenditure - diversions (rail electrification)

Asset replacement and refurbishment

Introduction

5.49. Asset replacement activity is used in the management of asset-related risks and is undertaken when an asset's condition is no longer consistent with an acceptable level of reliability or safety.

5.50. Asset replacement is the largest area of expenditure in non-load network investment, both in RIIO-ED1 and into RIIO-ED2. Our replacement strategy, which focusses on removing assets in poorest condition, is not changing. Our assessment of network requirements indicates that the need for a different mixture of work in RIIO-ED2 calls for a slight increase in total replacement expenditure.

5.51. We use a range of modelling techniques to determine the volumes of replacement activity required, including:

- Network Asset Risk Metrics (NARMs)
- Statistical age-based modelling
- Run-rate analysis
- Population impacted analysis
- Bespoke programmes

5.52. Our analysis suggests that, for some asset categories, the level of activity will differ in RIIO-ED2 when compared to RIIO-ED1. For example, replacement volumes of switchgear (particularly at HV) will be lower in RIIO-ED2 due to the fact that many older, poor condition assets have already been replaced. There will be a need to replace more LV Consac cable because of higher fault rates and associated inconvenience to customers.

5.53. Generally, assets will be replaced on a like-for-like basis using modern equivalents, although larger capacity assets may be used either to reduce network losses or to take account of anticipated load growth.

5.54. Refurbishment is carried out as an alternative to replacement, where it is possible to cost effectively replace components of assets instead of the complete asset and is generally viewed as providing a material extension to the life of assets.

5.55. Asset replacement and refurbishment activity is subdivided into NARM and non-NARM asset categories. NARM assets form the NARM outputs, against which performance will be monitored under the NARM price control deliverable/output delivery incentive. Ofgem uses 103 defined asset categories for regulatory reporting and cost forecasts. Of these, 61 are NARM asset categories, with the remaining 42 being non-NARM.

5.56. Furthermore, as well as having NARM and non-NARM asset categories, individual activities that may be undertaken as refurbishment activities are categorised as either providing a contribution towards delivering NARM risk reduction, if undertaken on a NARM asset, or as refurbishment activities that are not counted towards NARM delivery.

5.57. Total proposed expenditure for asset replacement and refurbishment are shown in Figure SA-06. 42 to Figure SA-06. 48. We propose to spend a total of £1,279m on asset replacement, civil works associated with plant items and refurbishment in RIIO-ED2. The tables below also show the split between NARM and non NARM activity for Asset Replacement and Refurbishment, along with the civils costs associated with asset replacement.

Asset replacement					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	53	50	30	50	184
RIIO-ED2 Annual Average (forecast)	62	58	33	62	216
RIIO-ED2 Total (5 years)	312	290	165	312	1,078

Figure SA-06. 42: RIIO-ED2 forecast total expenditure - asset replacement total

Asset replacement (non NARM)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Average	15	11	5	13	44
RIIO-ED2 Average (forecast)	18	14	7	16	55
RIIO-ED2 Total (5 Years)	92	70	37	78	276

Figure SA-06. 43: RIIO-ED2 forecast total expenditure - asset replacement (non NARM)

Asset replacement (NARM)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Average	38	38	25	37	138
RIIO-ED2 Average (forecast)	44	44	26	47	160
RIIO-ED2 Total (5 Years)	220	220	129	234	802

Figure SA-06. 44: RIIO-ED2 forecast total expenditure - asset replacement (NARM)

Civil works driven by condition of plant items					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	4	5	3	4	15
RIIO-ED2 Annual Average (forecast)	2	5	2	3	12
RIIO-ED2 Total (5 years)	12	23	9	17	61

Figure SA-06. 45: RIIO-ED2 forecast total expenditure - civil works driven by condition of plant items

Refurbishment					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	8	6	4	6	24
RIIO-ED2 Annual Average (forecast)	9	6	6	7	28
RIIO-ED2 Total (5 years)	46	29	30	34	139

Figure SA-06. 46: RIIO-ED2 forecast total expenditure - refurbishment (total)

Refurbishment (non NARM)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	6	4	2	4	16
RIIO-ED2 Annual Average (forecast)	7	4	3	4	19
RIIO-ED2 Total (5 years)	37	20	16	21	94

Figure SA-06. 47: RIIO-ED2 forecast total expenditure - refurbishment (non NARM)

Refurbishment (NARM)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	2	2	2	1	8
RIIO-ED2 Annual Average (forecast)	2	2	3	3	9
RIIO-ED2 Total (5 years)	9	9	14	13	46

Figure SA-06. 48: RIIO-ED2 forecast total expenditure - refurbishment (NARM)

Asset Resilience Strategy

5.58. The core objective of asset related activities is to maintain a safe and reliable supply of electricity. This means that we focus on addressing asset related issues that can cause equipment failure, resolving the issues before a failure arises.

5.59. We have a comprehensive programme of inspections that are carried out on a cyclical basis to collect data about the condition of the assets, which is stored within the company's asset management system. The data is either in the form of defects or test results.

5.60. The data is used for a range of programmes of work, with different elements of the data being used for different purposes including determining which assets should be replaced due to their condition, resolution of overhead line ground clearance issues and carrying out repairs either as part of maintenance or standalone tasks.

5.61. For asset replacement, we have developed systems that automatically process the data to derive health indices in line with the industry developed Common Network Asset Indices Methodology. The results are stored against assets within the asset register and made available in dashboards, which allows local teams to select which assets to replace.

5.62. The information is also fundamental to strategic planning and calculations of how the condition of the assets will deteriorate provides information to determine the future scale of investment requirements.

5.63. The evolution of regulatory metrics into NARMs inherently enables cost benefit justification, where the risk value removed exceeds the costs of carrying out the work. This information alongside a range of other indicators is used to determine the scale of investment programmes.

5.64. The approach is based upon determining the appropriate scale of programme for each asset category. This determines the level of risk change that will be delivered and the resultant risk is as a consequence of the selection. We do not set a pre-required risk level to determine the scale of the programme or work; the programme is determined from granular asset by asset analysis considering the specific needs and available information for each asset category.

5.65. This detailed analysis is carried out across all asset categories, not just those that apply to NARMs.

5.66. In order to gauge that the proposed investments are at the right scale, we consider historic run-rates and long term future requirements (informed by statistical survivor modelling). We also consider the proportion of the asset population that is being impacted to determine whether the amount of replacement is a reasonable level of activity given the typical life expectancy of the assets.

5.67. The approach allows us to focus on those assets that need to be replaced to maintain a safe and reliable network, as well as considering longer term requirements.

Background

5.68. The existing network has developed over many years with a large proportion being installed during the 1950s and 1960s.

5.69. Generally, assets deteriorate as they get older, but the rate of degradation is dependent upon many factors including quality of manufacture, whether they are installed indoors or outdoors, and local environmental conditions (e.g. assets close to the coast suffer from salt corrosion).

5.70. In WPD, actual asset replacement is primarily carried out on the basis of condition assessment. Condition assessment is carried out during routine inspection and maintenance and is supplemented by more detailed assessments once assets approach expected average lives. Where applicable, this data is used in the modelling and forecasting of asset replacement requirements, but where this data is not available or obtainable, age-based modelling gives an alternative indication of replacement need.

5.71. Equipment, particularly switchgear, may become embargoed with operational restrictions applied where defective components may lead to dangerous situations. Equipment modifications can eliminate some defects, but where defective components cannot be easily remedied, the equipment is replaced.

5.72. In some cases, early life failure is encountered, for example, switchgear containing SF_6 gas as an insulant may leak due to issues with encasement castings. These leaks are not repairable and therefore the switchgear needs to be replaced. The volume of these incidences is relatively low but, as they do occur, the forecast includes replacement for early life failure situations.

5.73. Generally, assets will be replaced on a like-for-like basis using modern equivalents, but larger capacity assets may be used either to reduce network losses or to take account of anticipated load growth.

5.74. The anticipated load growth from the increased uptake of low carbon technologies (electric vehicles and heat pumps) means that consideration will be given to installing greater capacity assets where there is a strong indication that load growth will take place. This opportunistic reinforcement should negate the need for subsequent reinforcement as load increases, meaning that assets are only ‘touched once’ before 2050. The small incremental increase in material costs will reduce long term costs particularly for cable assets where the majority of the costs arise from excavation and reinstatement.

5.75. Refurbishment will be considered where lower cost actions can extend the useful life of an asset by several years or where the construction of the assets suggests that it is more cost effective to replace components rather than the complete asset (e.g. steel lattice towers).

5.76. In summary, condition and defect information will be used to develop work programmes that are targeted to replace poor condition assets. Additional replacements will be carried out to remove assets with operational restrictions and safety issues or those are difficult to maintain. The overall programme will be a combination of cost effective solutions consisting of like-for-like replacement, refurbishment and opportunistic reinforcement. This is summarised in Figure SA-06. 49.

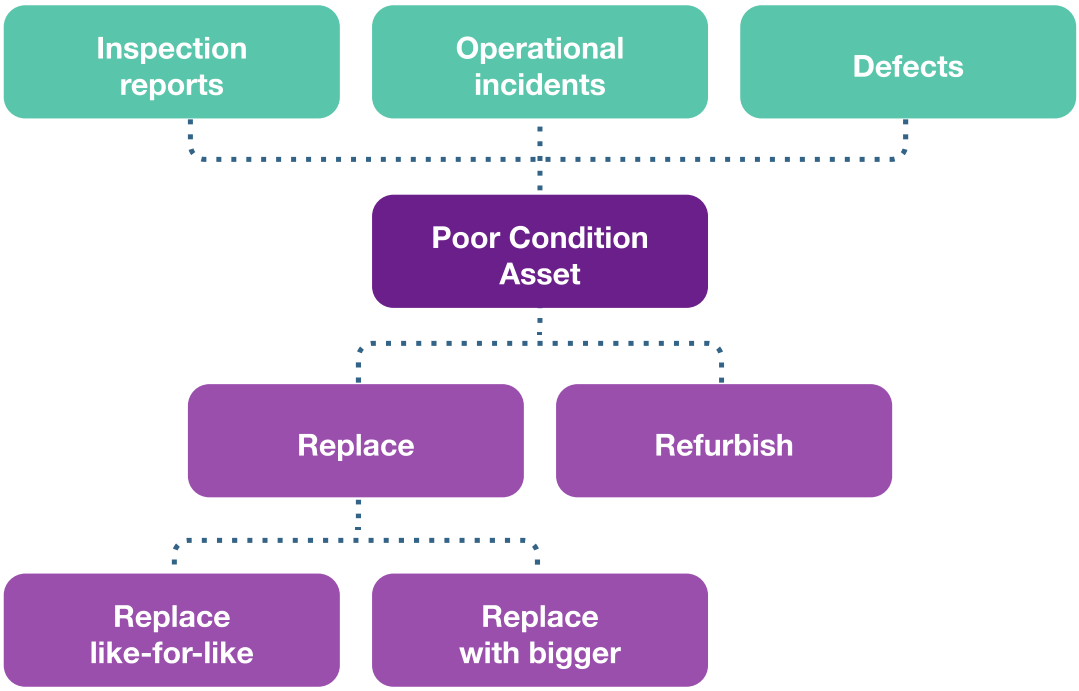


Figure SA-06. 49: Outline approach to condition based asset management

Track record

5.77. WPD proposed a comprehensive replacement programme for RIIO-ED1 and has spent over 80% of the allowances for asset replacement in RIIO-ED1 to date. Figure SA-06. 50 shows the allowances and expenditure for all four licence areas for the first five years of RIIO-ED1.

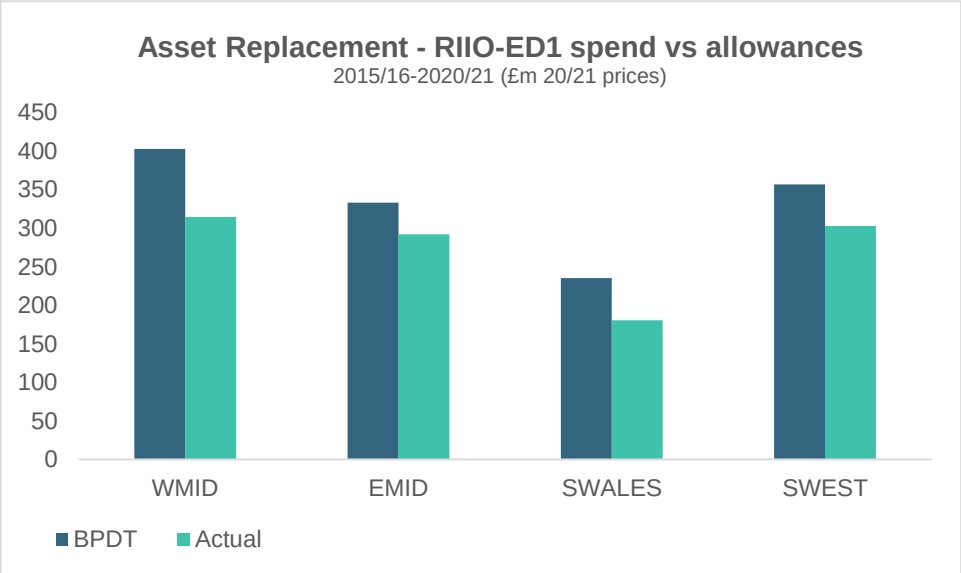


Figure SA-06. 50: Asset replacement - RIIO-ED1 spend compared to allowances

5.78. In RIIO-ED1, WPD has agreed regulatory targets for the reduction in condition-based risk that will be delivered through the asset replacement and specified refurbishment activities. These

are known as Network Asset Secondary Deliverables (NASDs); approximately two thirds of the asset replacement allowances were associated with asset categories that formed the NASDs.

5.79. Figure SA-06. 51 shows the performance against the end of period NASD targets. The target represents the full NASD monetised risk points (MRP) required across the whole of RIIO-ED1; while the actual represents the delivered MRP based upon the first six years of delivery. Most WPD areas have already delivered the required RIIO-ED1 targets, with SWEST forecast to achieve the target by the end of the period.

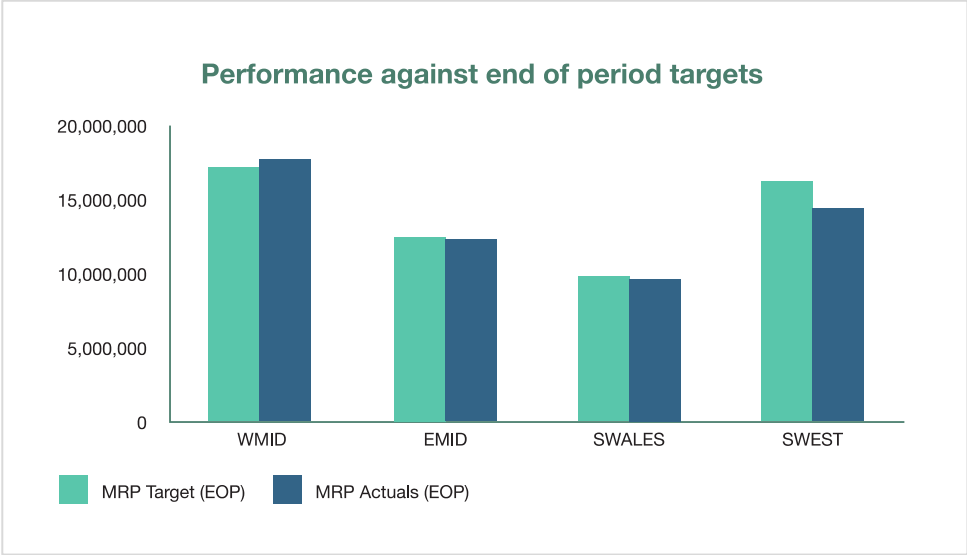


Figure SA-06. 51: Performance against end of period NASD targets

Volume forecasting

5.80. To develop the RIIO-ED2 forecast, WPD has used a range of different modelling techniques to determine the volumes of activity. This is, in part, due to the applicability and scope of modelling techniques to different asset categories (e.g. absence of condition data means that condition based modelling cannot be carried out).

5.81. The techniques used include:

- Network Asset Risk Measures
- Statistical age-based modelling
- Run-rate analysis
- Population impacted analysis
- Bespoke programmes

5.82. In many cases, all approaches are used before a balanced view is taken to determine the volume of activity to carry out. For example, approaches to dealing with certain assets may mean that condition information suggests a low volume but experience has shown that, due to rapid removal of poor condition assets, the condition data about remaining poor condition assets understates the actual higher volumes that are carried out. In this case, the condition data is considered alongside the run-rate data to derive the forecast volumes.

Network Asset Risk Measures (NARM)

5.83. Since asset replacement has historically accounted for the highest proportion of capital expenditure, regulatory mechanisms have been introduced to ensure that DNOs are completing

work programmes. Health Indices (HI), which only considered the condition of assets, were used in DPCR5; these evolved to Network Asset Secondary Deliverables (NASD) in RIIO-ED1, where both the probability of failure (represented by an asset's health) and consequences of failure led to a risk measure. For RIIO-ED2, Ofgem has introduced NARM which considers the long term risk of an asset, and enables the comparison of the risk benefit with the cost to determine cost benefit.

5.84. The data used for NARM for RIIO-ED2 is very similar to the data used for NASD in RIIO-ED1. An age-based health score is modified by observed and measured condition information to derive a modified health score that is then converted to a Health Index. This part of the process is the same as NASD (although there have been changes to specific calculations and parameters). The main difference is that NARM provides a measure of long term probability of failure by considering the cumulative probability of failure in future years.

5.85. The approach used to calculate NARM is common across the electricity distribution sector. All DNOs have worked collaboratively to evolve the Common Network Asset Indices Methodology (CNAIM) from version 1.1 used in RIIO-ED1 to version 2.1 applicable for RIIO-ED2.

5.86. CNAIM provides a common calculation methodology, but the data used to feed the models is unique to each DNO, determined by a DNO's inspection, maintenance and data collection policies. These DNO specific data points have been mapped and calibrated to the inputs required for CNAIM models.

5.87. WPD has built processes that extract the required data from corporate asset registers, map the data to CNAIM models, process the data through CNAIM models and present the results in dashboards. These dashboards are used to populate regulatory reporting, inform price control forecasts and determine candidates for actual asset replacement.

5.88. The CNAIM calculations provide both a Heath Index (HI) and Criticality Index (CI).

5.89. The Health Index is categorised into five bands of health from 'as new' condition to 'requiring intervention' as summarised in Figure SA-06. 52.

Health Index category	Description
HI1	New or as new
HI2	Good or serviceable condition
HI3	Deterioration requires assessment and monitoring
HI4	Material deterioration, intervention requires consideration
HI5	End of serviceable life, intervention required

Figure SA-06. 52: CNAIM health index categories

5.90. Within CNAIM, the overall consequences of failure are evaluated for each asset, taking into account:

- network performance consequences (i.e. the number of customers or demand interrupted as a result of a failure and the likely duration of the outage);
- safety consequences;
- environmental consequences; and
- financial consequences (i.e. cost of repair).

5.91. The criticality index measures use a reference consequence of failure for each asset category and each asset is allocated to a criticality band using the rules shown in Figure SA-06. 53.

Category	Description	Criticality values included
C1	Low criticality	Less than 75% of the reference consequence of failure
C2	Average criticality	Greater than, or equal to, 75% and less than 125% of the reference consequence of failure
C3	High criticality	Greater than, or equal to, 125% and less than 200% of the reference consequence of failure
C4	Very High criticality	Greater than, or equal to, 200% of the reference consequence of failure

Figure SA-06. 53: CNAIM criticality index categories

5.92. Figure SA-06. 54 presents NARM results in a 5x4 matrix, with five categories of health index and four categories of criticality index.

		Heath Index (Probability of failure)				
		HI1	HI2	HI3	HI4	HI5
Criticality	CI1	27	16	30	8	6
	CI2	35	5	43	12	13
	CI3	13	8	9	2	10
	CI4	2	-	3	-	6

Figure SA-06. 54: Example of health index / criticality index matrix

5.93. Assets with HI5 CI4 have the poorest health and highest consequences and therefore greatest risk.

5.94. Replacement of assets is primarily targeted at poor condition assets (i.e. assets with a HI4 or HI5 value), but there are situations where lower risk assets need to be replaced. This could arise where lower risk assets have to be replaced at the same time as replacing higher risk (poorer condition) assets due to the practicalities of being unable to remove only the poor condition assets at a site.

NARM target derivation

5.95. Ofgem has specified that NARM will form an Output Delivery Incentive and Price Control Deliverable. To enable these mechanisms to operate, there is a requirement to derive output targets.

5.96. To derive the targets, matrix movements (asset removals and asset additions) are assigned for the proposed asset replacement and refurbishment volumes of activity. These are produced for each relevant asset category.

5.97. NARM covers 61 asset categories, some of which do not apply to WPD because we have no assets in those categories. Figure SA-06. 55 shows that 162 NARM forecasts have been produced across the four WPD licence areas.

Coverage of NARM asset categories in WPD		
	Number of relevant NARM asset categories	Main exceptions
WMID	46	No 20kV assets
EMID	36	No 20kV or 66kV assets
SWALES	44	No 20kV assets
SWEST	36	No 20kV or 66kV assets
WPD	**162**	

Figure SA-06. 55: Coverage of NARM asset categories in WPD

5.98. WPD has used a number of approaches to derive which assets to select within the matrices including:

- NARM matrix self-justifies the selection based upon risk reduction/cost benefit;
- NARM matrix provides self-justification at a more granular basis;
- Assets associated with NARM justified assets;
- Special cases such as early life failures.

5.99. Figure SA-06. 56 illustrates that part of the NARM matrix provides self-justification for selecting assets in that part of the matrix. For these sectors, the risk reduction associated with replacing the assets is greater than the costs of carrying out the work. While assets in the HI5 C4 sector provide the greatest risk benefit, all the highlighted sectors (coloured green) provide a positive cost benefit and therefore are valid assets to select.

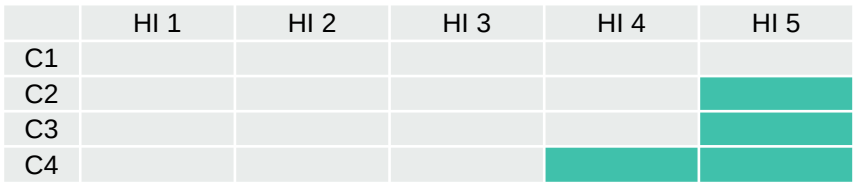


Figure SA-06. 56: NARM matrix – self-justification

5.100. Each health index band represents a range of underlying health scores, but CNAIM specifies that a single representative health score is used to provide the risk value for the matrix sector. We have carried out more detailed analysis subdividing the health index values into 150 bands and have assessed whether each of these bands provides a positive cost benefit. Figure SA-06. 57 illustrates parts of other bands (coloured orange) where there is self-justification and the risk benefit is greater than the cost.

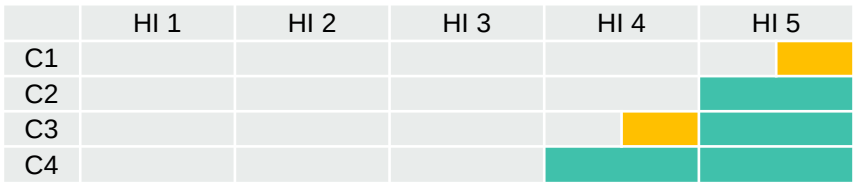


Figure SA-06. 57: NARM matrix – granular self-justification

5.101. Some assets need to be replaced for practical reasons, even though they are not the reason for replacement. Examples of these are circuit breakers that need to be replaced because of the practical issues of replacing a whole primary board, consequential cable works associated with moving assets to a new switching compound or replacing additional circuit length at the same time as replacing a leaky fluid filled cable. These assets generally do not fall into the self-justified parts of the matrix but will need to be replaced as part of other works. Figure SA-06. 58

illustrates the selection of these assets (coloured blue). The volumes of these assets are relatively low.

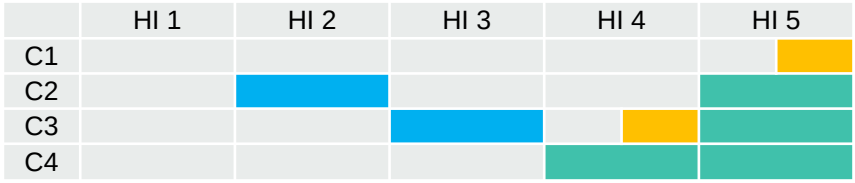


Figure SA-06. 58: NARM matrix – consequential assets

5.102. There are also special cases where assets will need to be replaced even though NARM may indicate they are in good condition. Typical situations are early life failures of assets, such as failure of SF6 casings within switchgear causing irreparable failures in relatively good condition assets. A small volume of assets have been selected to represent these special cases and Figure SA-06. 59 illustrates these (coloured yellow).

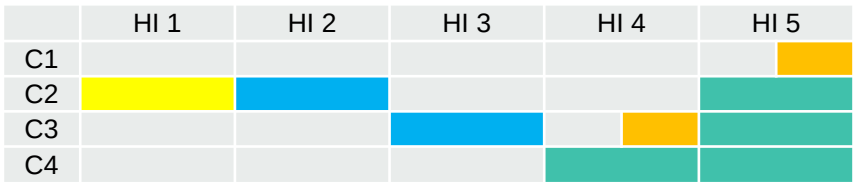


Figure SA-06. 59: NARM matrix – special early life failures

5.103. The appropriate selections for each asset category have been made and the risk reduction in each category contributes to the overall NARM targets for RIIO-ED2.

RIIO-ED2 NARM targets

5.104. The NARM targets are based upon the difference between risk at the end of the RIIO-ED2 price control without intervention and the risk at the end of RIIO-ED2 with the selected interventions applied.

5.105. For each NARM asset category, WPD has calculated:

- The starting position at the beginning of RIIO-ED2;
- How the matrix will change as a consequence of degradation without any intervention at the end of RIIO-ED2;
- The impact of proposed intervention programmes on the position at the end of RIIO-ED2.

5.106. Figure SA-06. 60 shows how network risk will change over RIIO-ED2; it shows that the interventions proposed in the RIIO-ED2 Business Plan will provide a 22% risk reduction compared to carrying out no interventions.

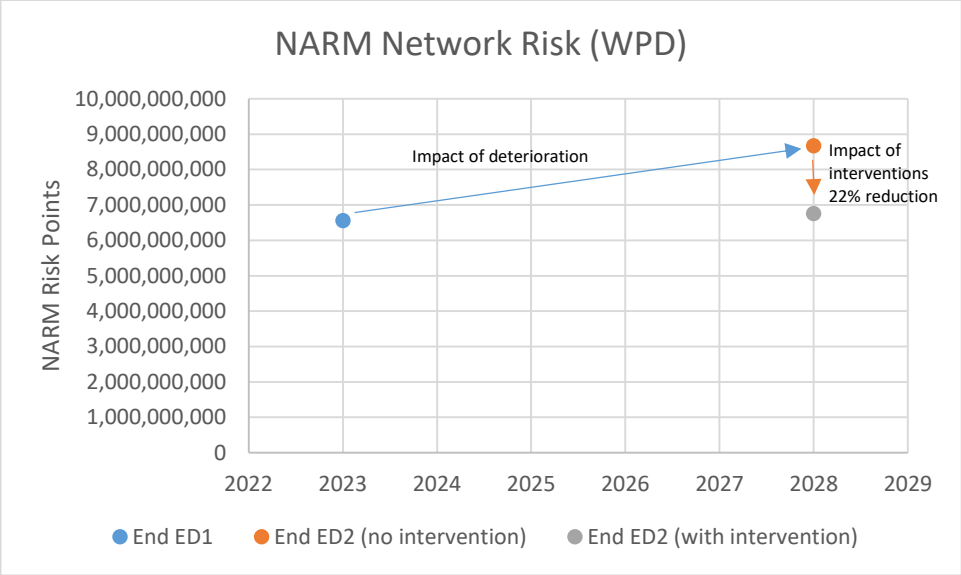


Figure SA-06. 60: NARM network risk, RIIO-ED2

5.107. Figure SA-06. 61 shows the risk reduction values for the WPD licence areas.

NARM Risk Change in RIIO-ED2					
	Start of RIIO-ED2	End of RIIO-ED2 (no interventions)	End of RIIO-ED2 (with interventions)	Risk Reduction	% age improvement
WMID	2,026,474,871	2,634,322,209	2,114,534,650	-519,787,560	20%
EMID	1,568,323,792	2,107,546,842	1,702,892,504	-404,654,338	19%
SWALES	1,070,970,887	1,417,980,616	1,055,269,033	-362,711,582	26%
SWEST	1,895,450,847	2,510,056,203	1,882,884,992	-627,171,211	25%
WPD	**6,561,220,396**	**8,669,905,870**	**6,755,581,178**	**-1,914,324,691**	**22%**

Figure SA-06. 61: NARM network risk change, RIIO-ED2

Statistical age-based modelling (Survivor Modelling)

5.108. Since DPCR3, the industry has used survivor modelling to forecast future asset replacement volumes. Survivor models are age-based models that use age as a proxy for condition. The presumption is that as an asset ages, it is more likely to be in poorer condition and to need to be replaced.

5.109. Survivor models are applied to each asset category where age data is available and rely upon the following types of information:

- Current age profile of the asset population;
- Mean asset life expectancy;
- An assumed distribution of replacement.

5.110. It is unrealistic to assume that all assets are replaced when they reach the mean life expectancy because assets have a spread of actual lives. The statistical distribution used within survivor models determines the proportion of the original population that is replaced at different ages. This generates a spread based on a normal distribution using the mean asset life expectancy and a standard deviation.

5.111. Because it is a statistical model, the survivor model produces a forecast of the probable volume of assets that will require replacement in each future year, but not the specific assets to be replaced.

Run-rate analysis

5.112. In many cases, historical levels of asset replacement activity can give a reasonable indication of future requirements. However, using run-rates alone can lock in higher or lower levels of activity which may not adequately represent future needs if historical levels have been lower or higher than required in the future. They may also fail to capture emerging need, particularly where there is an increasing need due to a larger number of old assets, or a reducing need, where many of the older poor condition assets have been removed.

5.113. Where policy has changed during the RIIO-ED1 price control, more recent three year average run-rates can be used to give an indication of the volumes based upon the revised business practice.

Combining survivor and run-rate analysis

5.114. Survivor modelling provides an indication of the likely volumes of replacement requirement but, as a statistical model, it relies on the use of a representative mean life assumption and standard deviation for the spread across the asset ages selected for replacement. There is therefore a possible margin of error from the modelling technique.

5.115. Run-rate represents the activity actually carried out. Using run-rate for forecasting may not fully address future requirements because the network requirements may change to become lower (because the bulk of work has already been carried out) or higher (because there is a growing aging asset population).

5.116. Combining both approaches allows the run-rate to reflect actual network need and the survivor model to provide a scale of change between price controls.

5.117. In doing this, two ratios are determined:

- RIIO-ED1 run-rate vs RIIO-ED1 survivor model forecast
- RIIO-ED2 survivor model forecast vs RIIO-ED1 survivor model forecast

5.118. The first ratio determines the accuracy of the RIIO-ED1 survivor model when compared to the actual volumes delivered. For example, if the survivor predicted that 100 assets would be required but only 80 have been delivered, the ratio of 0.8 represents a run-rate adjustment that can be applied to future survivor volumes.

5.119. The second ratio compares how the survivor model forecasts have changed. This takes into account whether there is an increasing or decreasing need for replacements. For example, if the RIIO-ED1 survivor predicted 100, but the RIIO-ED2 survivor is predicting 150, the ratio of 1.5 can be used as a multiplier against the run-rate to derive a survivor model forecast adjustment to run-rates.

5.120. In combination, the RIIO-ED2 survivor model is predicting 150, but run-rate shows that 80% of the survivor volumes are delivered. Therefore, applying 80% to the RIIO-ED2 prediction gives a run rate adjusted survivor model forecast (leading to a forecast of 120 assets).

Population impacted analysis

5.121. As well as using mean life expectancy in statistical age-based modelling, it can also be used in combination with the population of assets to determine the required level of replacement activity. This is derived by dividing the overall population of assets by the life expectancy. For

example, an asset population of 100,000 assets with a mean life expectancy of 50 years would lead to 2,000 assets (2% per annum) in need of replacement.

5.122. Due to its simplistic nature, this approach is mainly used as a cross check to determine if other models are providing a reasonable answer.

Bespoke programmes

5.123. In some cases, the models do not cater for specific issues such as:

- Operational restrictions
- Associated replacement assets
- Early life failures
- High cost maintenance requirements
- Lack of availability of spares

5.124. In these cases, asset cohorts are identified for replacement due to a specific reason.

Forecasting temporal reference

5.125. The need for asset replacement is forecast using the current data about the assets. This means that the derived volumes represent the network needs from the current data temporal reference (the end of the sixth year of RIIO-ED1). Figure SA-06. 62 illustrates how the forecasting process covers the remainder of the current price control period (RIIO-ED1) and the next (RIIO-ED2). To derive the RIIO-ED2 forecast volumes, the proposed asset replacement in the remainder of RIIO-ED1 is subtracted from the overall forecast. The data presented in the remainder of this annex refers to the volumes proposed for RIIO-ED2.

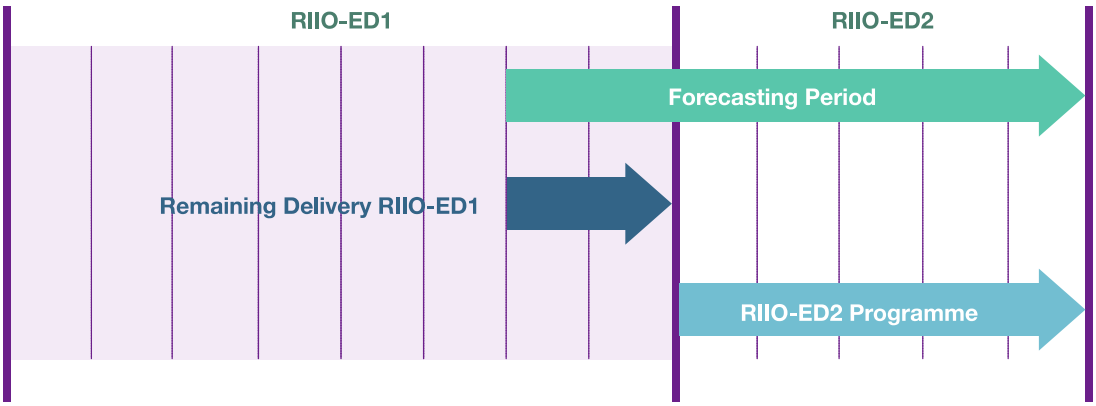


Figure SA-06. 62: Forecasting asset replacement volumes, temporal reference

Asset data used for modelling and outputs

5.126. Asset information is recorded in WPD's CROWN asset management system or Electric Office mapping system. These are prime asset record systems that incorporate the means for recording data that allows us to understand asset age, condition and criticality. This information is utilised as an input into the various forecasting models.

5.127. Condition information has been collected for a number of years; the introduction of iPad apps for inspection and maintenance during RIIO-ED1 has improved data accuracy and completeness. Data checking reports have been implemented to ensure that data is recorded for all activity events.

5.128. As technology evolves, further initiatives will be pursued to improve the quality of data capture. These include:

- Real time assessment of test / inspection results to identify and challenge unusual data entries;
- Improved condition assessment guidance to reduce subjective interpretation inconsistencies.

5.129. The data used for the forecasts is based upon data available on 31 March 2021, except survivor modelling that is based upon age profiles as at 31 March 2020.

Unit cost derivation

5.130. WPD has derived asset replacement costs by developing detailed bottom up models that represent typical work content for each asset replacement activity.

5.131. For most activities, this is based on the work content being similar across all licence areas, although regional variations are also taken into account, when calculating contract costs and asset size mixes.

5.132. The assessment considers labour content, materials and contractor costs. Material and contractor costs are based upon contemporary prices from competitively tendered contracts. Labour costs are derived from labour rates based upon pay scales negotiated with recognised unions.

5.133. For each asset replacement activity, the amount of materials, items from contractor cost schedules and amount of labour time are used as the base data. For each sub-element, an estimate is made of the number of times each sub-element would occur in an efficiently performed activity.

5.134. As an example, when replacing a pole, a pole is required every time (i.e. 100% of the time), but a stay wire is only required for every fifth pole (i.e. 20% of the time). The costs for a typical pole replacement would therefore include 100% of a new pole costs and 20% of the stay installation costs. This allows an average cost to be derived for a typical activity, taking into account the bottom up detail of work content.

5.135. Regional variations are accounted for by incorporating local contract rates. For example, there are different contracts in place for excavation activities across WPD's licence areas. These are all subject to competitive tendering processes but may vary across licence areas depending on factors such as the number of contractors operating in the area, the availability of contractors or the timing of contractual negotiations. The unit cost derivation incorporates these regional variations resulting in a range of typical costs for asset replacement activities across WPD, for some asset categories.

5.136. Asset size differences are also considered. This predominantly affects transformer asset replacement where the cost of materials reflects the combination of assets on each network. For example, in the West Midlands, there is limited 33kV network and therefore the majority of 132kV transformers are 132kV/11kV units, but in the East Midlands there is an extensive 33kV

network and therefore 132kV transformers are predominantly larger (and more expensive) 132kV/33kV units.

5.137. For some asset categories, where there is a greater reliance upon external contractors, such as tower reconductoring, unit costs have been based upon recent contract tenders to reflect current costs for delivery of the work. This has led to some regional differences.

5.138. This detailed bottom-up analysis allows greater scrutiny of the work content assumed in costs and has been verified and refined by the local teams who are directly involved in the activities. It has also been subject to an external review by consultants GHD, who assessed the process and compared the resultant unit costs to their reference database concluding that "the explanations provided by WPD and resulting unit costs for each asset are typical, accurate and efficient"[1].

5.139. For most asset replacement activities the unit costs are the same across all four WPD licence areas, with some minor variations due to pension costs. The following table Figure SA-06. 63 summarises the asset categories where different unit costs have been used and why.

Asset replacement unit cost differences	
Asset category	**Reason for variation**
LV Main (UG Plastic)	Different contractor rates across the licence areas
6.6/11kV UG Cable	Different contractor rates across the licence areas
6.6/11kV Transformer (PM)	Takes into account the mix of transformer types (i.e. transformer rating) forecast to be installed
6.6/11kV Transformer (GM)	Takes into account the mix of transformer types (i.e. transformer rating) forecast to be installed
33kV Transformer (GM)	Takes into account the mix of transformer types (i.e. transformer rating) forecast to be installed
66kV Transformer (GM)	Takes into account the mix of transformer types (i.e. transformer rating) forecast to be installed
132kV Transformer (GM)	Takes into account the mix of transformer types (i.e. transformer rating) forecast to be installed
33kV Switchgear - Other	Greater use of motorised disconnectors in some licence areas
33kV CB (Air Insulated Busbar) (ID)(GM	Differences in amount of consequential cable requirements associated with switchgear replacement
132kV Fittings	Incorporates higher tender prices for working on lines with greater number of road/rail crossings and associated scaffold protection due to more urban tower routes
132kV OHL (Tower Line) Conductor	Incorporates higher tender prices for working on lines with greater number of road/rail crossings and associated scaffold protection due to more urban tower routes

Figure SA-06. 63: Summary of asset categories where different unit costs have been used across WPD

[1] GHD (November 2021, Unit Cost Process Review: Assurance of process for RIIO-ED2 Business Plan Submission, pg ii

Forecasting approach for each asset category

5.140. In many cases, a number of different modelling approaches are considered together to derive a balanced judgement on the asset replacement forecast, as summarised in Figure SA-06. 64.

Forecasting approach for each asset category		
Asset Category	**NARM/ Non-NARM**	**Main Forecasting Approach**
UG – LV main (Consac)	Non-NARM	Combination of survivor model/run-rate uplifted to deal with high fault rates
UG – LV main (Paper)	Non-NARM	Combination of survivor model/run-rate and removal of VB cable
UG – LV main (Plastic)	Non-NARM	No forecast removals, all costs shown against this asset due to additions being plastic
UG – LV service replacement	Non-NARM	Run-rates with some additions for replacement of undereaves
UG – HV cable	Non-NARM	Combination of survivor model/run-rate uplifted to deal with increasing fault rates
UG – 33kV, 66kV and 132kV cable (non-pressurised)	NARM	NARM / local knowledge
UG – 33kV, 66kV and 132kV cable (oil)	NARM	NARM / local knowledge
UG – 33kV, 66kV and 132kV cable (gas)	NARM	NARM / local knowledge
OH – Services	Non-NARM	Run-rates with additional removals for undereaves
OH – LV, HV, 33kV, 66kV and 132kV pole conductor	Non-NARM	Survivor model/run-rate
OH – 33kV, 66kV and 132kV tower conductor	NARM	NARMS/run-rates/local knowledge
OH – LV, HV, 33kV, 66kV and 132kV pole	NARM	Combination of survivor model/run-rate
OH – Tower replacement	NARM	Informed by local knowledge (most activity is refurbishment)
OH – Tower refurbishment	NARM	Combination of NARM/run-rates
OH – Tower fitting replacement	NARM	Combination of NARM/run-rates/local knowledge
SG – Cut-out replacement	Non-NARM	Run-rates
SG – LV pillar replacement	NARM	NARM / run-rates
SG – UGB and pillars not at substations	NARM	NARM / run-rates
SG – HV ground mounted switchgear (Secondary)	NARM	NARM / run-rates. Assessment of associated equipment
SG – HV ground mounted switchgear (Primary)	NARM	NARM / local knowledge of issues at HV boards
SG – HV PM switchgear	Non-NARM	Run-rates
SG – 33kV, 66kV and 132kV switchgear	NARM	Combination of NARM / local knowledge
TX – HV ground mounted transformers	NARM	Combination of NARM / run-rates / survivor model
TX – HV pole mounted transformers	Non-NARM	Survivor model/run-rates
TX – 33kV, 66kV and 132kV transformers	NARM	Combination of NARM/ local knowledge (volumes generally lower than NARM suggests)
PR – Batteries	Non-NARM	Run-rates / application of policy for replacement of short life assets
Civil driven by asset replacement	Non-NARM	Derived from forecast plant asset volumes

Figure SA-06. 64: Summary of forecasting approach for each category of asset replacement

5.141. Figure SA-06. 65 summarise that £1.08 billion will be spent on asset replacement over RIIO-ED2. In addition there will be £61m of civils costs that will arise as a consequence of carrying out the asset replacement.

Asset Replacement Expenditure RIIO-ED2 (£m 2020/21)					
	West Midlands	East Midlands	South Wales	South West	WPD Total
LV Overhead Pole Line	22	12	13	40	87
LV Cable	26	11	3	11	51
LV Service	12	7	8	9	37
LV Switchgear	23	28	9	22	81
HV Overhead Pole Line	33	21	38	62	154
HV Cable	11	17	5	3	36
HV Switchgear	22	29	10	32	92
HV Transformer	13	20	14	24	71
HV Batteries	0	0	0	0	1
EHV Overhead Pole Line	7	7	11	9	34
EHV Overhead Tower Line	6	2	1	0	9
EHV Cable	7	9	1	10	27
EHV Switchgear	5	16	4	12	37
EHV Transformer	18	31	16	31	97
EHV Batteries	2	2	0	2	6
132kV Overhead Pole Line	0	0	2	0	2
132kV Overhead Tower Line	15	27	7	28	77
132kV Cable	41	21	7	2	72
132kV Switchgear	31	8	4	3	46
132kV Transformer	18	19	13	8	57
132kV Batteries	1	1	0	0	3
Other	0	1	0	0	1
TOTAL	**312**	**290**	**165**	**312**	**1,078**

Figure SA-06. 65: RIIO-ED2 forecast total expenditure - asset replacement by major category

5.142. Asset replacement is spread broadly across all voltages with most expenditure at HV. The split across assets types shows that most expenditure will be on overhead lines. Figure SA-06. 66 presents the proportions by voltage and by asset type.

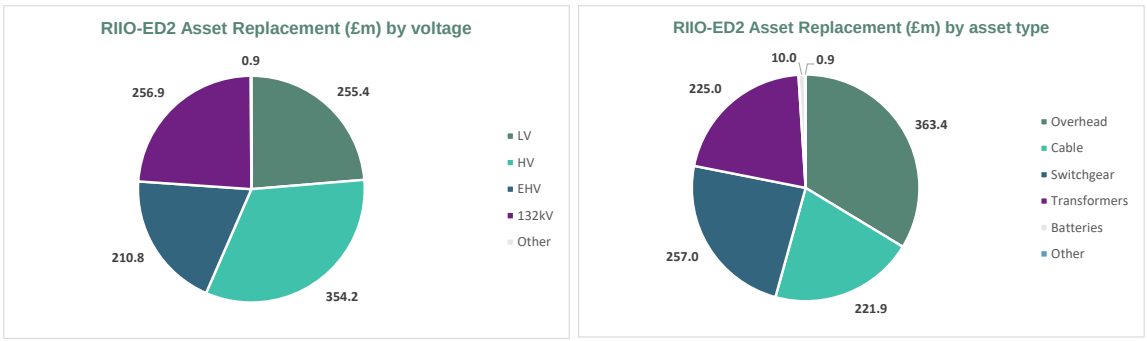


Figure SA-06. 66: RIIO-ED2 forecast total expenditure - asset replacement by voltage and asset type

5.143. Figure SA-06. 67 summarise that £139 million will be spent on asset refurbishment over RIIO-ED2.

Asset Refurbishment Expenditure RIIO-ED2 (£m 2020/21)					
	West Midlands	East Midlands	South Wales	South West	Total
LV Overhead Pole Line	3	3	1	2	8
LV Cable	0	0	0	0	0
LV Service	11	2	1	5	20
LV Switchgear	0	0	0	0	0
HV Overhead Pole Line	11	5	5	7	28
HV Cable	0	0	0	0	0
HV Switchgear	0	0	0	0	0
HV Transformer	0	0	0	0	0
HV Batteries	0	0	0	0	0
EHV Overhead Pole Line	1	1	1	1	3
EHV Overhead Tower Line	3	2	1	1	7
EHV Cable	0	0	0	0	1
EHV Switchgear	0	0	0	0	0
EHV Transformer	0	1	0	1	2
EHV Batteries	0	0	0	0	0
132kV Overhead Pole Line	0	0	0	0	0
132kV Overhead Tower Line	6	6	14	12	37
132kV Cable	4	2	3	2	10
132kV Switchgear	0	0	0	0	0
132kV Transformer	1	0	1	1	2
132kV Batteries	0	0	0	0	0
Other	7	7	5	3	21
TOTAL	**46**	**29**	**30**	**34**	**139**

Figure SA-06. 67: RIIO-ED2 forecast total expenditure - asset refurbishment by major category

5.144. The majority of asset refurbishment will be on overhead line networks with the activity spread across the voltage range with work taking place on both wooden pole and tower lines. LV services are higher in West Midlands and South West due to service transfers associated with additional LV Consac cable replacement. Figure SA-06. 68 presents the proportions by voltage and by asset type.

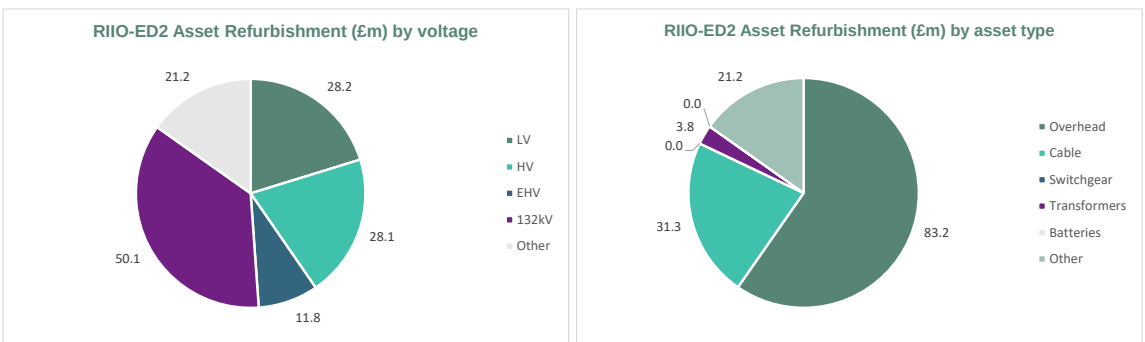


Figure SA-06. 68: RIIO-ED2 forecast total expenditure - asset refurbishment by voltage (LHS) and asset type (RHS)

Longer term requirements

5.145. The asset replacement forecast for RIIO-ED2 must consider the specific needs during the next price control. However, it is important to consider the longer term requirements to determine whether future requirements are increasing or decreasing.

5.146. The most appropriate modelling tool to provide an indication of longer term asset replacement requirements is statistical survivor modelling. This primarily considers the impact of an ageing network and predicts the volumes of replacement requirements.

5.147. This analysis is possible for any asset category where age data is available. In order to show data on a comparable basis, the following charts are presented using Modern Equivalent Asset Value (MEAV) derived from the unit costs used for the RIIO-ED2 asset replacement forecast.

5.148. Due to the high volume of different asset categories, the data has been summarised by voltage and by asset type to provide an indication of which parts of the network will see the greatest change in need for asset replacement over the longer term.

5.149. The data is presented for WPD as a whole and also for each licence area.

WPD total

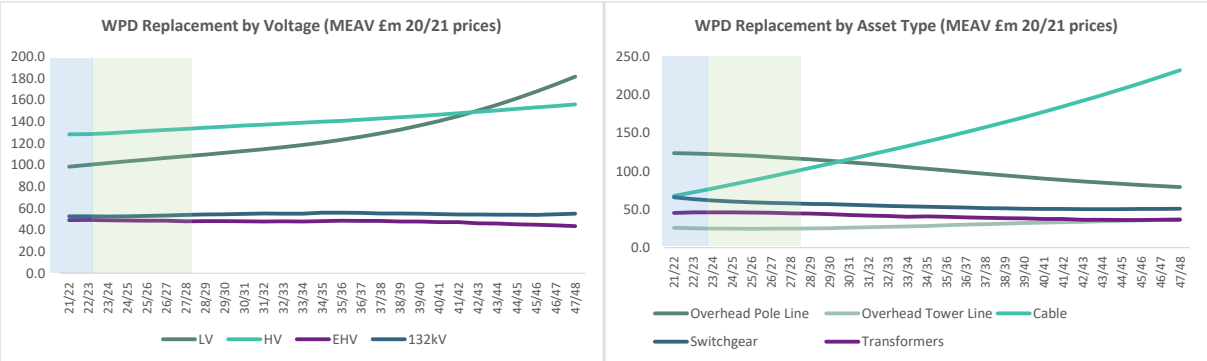


Figure SA-06. 69: WPD - Replacement MEAV expenditure split by voltage and asset type

5.150. For WPD, the main observations for Figure SA-06. 69 by voltage are:

- Replacement on LV and HV parts of the network continues to rise for the foreseeable future;
- By 2040, there is an exponential growth on the LV networks;
- For EHV and 132kV, expenditure requirements remain broadly flat.

5.151. The main observations for Figure SA-06. 69 by asset type are:

- Switchgear and transformer expenditure reduces slightly;
- Overhead pole line reduces by half by 2048;
- Overhead tower line work steadily increases;
- Most notably, cable replacement increases significantly and is approximately four times larger by 2048.

5.152. In totality, asset replacement requirements continue to increase, primarily driven by an increased need for cable replacement work, over the next five price controls up to 2048.

West Midlands

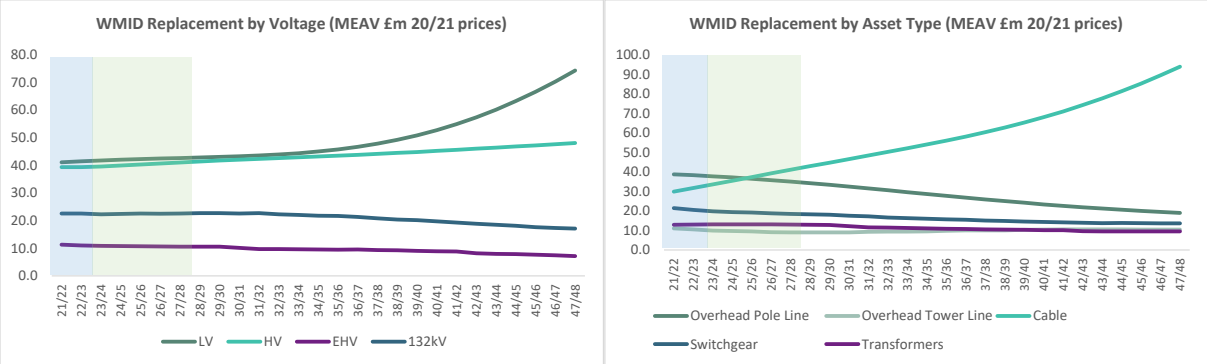


Figure SA-06. 70: WMID - Replacement MEAV expenditure split by voltage and asset type

5.153. For the West Midlands, the main observations of Figure SA-06. 70 are very similar to the overall WPD position:

- Replacement on LV and HV parts of the network continues to rise for the foreseeable future;
- Switchgear and transformer expenditure reduces slightly;
- Overhead pole line reduces by half by 2048;
- Overhead tower line work steadily increases;
- Cable replacement increases significantly and is approximately three times larger by 2048.

East Midlands

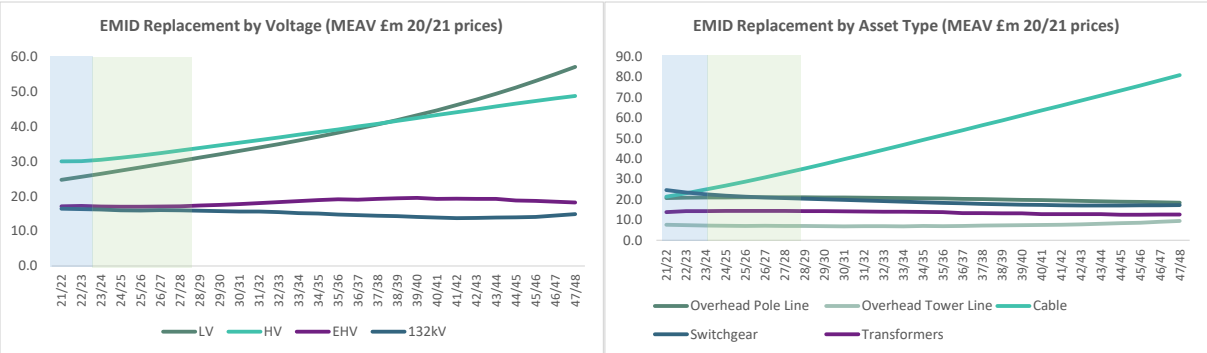


Figure SA-06. 71: EMID - Replacement MEAV expenditure split by voltage and asset type

5.154. For the East Midlands, the main observations of Figure SA-06. 71 are very similar to the overall WPD position:

- Replacement on LV and HV parts of the network continues to rise for the foreseeable future;
- Switchgear and transformer expenditure reduces slightly;
- Overhead pole line reduces slightly;
- Overhead tower line work steadily increases;
- Cable replacement increases significantly and is approximately four times larger by 2048.

South Wales

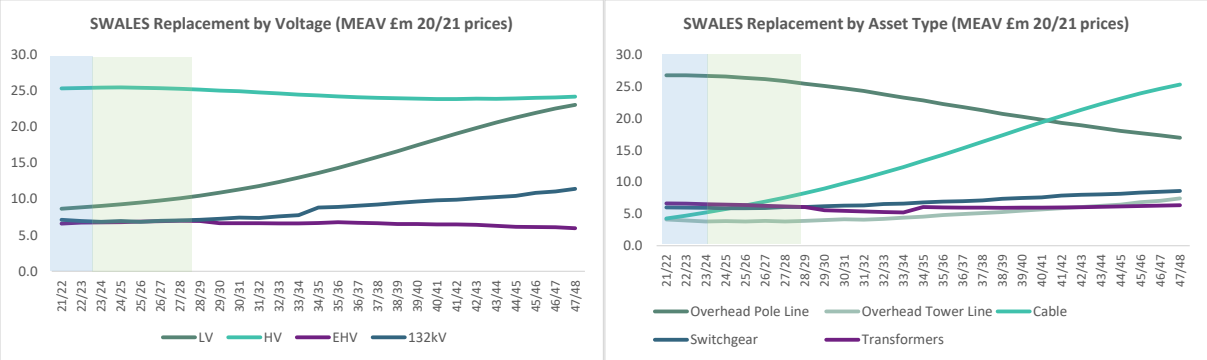


Figure SA-06. 72: SWALES - Replacement MEAV expenditure split by voltage and asset type

5.155. For South Wales, the main observations of Figure SA-06. 72 are slightly different to the overall WPD position:

- Replacement on LV part of the network continues to rise for the foreseeable future, but the requirement on the HV network remains the dominant area of expenditure;
- Switchgear and transformer expenditure increases slightly;
- Overhead pole line steadily reduces, but remains the dominant area of expenditure until circa 2040 when cable replacement starts to dominate;
- Overhead tower line work steadily increases;
- Cable replacement increases significantly and is approximately five times larger by 2048.

South West

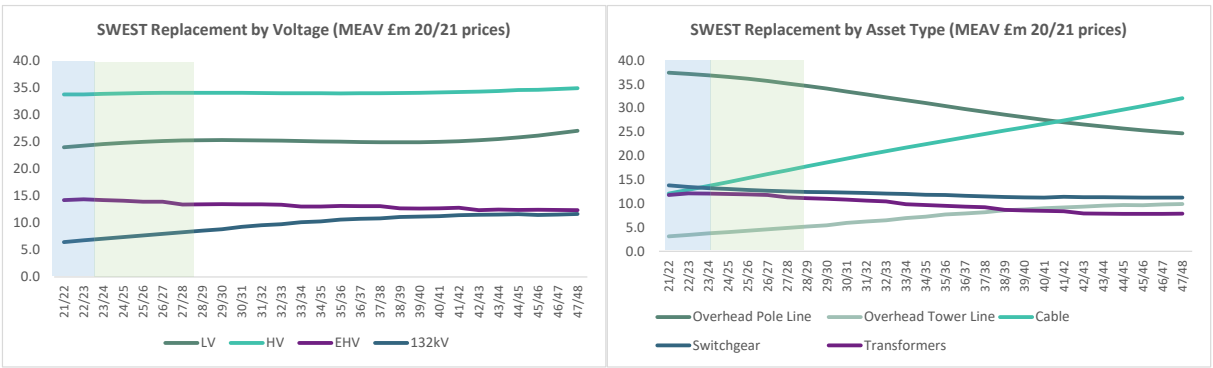


Figure SA-06. 73: SWEST - Replacement MEAV expenditure split by voltage and asset type

5.156. For the South West, the main observations of Figure SA-06. 73 are slightly different to the overall WPD position:

- Replacement on all voltages remains broadly steady across all voltage levels.
- Switchgear and transformer expenditure decreases slightly;
- Overhead pole line steadily reduces, but remains the dominant area of expenditure until circa 2040 when cable replacement starts to dominate;
- Overhead tower line work increases significantly and approximately three times larger by 2048;
- Cable replacement increases significantly and is approximately three times larger by 2048.

Asset replacement and refurbishment details

5.157. The following sections provide specific details, volumes and costs for each asset category.

5.158. The majority of the data presented relates to asset replacement but, where relevant, data is also provided for refurbishment.

5.159. For asset replacement, the costs are based upon the assets installed. This is consistent with the regulatory guidance on submitting cost data. This means that, for some asset categories, there may not be any expenditure shown, especially where non like-for-like replacement is carried out. For example, LV Consac cable is no longer used and, when removed, is replaced with new plastic cables leading to volumes of removals being shown against LV Consac and volumes of additions and associated costs shown against LV plastic cable.

Underground cables

LV main (underground Consac cable)

5.160. WPD has 5,400km of Consac cable predominantly installed in the West Midlands (3,400km) and the South West (2,100km). This aluminium cable was largely installed in the 1970s as a lower cost alternative cable. Consac cable is prone to faults, mainly caused by water ingress where cables are jointed together. The joints on an individual cable were mostly installed at the same time, meaning faults can occur in geographical clusters causing repeat interruption and nuisance for customers.

5.161. In addition, the cable construction provides limited protection from damage. The outer neutral earth conductor is made from aluminium, covered in a thin layer of bitumen and a PVC oversheath. Protrusions from stones or third party excavations can damage the oversheath leading to water ingress and corrosion of the aluminium. Where the corrosion affects the integrity of the neutral earth, there is a potential for higher operating voltages to occur that can cause damage to customers' appliances.

5.162. When circuits are beyond their useful life because of their condition (i.e. where there are multiple failures and neutral faults), they will be replaced with modern plastic insulated cables.

5.163. During RIIO-ED2, approximately 3.5% of the Consac cable population in the West Midlands and South West will be replaced. This represents an increase compared to historical run-rates, which is expected to increase further in future price controls as more of the Consac cable becomes unreliable. Figure SA-06. 74 summarises our proposed activity and expenditure for Consac cable.

LV Main (UG Consac) (Mean life 55 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	3,351	120	0.7%	0	0
East Midlands	12	2	3.4%	0	0
South Wales	0	0	0.0%	0	0
South West	2,063	67	0.6%	0	0
Total	**5,427**	**189**	**0.7%**	**0**	**0**

Figure SA-06. 74: RIIO-ED2 asset replacement - LV Main (UG Consac)

LV main (underground paper insulated cable)

5.164. The majority of the low voltage network built before the 1970s is constructed using paper insulated cables. The robust construction of these cables incorporates lead sheaths and steel tapes wrapped around the lead providing good physical protection. It is expected that these cables will last a long time with average lives of 100 years.

5.165. There are pockets of the network where joints on the paper LV cables have deteriorated and cause repeat interruptions to customers. These generally occur during wet weather when water ingress leads to faults. The faults cause substation fuses to blow, but in many circumstances do not lead to a permanent fault (which means that the faults are difficult to locate). In practice, the fuses are replaced and all customers are restored until the next period of heavy rain where the circuit faults again. This causes a nuisance for customers.

5.166. Developments in LV fault technology means that these intermittent faults can more readily be located. When fuses operate, the devices can be installed; some have a reclosing function that restores the customers without the need for a site visit, but the greatest benefit is that some have inbuilt fault locating capability that provides an indicative location for the fault. This means that proactive action can be taken using the data to replace the cables before they fault again.

5.167. Historically, these cables have not been overlaid until several permanent faults have occurred. With better fault location and the increasing reliance on electricity for heating, transport and distributed generation, the volume of these repeat interruptions needs to be limited and replacement considered earlier. Even so, the volume of replacement is a very small proportion of the population of assets as summarised in Figure SA-06. 75.

LV Main (UG Paper) (Mean life 100 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	15,691	63	0.1%	0	0
East Midlands	17,104	42	0.0%	0	0
South Wales	4,792	13	0.1%	0	0
South West	6,398	26	0.1%	0	0
Total	**43,984**	**144**	**0.1%**	**0**	**0**

Figure SA-06. 75: RIIO-ED2 asset replacement - LV Main (UG Paper)

LV main (underground plastic insulated cable)

5.168. There are two main types of plastic cables; the main difference between the two is the material used for the neutral earth waveform wire conductor. The cable currently used throughout WPD has copper as the neutral earth, laid on top of soft plastic bedding used mainly to hold the waveform wires in place. The alternative (previously installed in South Wales and the East Midlands) uses aluminium for the neutral earth but, as aluminium is more susceptible to corrosion, it is totally encased in the bedding, giving it more protection from moisture. However, if the cable is damaged, there can be progressive corrosion of the aluminium neutral earth wires that eventually leads to loss of continuity of the neutral conductor (albeit after a long time).

5.169. No volumes are forecast for removal, even though a very small volume of underground plastic insulated cables may be replaced where damage is found to have caused corrosion of the neutral.

5.170. The volume of assets installed and their associated costs, as summarised in Figure SA-06. 76, represents the total volume resulting from the replacement of all types of LV cable (plus a volume for where LV cables are installed as a replacement for LV overhead lines and where undereaves are converted to underground services).

LV Main (UG Plastic) (Mean life 90 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	8,670	0	0.0%	214	26
East Midlands	18,381	0	0.0%	92	11
South Wales	6,579	0	0.0%	31	3
South West	6,035	0	0.0%	109	11
Total	**39,664**	**0**	**0.0%**	**447**	**51**

Figure SA-06. 76: RIIO-ED2 asset replacement - LV Main (UG Plastic)

LV service (underground)

5.171. Service work will generally be carried out in coordination with LV mains cable replacement. Most of the activity involves reconnecting the existing service cable to the new main (service transfers), usually by letting in a new short length of service cable. Under reporting rules, these costs are included in refurbishment costs. The higher volume of service transfers illustrated in Figure SA-06. 77 in the West Midlands and South West is due to service transfers associated with LV Consac mains cable replacement.

LV Underground service transfers			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	18,178	0.14%	10
East Midlands	3,740	0.03%	2
South Wales	845	0.02%	1
South West	5,245	0.07%	3
Total	**28,008**	**0.07%**	**15**

Figure SA-06. 77: RIIO-ED2 asset replacement - LV UG service transfers

5.172. In some instances, where the existing service cable is found to be in poor condition, the service will be replaced in its entirety. The volume of replacement carried out is a very small proportion of the population, as summarised in Figure SA-06. 78.

LV Service (UG) (Mean life 100 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	2,681,518	4,135	0.0%	5,275	8
East Midlands	2,874,688	3,725	0.0%	4,505	6
South Wales	953,200	1,335	0.0%	3,625	6
South West	1,489,972	2,935	0.0%	4,235	6
Total	**7,999,378**	**12,130**	**0.0%**	**17,640**	**27**

Figure SA-06. 78: RIIO-ED2 asset replacement - LV Service (UG)

Rising and lateral mains (RLM)

5.173. During RIIO-ED1, WPD has been surveying the service arrangements to multi-occupancy buildings to determine ownership of equipment. This work has primarily focused on the equipment at intake locations. Equipment ownership schedules have been drawn up and agreements established with building owners. It is expected that WPD will have to carry out certain works to remedy specific issues and therefore a small amount of funding is proposed. More details are provided in the section specifically on Rising and Lateral Mains.

HV underground cable

5.174. Before the 1990s, most HV cable was paper insulated and came in varying designs. Earlier cables constructed with lead sheaths and steel wire armours were replaced with corrugated aluminium sheaths and plastic outer sheaths. More recent designs of cable have used cross linked polyethylene (XLPE) or ethylene propylene rubber (EPR) as the main insulation medium instead of impregnated paper.

5.175. The main problems encountered in HV paper cables relate to the drying out of the oil-based mineral from paper insulation, causing discharge to occur and a fault to develop.

5.176. XLPE cables can also be susceptible to deterioration of the insulation. The deterioration weakens the insulating strength and leads to failure. The deterioration is accelerated where impurities have been introduced into the insulating material during the manufacturing process.

The degree of contamination in the insulation will determine whether there are individual point defects or whether whole cable lengths are affected.

5.177. In the past, many 6.6kV networks have been uprated to 11kV by changing transformers but leaving old cables in situ, thereby providing greater network capacity without the cost of replacing cables. However, due to prolonged operation at higher operating voltages, these cables are now showing signs of stress and insulation degradation.

5.178. HV cable replacement will be considered where there is a history of faults or where condition assessment at time of fault identifies that the insulation is dry or in poor condition. The overall volume being proposed for replacement is very small, as summarised in Figure SA-06. 79. At the proposed replacement rate, it would take over 1000 years to replace the population, which is why we anticipate an increase in requirements in future price controls.

5.179. The volume of assets installed is higher than the volume removed because HV cables are installed as a replacement for a proportion of the HV overhead lines being replaced.

6.6/11kV UG Cable (Mean life 87 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	13,779	54	0.1%	85	11
East Midlands	15,761	75	0.1%	137	17
South Wales	5,999	38	0.1%	44	5
South West	7,670	23	0.1%	31	3
Total	**43,209**	**190**	**0.1%**	**297**	**36**

Figure SA-06. 79: RIIO-ED2 asset replacement - 6.6/11kV UG cable

33kV, 66kV and 132kV underground cable (non-pressurised)

5.180. Older types of non-pressurised cables are constructed using paper insulation. Insulation degradation, such as observed in HV cables, is the main reason for any replacement. Most of the activity will be replacing 33kV cable, but the amount proposed for replacement is a small amount. Figure SA-06. 80 to Figure SA-06. 82 summarise our RIIO-ED2 proposals.

5.181. Volumes of asset additions are higher than asset removals because additional plastic non-pressurised cables will be installed as replacements for fluid filled cables.

33kV UG Cable (Non Pressurised) (Mean life 75 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	377	4	0.2%	24	6
East Midlands	2,328	16	0.1%	35	9
South Wales	532	4	0.2%	4	1
South West	1,109	19	0.3%	38	10
Total	**4,346**	**43**	**0.2%**	**101**	**27**

Figure SA-06. 80: RIIO-ED2 asset replacement - 33kV UG cable (non pressurised)

66kV UG Cable (Non Pressurised) (Mean life 70 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	101	0	0.0%	1	0
East Midlands	0	0	0.0%	0	0
South Wales	17	0	0.0%	0	0
South West	0	0	0.0%	0	0
Total	**119**	**0**	**0.0%**	**1**	**0**

Figure SA-06. 81: RIIO-ED2 asset replacement - 66kV UG cable (non pressurised)

132kV UG Cable (Non Pressurised) (Mean life 65 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	143	0	0.0%	37	41
East Midlands	148	0	0.0%	16	21.5
South Wales	46	0	0.0%	7	7
South West	40	0	0.0%	3	2
Total	**377**	**0**	**0.0%**	**63**	**72**

Figure SA-06. 82: RIIO-ED2 asset replacement - 132kV UG cable (non pressurised)

33kV, 66kV and 132kV underground cable (oil filled)

5.182. A large proportion of 33kV, 66kV and 132kV underground cables are constructed using a biodegradable oil-based fluid that enhances the insulating properties by maintaining the integrity of paper insulation reducing the likelihood of electrical discharge. This construction makes the cables extremely reliable electrically but does pose the risk of fluid leakage. The potential environmental impact of fluid leakage has been identified as an area of concern by stakeholders who want to see proactive management of fluid filled cables. We propose to remove 15% of the overall population during RIIO-ED2.

5.183. Prioritised replacement programmes are derived using information on leakage rates, the cause of leaks and their environmental impact. Priority is given to those cables with condition deficiencies such as porous lead sheathing and those that pass through Environment Agency 'Source Protection Zones'.

5.184. As Figure SA-06. 83 to Figure SA-06. 85 shows, no forecast costs are shown against these asset categories because these cables are replaced with non-pressurised cables.

33kV UG Cable (Oil) (Mean life 70 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	46	12	5.0%	0	0
East Midlands	148	19	2.5%	0	0
South Wales	0	0	0.0%	0	0
South West	53	19	7.3%	0	0
Total	**246**	**49**	**4.0%**	**0**	**0**

Figure SA-06. 83: RIIO-ED2 asset replacement - 33kV UG cable (oil)

66kV UG Cable (Oil) (Mean life 70 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	6	1	2.0%	0	0
East Midlands	0	0	0.0%	0	0
South Wales	2	0	0.0%	0	0
South West	0	0	0.0%	0	0
Total	**7**	**1**	**1.5%**	**0**	**0**

Figure SA-06. 84: RIIO-ED2 asset replacement - 66kV UG cable (oil)

132kV UG Cable (Oil) (Mean life 65 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	226	37	3.3%	0	0
East Midlands	116	7	1.2%	0	0
South Wales	57	7	2.5%	0	0
South West	60	3	0.9%	0	0
Total	**458**	**54**	**2.4%**	**0**	**0**

Figure SA-06. 85: RIIO-ED2 asset replacement - 132kV UG cable (oil)

33kV, 66kV and 132kV underground cable (gas filled)

5.185. As an alternative to using oil-based fluid, some cables use inert gas under pressure to fill any voids between papers within the insulation. Internal gas pressure cables incorporate porous pipes within their construction to distribute the gas along the cable length. The cable is prevented from bursting by being wrapped with springy metal tapes. These tapes can corrode causing weak points and gas leaks. Leaks can also develop at joint interfaces.

5.186. An alternative construction uses an external steel pipeline with sections welded together to create a homogenous tube in which the cores are laid. The whole pipeline is pressurised with the gas filling the voids between the paper insulation by external pressure on the cores. The main problem with this cable arises when the pipeline becomes depressurised as a result of damage, leaks or during a fault repair. Once depressurised, moist air may enter the pipeline and penetrate into the cores leading to increased likelihood of failure. Once a failure occurs, repeat failures become common, causing severe risk to network security.

5.187. We have ongoing work in the South West to replace the existing 33kV gas cables in RIIO-ED1 and we propose to replace the 2km of 33kV gas cable in the West Midlands during RIIO-ED2. We have no gas cable at 66kV and do not propose any work at 132kV. Figure SA-06. 86 and Figure SA-06. 87 summarises our RIIO-ED2 proposals for 33kV and 132kV cable.

5.188. No forecast costs are shown against these asset categories because these cables are replaced with non-pressurised cables.

33kV UG Cable (Gas) (Mean life 70 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	2	2	20.0%	0	0
East Midlands	0	0	0.0%	0	0
South Wales	2	0	0.0%	0	0
South West	24	0	0.0%	0	0
Total	**27**	**2**	**1.3%**	**0**	**0**

Figure SA-06. 86: RIIO-ED2 asset replacement - 33kV UG cable (gas)

132kV UG Cable (Gas) (Mean life 65 years)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	8	0	0.0%	0	0
East Midlands	0	0	0.0%	0	0
South Wales	0	0	0.0%	0	0
South West	0	0	0.0%	0	0
Total	**8**	**0**	**0.0%**	**0**	**0**

Figure SA-06. 87: RIIO-ED2 asset replacement - 132kV UG cable (gas)

Overhead lines

5.189. Overhead lines can be subdivided into five main sub elements:

- The conductor;
- The support, either a steel tower or wooden, metal, concrete or composite pole;
- Pole fittings, including pole top steelwork, insulators, stays and anti-climbing devices;
- Tower fittings, including insulator strings, vibration dampers, shackles and clamps;
- Tower access and security measures, including anti-climbing devices, access gates and step-bolts.

5.190. The wholesale replacement of conductor, a support (pole or tower) and tower fittings is classified as asset replacement.

5.191. Where pole top fittings are replaced at the same time as the pole itself, this work is incorporated into the asset replacement costs.

5.192. Costs are classified as refurbishment where pole top fittings are replaced without changing the pole; sections of tower steelwork are renewed without wholesale tower replacement or components such as tower access and security measures are replaced.

5.193. Costs for both replacement and refurbishment activity on overhead lines are detailed below.

LV service (overhead)

5.194. Overhead line services provide connections to properties from overhead main lines. They are generally supported on wall brackets on buildings before being clipped down or along external walls for entry into service positions. Overhead line services will be replaced where they are found to be in poor condition during main line or pole replacement.

5.195. Some properties are serviced by undereave installations (sometimes referred to as house service overhead system (HSOS)) where a main line, either underground or overhead, terminates in a wall mounted distribution box and service cables are cleated along property walls, sometimes crossing a number of properties. The insulation on older cables is made from jute-covered butyl insulation that perishes, becomes brittle and cracks over time. The insulation can easily be dislodged by homeowners using ladders, thereby causing a safety hazard. Undereaves services that are in poor condition will either be replaced with modern service cables or, where there are several properties fed from the undereaves, the service arrangements will be changed to feed them from underground cables.

5.196. Figure SA-06. 88 summarises our proposed activity and costs for LV services (OHL). There are fewer services being installed than removed because some overhead lines will be replaced by underground arrangements.

LV Service (OHL) (Mean life 55 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	254,943	13,390	1.1%	12,250	4
East Midlands	137,620	3,095	0.4%	2,315	1
South Wales	317,000	6,090	0.4%	3,800	1
South West	442,000	9,300	0.4%	8,000	3
Total	**1,151,563**	**31,875**	**0.6%**	**26,365**	**10**

Figure SA-06. 88: RIIO-ED2 asset replacement - LV service (OHL)

LV, HV, 33kV, 66kV and 132kV poles

5.197. The majority of the overhead line network is supported on wooden poles. They have been impregnated to slow down the rate of degradation. While this prolongs their life, they do progressively decay, especially at ground level, and are susceptible to woodpecker damage.

5.198. Poles have traditionally been impregnated with creosote but alternative substances such as water soluble copper treatment have also been used. WPD starting using copper treated poles in 2006 but experience has shown that life expectancy is much shorter than creosote impregnated poles.

5.199. At WPD, we place a very high priority on the replacement of poor condition wooden poles and have KPIs in place to ensure that poor condition poles are removed from the network within a year of being identified.

5.200. This activity removes weak points from overhead line networks. This not only reduces safety risks and but also reduces the likelihood of failure during severe weather conditions (therefore limiting the impact of storms on customers).

5.201. When poles are replaced, the associated steelwork, insulators, anti-climbing devices and stays are also renewed. Where an overhead line is upgraded, not all poles may need to be replaced but the pole top equipment can be in poor condition; in these instances, the replacement of pole top equipment is treated as pole refurbishment.

5.202. WPD has identified a specific issue with a type of insulator arrangement used on HV circuits known as ‘swan necks’. It has been found that some larger conductors terminated on the fittings can wear and fail. When these failures occur, the conductors can hang low causing dangerous situations for the public and livestock. A programme of identifying the locations of all swan necks has started with a view to replacing them during RIIO-ED2. Where they are associated with poor condition poles or the poles are older than 60 years, the poles will also be replaced.

5.203. EU legislation, The Biocidal Products Directive, may result in prohibition of the use of creosote as a wood preserver. The regulations are currently under review and could lead to a ban on the use of creosote during RIIO-ED2, although the utility industry has petitioned for a further five year extension to the permitted use of creosoted poles. The alternative impregnation substances are less effective than creosote and alternatives to wooden poles are more

expensive; composite material poles are estimated to be three times the cost of wooden poles while concrete poles are five times more expensive.

5.204. WPD's cost forecasts are based upon the continued use of the creosote impregnated poles. It does not include any additional costs for alternative types. The volumes and costs for pole replacement and refurbishment for all voltage levels are shown in Figure SA-06. 89 to Figure SA-06. 98.

LV Poles (Mean life 60 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	141,321	9,680	1.4%	9,215	17
East Midlands	104,370	6,345	1.2%	5,500	10
South Wales	103,626	6,615	1.3%	6,565	12
South West	196,044	18,500	1.9%	18,370	34
Total	**545,361**	**41,140**	**1.5%**	**39,650**	**73**

Figure SA-06. 89: RIIO-ED2 asset replacement - LV poles

LV pole refurbishment			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	13,116	1.9%	3
East Midlands	13,545	2.6%	3
South Wales	4,185	0.8%	1
South West	11,803	1.2%	2
Total	**42,649**	**1.6%**	**8**

Figure SA-06. 90: RIIO-ED2 asset refurbishment - LV poles

6.6/11kV Poles (Mean life 60 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	200,500	10,390	1.0%	10,075	24
East Midlands	147,741	6,545	0.9%	5,920	14
South Wales	159,546	15,325	1.9%	15,265	36
South West	212,143	19,500	1.8%	19,425	46
Total	**719,930**	**51,760**	**1.4%**	**50,685**	**120**

Figure SA-06. 91: RIIO-ED2 asset replacement - 6.6/11kV poles

HV pole refurbishment			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	19,291	1.9%	11
East Midlands	11,069	1.5%	5
South Wales	12,236	1.5%	5
South West	15,225	1.4%	7
Total	**57,821**	**1.6%**	**28**

Figure SA-06. 92: RIIO-ED2 asset refurbishment - 6.6/11kV poles

33kV Pole (Mean life 60 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	10,939	650	1.2%	590	2
East Midlands	25,904	1,605	1.2%	1,605	5
South Wales	15,933	1,735	2.2%	1,735	6
South West	29,377	2,025	1.4%	2,025	7
Total	**82,153**	**6,015**	**1.5%**	**5,955**	**20**

Figure SA-06. 93: RIIO-ED2 asset replacement - 33kV poles

33kV pole refurbishment			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	739	1.4%	1
East Midlands	855	0.7%	1
South Wales	480	0.6%	0
South West	540	0.4%	1
Total	**2,614**	**0.6%**	**2**

Figure SA-06. 94: RIIO-ED2 asset refurbishment - 33kV poles

66kV Pole (Mean life 60 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	8,999	650	1.4%	650	3
East Midlands	0	0	0.0%	0	0
South Wales	4,855	770	3.2%	770	3
South West	0	0	0.0%	0	0
Total	**13,854**	**1,420**	**2.0%**	**1,420**	**6**

Figure SA-06. 95: RIIO-ED2 asset replacement - 66kV poles

66kV pole refurbishment			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	135	0.30%	0
East Midlands	0	0.00%	0
South Wales	235	0.97%	0
South West	0	0.00%	0
Total	**370**	**0.53%**	**0**

Figure SA-06. 96: RIIO-ED2 asset refurbishment - 66kV poles

132kV Pole (Mean life 60 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	2	0	0.0%	0	0
East Midlands	294	0	0.0%	0	0
South Wales	1,796	100	1.1%	100	1
South West	574	15	0.5%	15	0
Total	**2,666**	**115**	**0.9%**	**115**	**1**

Figure SA-06. 97: RIIO-ED2 asset replacement - 132kV poles

132kV pole refurbishment			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	0	0.0%	0
East Midlands	0	0.0%	0
South Wales	35	0.4%	0
South West	0	0.0%	0
Total	**35**	**0.3%**	**0**

Figure SA-06. 98: RIIO-ED2 asset refurbishment - 132kV poles

LV main (overhead conductor)

5.205. Low voltage overhead lines have traditionally been constructed with bare copper conductors spaced in an open vertical formation supported on wooden poles. The bare conductor has either been made up of one solid conductor or made from a number of strands. While it is generally robust, it can be prone to damage from trees and windborne materials.

5.206. WPD's current design standard is to use insulated conductors that are twisted together (known as Aerial Bundled Conductor (ABC)). ABC is used because it is safer and more resilient.

5.207. Low voltage conductor found to be damaged or deteriorated will, wherever possible, be replaced with ABC but, in some cases, may be replaced with underground cable, where this is more practical. Some replacement may be coincidental with other works; for example, where a conductor is diverted due to ground clearance issues, additional length of overhead line may be replaced at the same time.

5.208. The volumes of assets installed is forecast to be lower than the volume of assets removed due to a proportion being replaced with underground cables. The volumes have been informed by the proportions placed underground during RIIO-ED1. Figure SA-06. 99 summarises our proposed activity and costs for LV main (OHL) conductors.

LV Main (OHL) Conductor					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	5,600	290	1.0%	266	5
East Midlands	4,205	141	0.7%	99	2
South Wales	3,057	48	0.3%	46	1
South West	7,078	330	0.9%	323	6
Total	**19,941**	**809**	**0.8%**	**734**	**14**

Figure SA-06. 99: RIIO-ED2 asset replacement - LV main (OHL) conductor

HV main (overhead conductor)

5.209. HV conductor is generally robust and can last a long time. Strong winds can cause the conductor to vibrate which causes wear near to the points where the conductor is bound onto insulators. Conductors with a small cross-sectional area can also be more prone to damage because of their lower tensile strength which is why they have been progressively phased out since snow storms caused severe damage to the UK network in December 1981.

5.210. Conductors will be replaced on the poorest-performing circuits or where the conductor has deteriorated significantly. Where economically viable, the opportunity may be taken to reconfigure networks (e.g. installing remotely operated switches or interconnecting circuits) and increase network flexibility to improve the capability to restore customers' supplies under fault situations.

5.211. The volumes of assets installed is forecast to be lower than the volume of assets removed due to a proportion being replaced with underground cables. The volumes have been informed by the proportions placed underground during RIIO-ED1. Figure SA-06. 100 summarises our proposed activity and costs for 6.6/11kV OHL (conventional conductor).

6.6/11kV OHL (Conventional Conductor)					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	14,516	450	0.6%	418	9
East Midlands	11,816	416	0.7%	354	7
South Wales	12,032	104	0.2%	98	2
South West	16,285	756	0.9%	748	16
Total	**54,649**	**1,726**	**0.6%**	**1,618**	**34**

Figure SA-06. 100: RIIO-ED2 asset replacement - 6.6/11kV OHL (conventional conductor)

33kV, 66kV and 132kV overhead (pole line) conductor

5.212. 33kV, 66kV and 132kV conductor on wooden pole supports is robust but can corrode and wear over several decades leading to broken strands and the increased risk of conductor failure. Excessively corroded and worn conductors will be replaced with new overhead line conductors. Figure SA-06. 101 to Figure SA-06. 103 summarises our proposed activity and costs for each voltage of conductor.

33kV OHL (Pole Line) Conductor					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	793	60	1.5%	54	2
East Midlands	2,116	64	0.6%	64	2
South Wales	1,144	34	0.6%	34	1
South West	2,625	80	0.6%	80	3
Total	**6,678**	**238**	**0.7%**	**232**	**7**

Figure SA-06. 101: RIIO-ED2 asset replacement - 33kV OHL (pole line) conductor

66kV OHL (Pole Line) Conductor					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	605	18	0.6%	18	1
East Midlands	0	0	0.0%	0	0
South Wales	316	14	0.9%	14	0
South West	0	0	0.0%	0	0
Total	**921**	**32**	**0.7%**	**32**	**1**

Figure SA-06. 102: RIIO-ED2 asset replacement - 66kV OHL (pole line) conductor

132kV OHL (Pole Line) Conductor					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	0	0	0.0%	0	0
East Midlands	26	0	0.0%	0	0
South Wales	148	18	2.4%	18	1
South West	48	0	0.0%	0	0
Total	**223**	**18**	**1.6%**	**18**	**1**

Figure SA-06. 103: RIIO-ED2 asset replacement - 132kV OHL (pole line) conductor

33kV, 66kV and 132kV overhead (tower line) conductor

5.213. Where steel towers are used to support conductors, the distance between towers (span length) is longer than the distance between wood poles. The increased span length makes the conductors more susceptible to wind-induced movement such as vibration, horizontal sway or vertical galloping. This movement can lead to wear of the conductor where it comes into contact with fittings. It can also cause the strands to become loose, leading to an effect referred to as bird-caging.

5.214. To limit the effect of movement, vibration dampers are installed on the lines to dissipate the oscillations. However, the vibration dampers are also subject to corrosion and over time their effectiveness is reduced. When this happens, wear occurs at the point of connection.

5.215. Aluminium Conductor Steel Reinforced (ACSR) conductor uses steel inner strands to provide mechanical strength and aluminium outer conductors to carry the current. The aluminium conductor can suffer from bi-metallic corrosion caused by the interaction of the different metals. In order to limit the corrosion, the steel core is zinc galvanized and the aluminium strands are greased during manufacture. Over time, these protective measures become ineffective and the aluminium degrades and individual strands can break.

5.216. Conductors showing signs of excessive wear, fatigue or corrosion will be replaced with new overhead line conductors. Conductors may also be replaced at the same time as poor condition fittings, especially of the conductors have been installed for over 50 years. Figure SA-06. 104 to Figure SA-06. 106 summarises our proposed activity and costs for each voltage of conductor.

33kV OHL (Tower line) Conductor					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	173	59	6.9%	59	4
East Midlands	229	26	2.3%	26	2
South Wales	67	0	0.0%	0	0
South West	234	4	0.3%	4	0
Total	**703**	**90**	**2.6%**	**90**	**6**

Figure SA-06. 104: RIIO-ED2 asset replacement - 33kV OHL (tower line) conductor

66kV OHL (Tower Line) Conductor					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	156	11	1.4%	11	1
East Midlands	0	0	0.0%	0	0
South Wales	45	6	2.7%	6	0
South West	0	0	0.0%	0	0
Total	**202**	**17**	**1.7%**	**17**	**1**

Figure SA-06. 105: RIIO-ED2 asset replacement - 66kV OHL (tower line) conductor

66kV OHL (Tower Line) Conductor					
	Population (km)	RIIO-ED2 Period Assets Removed (km)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (km)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	156	11	1.4%	11	1
East Midlands	0	0	0.0%	0	0
South Wales	45	6	2.7%	6	0
South West	0	0	0.0%	0	0
Total	**202**	**17**	**1.7%**	**17**	**1**

Figure SA-06. 106: RIIO-ED2 asset replacement - 132kV OHL (tower line) conductor

33kV, 66kV and 132kV tower replacement and refurbishment

5.217. Overhead tower steelwork is prone to atmospheric corrosion that is particularly aggressive near coastal regions. The acidity in bird droppings can also produce corrosion at the top of towers where birds roost.

5.218. Routine tower painting (classified as refurbishment) is carried out on cycles of typically 12 to 20 years, depending upon the locational factors affecting each tower line. This prevents most of the corrosion. However, where corrosion occurs, towers can be refurbished by changing individual sections of corroded steelwork. The majority of tower work will be refurbishment, but where corrosion is widespread or affects the main legs or cross arms the replacement of the whole tower will be considered. A higher volume of 132kV tower replacements has been proposed in the South West because towers are more prone to salt air corrosion.

5.219. Ground conditions can affect the stability of towers and a small number of towers have fallen over during strong winds or where flood water has undermined the foundations. Examination of foundations may identify that there are cracks in the concrete, corrosion of the steel reinforcing bars or corrosion of the tower steelwork within the foundation. Where defective foundations are found, they will be removed, tower steelwork refurbished and foundations recast.

5.220. Tower condition will be assessed during routine inspections and by using high-resolution photography taken by cameras mounted on helicopters.

5.221. Figure SA-06. 107 to Figure SA-06. 112 summarises our proposed replacement and refurbishment activity by tower voltage.

33kV Tower (Mean life 110 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	496	0	0.0%	0	0
East Midlands	676	0	0.0%	0	0
South Wales	130	0	0.0%	0	0
South West	612	0	0.0%	0	0
Total	**1,914**	**0**	**0.0%**	**0**	**0**

Figure SA-06. 107: RIIO-ED2 asset replacement - 33kV tower

33kV tower refurbishment			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	220	8.9%	2
East Midlands	290	8.6%	2
South Wales	95	14.6%	1
South West	228	7.5%	1
Total	**833**	**8.7%**	**5**

Figure SA-06. 108: RIIO-ED2 asset refurbishment - 33kV tower

66kV Tower (Mean life 110 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	469	0	0.0%	0	0
East Midlands	0	0	0.0%	0	0
South Wales	127	0	0.0%	0	0
South West	0	0	0.0%	0	0
Total	**596**	**0**	**0.0%**	**0**	**0**

Figure SA-06. 109: RIIO-ED2 asset replacement - 66kV tower

66kV tower refurbishment			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	155	6.6%	1
East Midlands	0	0.0%	0
South Wales	40	6.3%	0
South West	0	0.0%	0
Total	**195**	**6.5%**	**2**

Figure SA-06. 110: RIIO-ED2 asset refurbishment - 66kV tower

132kV Tower (Mean life 110 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	2,529	0	0.0%	0	0
East Midlands	4,499	0	0.0%	0	0
South Wales	2,194	10	0.1%	10	2
South West	2,909	78	0.5%	78	16
Total	**12,131**	**88**	**0.1%**	**88**	**18**

Figure SA-06. 111: RIIO-ED2 asset replacement - 132kV tower

132kV tower refurbishment			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	1,011	8.00%	6
East Midlands	1,332	5.92%	6
South Wales	1,964	17.90%	14
South West	1,641	11.28%	12
Total	**5,948**	**9.81%**	**37**

Figure SA-06. 112: RIIO-ED2 asset refurbishment - 132kV tower

33kV, 66kV and 132kV tower insulators and fittings

5.222. Tower insulators and fittings are subject to atmospheric corrosion that rusts components.

5.223. Fittings can also be affected by the movement of the line which causes the components to rub and wear. This leads to a reduction in the cross-sectional area of the component and affects its mechanical strength.

5.224. The wear can be exaggerated at support points when other components seize up because of rust. Insulator strings are made up from a number of individual insulators linked together by pin and socket arrangements. As the pin corrodes, the expanding rust causes the pin to jam in the socket reducing the flexing movement of the insulators. Where the links become rigid, all the movement is transferred to the supporting fittings connecting the insulator string onto the tower. This transfer of movement causes excessive wear of the fittings leading to potential failure and the possibility of conductors falling to the ground.

5.225. It has been found that anti-fog insulators are particularly prone to rusting of the cap and pin because the extra length of the insulator sheds creates a micro-climate that accelerates the rusting process.

5.226. Damaged, rusty or seized components identified by routine inspections and high-resolution photography will be replaced. Replacement of fittings may also take place when conductors are replaced. Figure SA-06. 113 to Figure SA-06. 115 summarises our proposed activity and costs by voltage.

33kV Fittings					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	916	245	5.3%	245	0
East Midlands	1,476	126	1.7%	126	0
South Wales	461	55	2.4%	55	0
South West	1,378	20	0.3%	20	0
Total	**4,231**	**446**	**2.1%**	**446**	**1**

Figure SA-06. 113: RIIO-ED2 asset replacement - 33kV fittings

66kV Fittings					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	1,163	90	1.5%	90	0
East Midlands	0	0	0.0%	0	0
South Wales	308	5	0.3%	5	0
South West	0	0	0.0%	0	0
Total	**1,471**	**95**	**1.3%**	**95**	**0**

Figure SA-06. 114: RIIO-ED2 asset replacement - 66kV fittings

132kV Fittings					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	6,224	725	2.3%	725	5
East Midlands	11,068	1,295	2.3%	1,295	4
South Wales	6,482	734	2.3%	734	2
South West	6,683	645	1.9%	645	2
Total	**30,457**	**3,399**	**2.2%**	**3,399**	**13**

Figure SA-06. 115: RIIO-ED2 asset replacement - 132kV fittings

Switchgear

LV cutouts

5.227. Low voltage supplies terminate in cutouts near the meter point. This means there are approximately eight million cutouts installed in houses, shops and industrial properties across WPD's area. To ensure public safety, damaged, defective and obsolete cutouts are changed when customers report problems or when defects are identified from data flow from suppliers and meter operators.

5.228. The ongoing smart meter roll out programme is identifying defective LV cutouts when meter operators visit properties to install a smart meter. Urgent defects that are rectified to enable a smart meter to be fitted are included in the smart meter related defects forecast.

5.229. Some LV cutouts may be changed during response to customer calls and loss of supply. These are included under Occurrence Not Incentivised.

5.230. The increased take up of low carbon technologies including electric vehicles is likely to continue to have an impact on the amount of cutouts we have to change, due to low fuse ratings or obsolete design. Where cutouts are changed to provide increased capacity or where the work is associated with unbundling looped services, these costs are included under either socialised reinforcement in connections (where the work is reactive) or proactive service enhancements in reinforcement (where the work is proactive).

5.231. Other minor defects (specified as category C defects) or issues identified through other means will require rectification as asset replacement. The volumes and costs in Figure SA-06. 116 represent asset replacement activity.

Cut Out (Metered)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	2,514,311	30,950	0.2%	30,950	8
East Midlands	2,723,740	27,170	0.2%	27,170	7
South Wales	1,156,028	5,960	0.1%	5,960	2
South West	1,657,923	28,050	0.3%	28,050	7
Total	**8,052,002**	**92,130**	**0.2%**	**92,130**	**24**

Figure SA-06. 116: RIIO-ED2 asset replacement - 33kV fittings - cut out (metered)

LV substation pillars

5.232. LV substation pillars are either

- Wall-mounted with open busbars (installed indoors);
- free standing in metal housings (mostly outdoors);
- transformer mounted as part of package substations (either outdoors or within glass reinforced plastic (GRP) housings).

5.233. Typical issues include degradation of cable terminations, contacts working loose causing electrical arcing and pillars installed outdoors that may be subject to corrosion.

5.234. In some instances, the arrangements at a substation are changed when either the main HV switchgear or transformer are the main driver of asset replacement. Depending on the condition of all the components, the solution used for the new assets can be a package substation with all the components bolted together and covered by a GRP housing. In these circumstances, the type of equipment may change (for example, a free standing unit outdoors could be replaced by an indoor pillar). This is demonstrated by the fact that the forecast volumes of assets removed and installed for each individual asset category are different, while the overall total of LV switchgear removed and installed are the same. The expenditure shown relates to the costs of the new assets being installed.

5.235. Figure SA-06. 117 to Figure SA-06. 119 summarises our proposed activity and costs.

LV Board (WM) (Mean life 65 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	2,555	145	1.1%	30	0
East Midlands	1,410	175	2.5%	35	0
South Wales	135	15	2.2%	5	0
South West	1,119	220	3.9%	0	0
Total	**5,219**	**555**	**2.1%**	**70**	**1**

Figure SA-06. 117: RIIO-ED2 asset replacement - LV board (WM)

LV Pillar (OD at Substation) (Mean life 60 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	8,907	385	0.9%	125	1
East Midlands	4,451	590	2.7%	195	2
South Wales	2,452	295	2.4%	95	1
South West	2,567	395	3.1%	130	1
Total	**18,377**	**1,665**	**1.8%**	**545**	**5**

Figure SA-06. 118: RIIO-ED2 asset replacement - LV pillar (OD at Substation)

LV Pillar (ID) (Mean life 65 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	4,459	10	0.0%	385	3
East Midlands	13,481	170	0.3%	705	6
South Wales	5,360	120	0.4%	330	3
South West	8,650	305	0.7%	790	7
Total	**31,950**	**605**	**0.4%**	**2,210**	**19**

Figure SA-06. 119: RIIO-ED2 asset replacement - LV pillar (ID)

5.236. Figure SA-06. 120 shows the overall activity for LV switchgear at substations.

LV Switchgear at Substations					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	15,921	540	0.7%	540	5
East Midlands	19,342	935	1.0%	935	8
South Wales	7,947	430	1.1%	430	4
South West	12,336	920	1.5%	920	8
Total	**55,546**	**2,825**	**1.0%**	**2,825**	**26**

Figure SA-06. 120: RIIO-ED2 asset replacement - LV switchgear at substations

LV underground boxes, pillars (not at substations) and service turrets

5.237. The replacement programmes for LV link boxes (sometimes referred to as underground boxes) and LV pillars not at substations (sometimes referred to as street pillars) will target the removal of those in poor condition or where there are operational safety concerns (e.g. absence of barriers between phase conductors and earthed metalwork).

5.238. Older types of link boxes used bitumen based compound as an insulating medium. The compound can become deformed when the link box is subject to high loads; the distortion can prevent the insertion/removal of links, while bubbling can create voids that allow moisture to come into contact with live components.

5.239. New types of link boxes use resin as an insulating medium. Defects such as cracking of the resin or surface tracking can arise.

5.240. Other defects include misalignment of link posts, excessive contact burning or cracked casings.

5.241. Figure SA-06. 121 to Figure SA-06. 122 summarises our proposed activity and costs for RIIO-ED2.

LV UGB					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	22,219	1,850	1.7%	1,850	10
East Midlands	28,553	2,250	1.6%	2,250	12
South Wales	4,277	560	2.6%	560	3
South West	12,993	1,200	1.8%	1,200	6
Total	**68,042**	**5,860**	**1.7%**	**5,860**	**31**

Figure SA-06. 121: RIIO-ED2 asset replacement - LV UGB

LV Pillar (OD not at a Substation)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	84	10	2.4%	10	0
East Midlands	886	40	0.9%	40	0
South Wales	631	20	0.6%	20	0
South West	401	5	0.2%	5	0
Total	**2,002**	**75**	**0.7%**	**75**	**1**

Figure SA-06. 122: RIIO-ED2 asset replacement - LV pillar (OD not at a substation)

Secondary substation ground-mounted (GM) HV switchgear – (circuit breakers (CB), switches and ring main units (RMU))

5.242. Secondary HV switchgear replacement will be focused on those items that are in poor condition, have type specific operational restrictions or unit specific defects (such as leakage of SF_6 gas). This will remove potential safety risks and increase the availability of network switching points.

5.243. Operational restrictions may arise following a disruptive failure of an item of switchgear anywhere in the industry. The Energy Networks Association (ENA) provides an information sharing service where DNOs are informed of reported dangerous incidents and equipment defects. This allows each DNO to assess the impact on their network. As a consequence, operational restrictions may be applied to limit what can be done with the switchgear. In some cases, the restrictions can be removed by changing components during maintenance. In others, it is more cost effective to replace the whole item of switchgear. Where operational restrictions affect a small number of items of equipment, the whole population will be replaced. If a large number is affected, a structured programme will be developed.

5.244. Where replacement is carried out at secondary substations, older extensible switchgear consisting of individual switches and circuit breakers will, in many cases, be replaced by ring main units that have two switches and a circuit breaker built into a single smaller unit. This is illustrated by fewer additions of switches and more additions of ring main units in the details below. Where there is a single infeed into a secondary substation, the existing switchgear may be a single switch fuse arrangement, which will be replaced by a circuit breaker. The volumes of new circuit breakers are therefore affected by reductions due to installation of ring main units and increases due to installations at single infeed sites. The expenditure shown in Figure SA-06. 123 to Figure SA-06. 125 relates to the costs of the new assets being installed.

6.6/11kV Switch (GM) (Mean life 55 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	5,315	810	3.0%	160	1
East Midlands	4,737	970	4.1%	195	1
South Wales	1,288	90	1.4%	20	0
South West	5,579	1,095	3.9%	165	1
Total	**16,919**	**2,965**	**3.5%**	**540**	**4**

Figure SA-06. 123: RIIO-ED2 asset replacement - 6.6/11kV switch (GM)

6.6/11kV CB (GM) Secondary (Mean life 55 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	3,933	450	2.3%	250	3
East Midlands	1,808	60	0.7%	205	2
South Wales	756	25	0.7%	25	0
South West	2,073	45	0.4%	340	4
Total	**8,570**	**580**	**1.4%**	**820**	**10**

Figure SA-06. 124: RIIO-ED2 asset replacement - 6.6/11kV CB (GM) secondary

6.6/11kV RMU (Mean life 50 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	16,992	135	0.2%	505	7
East Midlands	21,845	175	0.2%	450	6
South Wales	8,533	70	0.2%	100	1
South West	9,329	390	0.8%	665	9
Total	**56,699**	**770**	**0.3%**	**1,720**	**22**

Figure SA-06. 125: RIIO-ED2 asset replacement - 6.6/11kV RMU

Pole-mounted (PM) HV switchgear circuit breakers, switches, links and fuses

5.245. Pole-mounted switchgear is subdivided into three broad categories:

- Circuit breakers – predominantly high speed auto reclosers (HSARs) and metal encased oil circuit breakers.
- Switches – metal-encased remotely controlled and manually operated switches.
- Other – including air break switches, drop out fuses and links.

5.246. The replacement of pole-mounted switchgear will be driven by those that are in poor condition or have some form of operational defect that cannot be rectified.

5.247. Figure SA-06. 126 to Figure SA-06. 128 summarised our proposed RIIO-ED2 activity and costs.

6.6/11kV CB (PM) (Mean life 45 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	1,577	215	2.7%	215	3
East Midlands	1,135	90	1.6%	90	1
South Wales	1,123	105	1.9%	105	1
South West	974	225	4.6%	225	3
Total	**4,809**	**635**	**2.6%**	**635**	**7**

Figure SA-06. 126: RIIO-ED2 asset replacement - 6.6/11kV CB (PM)

6.6/11kV Switch (PM) (Mean life 45 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	959	110	2.3%	110	1
East Midlands	851	10	0.2%	10	0
South Wales	488	10	0.4%	10	0
South West	457	40	1.8%	40	0
Total	**2,755**	**170**	**1.2%**	**170**	**2**

Figure SA-06. 127: RIIO-ED2 asset replacement - 6.6/11kV switch (PM)

6.6/11kV Switchgear - Other (PM)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	12,130	650	1.1%	650	1
East Midlands	13,542	360	0.5%	360	0
South Wales	6,727	350	1.0%	350	0
South West	28,679	1,295	0.9%	1,295	2
Total	**61,078**	**2,655**	**0.9%**	**2,655**	**4**

Figure SA-06. 128: RIIO-ED2 asset replacement - 6.6/11kV switchgear - other (PM)

Primary substation HV circuit breakers (CB)

5.248. Circuit breakers at primary substations are generally installed in a bank (also known as a board) to allow a common busbar to feed a number of outgoing circuits. This arrangement means that the replacement of defective circuit breakers usually requires the whole board to be replaced. As a consequence, some assets that appear in reasonable condition may have to be replaced with the poor condition assets. Our proposed activity and costs are set out in Figure SA-06. 129.

6.6/11kV CB (GM) Primary (Mean life 55 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	3,722	180	1.0%	180	6
East Midlands	4,713	500	2.1%	500	18
South Wales	2,335	170	1.5%	170	6
South West	3,030	362	2.4%	362	13
Total	**13,800**	**1,212**	**1.8%**	**1,212**	**43**

Figure SA-06. 129: RIIO-ED2 asset replacement - 6.6/11kV CB (GM) Primary

33kV, 66kV and 132kV switchgear

5.249. Corrosion, moisture ingress, mechanical defects and limited availability of spares can lead to switchgear problems. While rare, catastrophic failures arising anywhere in the industry can lead to operational restrictions being applied to entire populations. In addition, local defects (such as distorted housings) may lead to local operational limitations.

5.250. Modern switchgear uses SF_6 gas as the main insulant. SF_6 is a potent greenhouse gas and can sometimes result in leaks. During RIIO-ED2, WPD has committed to reduce the amount of gas being released. As a result, SF_6 switchgear will be replaced where it cannot be effectively repaired.

5.251. There are various categories of higher voltage switchgear. Figure SA-06. 130 to Figure SA-06. 132 provides summary activities for each voltage level.

33kV Circuit Breakers, Switches and RMUs					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	477	42	1.8%	42	3
East Midlands	1,627	160	2.0%	180	14
South Wales	846	15	0.4%	15	1
South West	1,332	140	2.1%	140	8
Total	**4,282**	**357**	**1.7%**	**377**	**26**

Figure SA-06. 130: RIIO-ED2 asset replacement - 33kV circuit breakers, switches and RMUs

66kV Circuit Breakers					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	121	0	0.0%	0	0
East Midlands	0	0	0.0%	0	0
South Wales	64	14	4.4%	14	1
South West	0	0	0.0%	0	0
Total	**185**	**14**	**1.5%**	**14**	**1**

Figure SA-06. 131: RIIO-ED2 asset replacement - 66kV circuit breakers

132kV Circuit Breakers					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	260	44	3.4%	46	27
East Midlands	272	24	1.8%	24	3
South Wales	250	18	1.4%	18	2
South West	172	10	1.2%	10	1
Total	**954**	**96**	**2.0%**	**98**	**33**

Figure SA-06. 132: RIIO-ED2 asset replacement - 132kV circuit breakers

Transformers

HV transformers (ground and pole-mounted)

5.252. There are around 187,000 distribution transformers across the four WPD licence areas, with over two thirds of these being installed on pole-mounted substations.

5.253. Ground-mounted distribution transformers are robust items of plant that have limited moving parts. Therefore, the main problems encountered with ground-mounted transformers are caused by external corrosion, insulation degradation caused by excessive loads or moisture ingress. Replacement decisions will be based upon condition assessments and oil test results.

5.254. Replacement of transformers at ground-mounted substations may also be coordinated with the replacement of other components such as LV pillars and HV switchgear with the installation of package substations.

5.255. Pole-mounted distribution transformers are more susceptible to damage from inclement weather such as lightning strikes that cause internal failure or flash-over across insulators. Since the impact of an incident on pole-mounted transformers affects a limited number of people, they are generally replaced only when they experience a fault, although a proportion will be replaced where inspections identify poor condition assets.

5.256. There are several other work programmes that will also lead to the replacement of transformers:

- Replacement of pre-1958 ground-mounted transformers that have high losses (this activity is included under losses and most of these will be replaced in RIIO-ED1)
- Replacement of pre-1958 pole-mounted transformers that have high losses (this is a new losses related activity for RIIO-ED2)
- Replacement of pole-mounted transformers contaminated with persistent organic pollutants such as polychlorinated biphenyls (included under environmental activities).
- Replacement of transformers to provide additional capacity (included under reinforcement)

5.257. Figure SA-06. 133 to Figure SA-06. 134 shows data specifically related to the asset replacement activity.

6.6/11kV Transformer (PM) (Mean life 55 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	34,352	930	0.5%	930	4
East Midlands	22,574	830	0.7%	830	4
South Wales	31,798	1,880	1.2%	1,880	7
South West	39,159	2,200	1.1%	2,200	8
Total	**127,883**	**5,840**	**0.9%**	**5,840**	**23**

Figure SA-06. 133: RIIO-ED2 asset replacement - 6.6/11kV transformer (PM)

6.6/11kV Transformer (GM) (Mean life 60 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	16,223	565	0.7%	565	9
East Midlands	20,854	970	0.9%	970	16
South Wales	8,489	455	1.1%	455	7
South West	13,627	975	1.4%	975	16
Total	**59,193**	**2,965**	**1.0%**	**2,965**	**48**

Figure SA-06. 134: RIIO-ED2 asset replacement - 6.6/11kV transformer (GM)

33kV, 66kV and 132kV transformers

5.258. The failure of grid and primary transformers can have a significant impact on network security. Degradation is driven by a combination of the demand placed upon transformers, corrosion of steelwork, degradation of seals and the effect of moisture ingress.

5.259. Transformer insulation is constructed from cellulose paper submersed in oil. Excessive loads on the transformer can lead to high operating temperatures that cause the creation of acids in the oil. Moisture ingress combined with the acid can lead to degradation of the paper insulation. As the insulation weakens, discharges may arise causing further damage and potential failure.

5.260. Condition assessment is used to determine the external integrity of the oil tanks, coolers and connecting pipework. Oil testing is used to assess the internal condition of the insulation and measure the amount of acid, dissolved gases (caused by discharges) and concentration of furfuraldehyde (released as a by-product of paper insulation breakdown).

5.261. Transformers will be changed where they exhibit excessive oil leakage or where oil tests suggest evidence of electrical discharge or significant insulation degradation.

5.262. In a limited number of cases, transformers will be refurbished. These will be limited to repair of localised corrosion (e.g. changing cooling fins), stemming of leaks by replacement of seals or application of sealing agents and retrofitting of tap-changers.

5.263. Processes to remove moisture and acidity from the insulating oil may be used in limited cases, but these are very short term measures that temporarily improve the condition of the oil. Such actions would not have a marked impact on the health of the transformer.

5.264. We have considered returning transformers to manufacturers to be refurbished in their workshops but will not be pursuing this because the costs of dismantlement, transport, fees and reconnection outweigh the benefits.

5.265. Figure SA-06. 135 to Figure SA-06. 140 summarises our proposed activity and costs.

33kV Transformer (GM) (Mean life 60 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	183	29	3.2%	29	11
East Midlands	749	75	2.0%	75	31
South Wales	259	30	2.3%	30	12
South West	597	81	2.7%	81	31
Total	**1,788**	**215**	**2.4%**	**215**	**86**

Figure SA-06. 135: RIIO-ED2 asset replacement - 33kV transformer (GM)

33kV transformer refurbishment			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	5	0.5%	0
East Midlands	45	1.2%	1
South Wales	2	0.2%	0
South West	20	0.7%	1
Total	**72**	**0.8%**	**2**

Figure SA-06. 136: RIIO-ED2 asset refurbishment - 33kV transformer (GM)

66kV Transformer (GM) (Mean life 50 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	92	15	3.3%	15	7
East Midlands	0	0	0.0%	0	0
South Wales	28	10	7.1%	10	4
South West	0	0	0.0%	0	0
Total	**120**	**25**	**4.2%**	**25**	**11**

Figure SA-06. 137: RIIO-ED2 asset replacement - 66kV transformer (GM)

66kV transformer refurbishment			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	0	0.0%	0
East Midlands	0	0.0%	0
South Wales	0	0.0%	0
South West	0	0.0%	0
Total	**0**	**0.0%**	**0**

Figure SA-06. 138: RIIO-ED2 asset refurbishment - 66kV transformer (GM)

132kV Transformer (GM) (Mean life 60 years)					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	245	21	1.7%	21	18
East Midlands	189	20	2.1%	20	19
South Wales	129	15	2.3%	15	13
South West	93	8	1.7%	8	8
Total	**656**	**64**	**2.0%**	**64**	**57**

Figure SA-06. 139: RIIO-ED2 asset replacement - 132kV transformer (GM)

132kV transformer refurbishment			
	RIIO-ED2 Period Assets Refurbished	Average Population Refurbished (% per annum)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	10	0.8%	1
East Midlands	2	0.2%	0
South Wales	5	0.8%	1
South West	5	1.1%	1
Total	**22**	**0.7%**	**2**

Figure SA-06. 140: RIIO-ED2 asset refurbishment - 132kV transformer (GM)

Batteries (protection)

Batteries at HV, EHV and 132kV substations

5.266. Substation batteries are used for protection systems, switchgear tripping and closing functionality and automation. Dedicated battery systems are also required for SCADA communications, but these are not included within the battery asset categories considered under asset replacement (these are included under operational IT&T).

5.267. Where there is insufficient protection/ tripping battery capacity, the protection of the network would be compromised and the operation of switchgear would be unreliable. The absence of protection would mean a failure to identify and disconnect faults on the distribution networks, potentially endangering people and leading to catastrophic failure of equipment.

5.268. Batteries can become defective and suffer from a range of problems, including:

- Cracked cases;
- Contamination of the electrolyte;
- Build-up of sediment;
- Internal short circuits;
- Excessive corrosion.

5.269. Battery cells found to be in poor condition during routine testing will either be replaced or refurbished. Figure SA-06. 141 to Figure SA-06. 142 summarises our proposed activity and costs.

Batteries at GM HV Substations					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	1,669	175	2.1%	175	0
East Midlands	1,022	125	2.4%	125	0
South Wales	152	10	1.3%	10	0
South West	288	65	4.5%	65	0
Total	**3,131**	**375**	**2.4%**	**375**	**1**

Figure SA-06. 141: RIIO-ED2 asset replacement - batteries at GM HV substations

Batteries at 33kV, 66kV and 132kV					
	Population (Each)	RIIO-ED2 Period Assets Removed (Each)	Average Population Removed (% per annum)	RIIO-ED2 Period Assets Installed (Each)	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	353	377	21.4%	377	3
East Midlands	679	455	13.4%	455	3
South Wales	365	100	5.5%	100	1
South West	560	390	13.9%	390	3
Total	**1,957**	**1,322**	**13.5%**	**1,322**	**9**

Figure SA-06. 142: RIIO-ED2 asset replacement - batteries at 33kV, 66kV and 132kV

Protection schemes at HV, EHV and 132kV substations

5.270. Protection schemes are either individual relays or groups of relays that perform various different functions to disconnect the flow of power when faults are detected on the network. The devices are either mounted on switchgear or dedicated protection panels within substations.

5.271. Where the protection is replaced as part of the replacement of the main item of switchgear, the costs are incorporated within the costs of replacing the switchgear. However, in some cases, only the protection devices are replaced. This may be because the equipment has become defective or where the functionality is inadequate. This work is classified as refurbishment of protection. Some types of protection have been identifies as being unreliable and will be changed during RIIO-ED2. The following Figure SA-06. 143 shows the volumes and costs forecast for RIIO-ED2.

Protection refurbishment		
	RIIO-ED2 Period Assets Refurbished	RIIO-ED2 Period Forecast Expenditure £m
West Midlands	1,865	7
East Midlands	2,415	7
South Wales	1,425	5
South West	1,390	3
Total	**7,095**	**21**

Figure SA-06. 143: RIIO-ED2 asset refurbishment - protection schemes

Civil works driven by condition of plant items

5.272. There will be a range of civil activities that result from replacement of electrical network assets (e.g. new plinths and structures for switchgear, modifications to trenches, and alterations to buildings). Changes may also be dictated by policy, for example, providing enclosures for switchgear that was previously installed outdoors.

5.273. The civils costs are effectively an overhead cost of carrying out the replacement. Costs are forecast by considering the volumes of asset replacement activity being carried out.

5.274. Average civils costs have been derived for each asset category and are multiplied by the volumes of replacement activity (volumes of additions) to derive the related civils costs for each asset category. The following table summarises the total civils cost due to the replacement of plant assets for RIIO-ED2.

Civils due to condition of plant items expenditure RIIO-ED2 (£m)					
	West Midlands	East Midlands	South Wales	South West	Total
Civils Works Associated With LV Asset Replacement (not at Substation)	0	0	0	0	0
Civils Works Associated With HV or LV Asset Replacement (at secondary substation)	3	4	2	5	14
Civils Works Associated With HV Asset Replacement (at primary substation)	3	8	3	6	20
Civils Works Associated With 33kV Asset Replacement	2	9	2	6	19
Civils Works Associated With 66kV Asset Replacement	1	0	1	0	1
Civils Works Associated With 132kV Asset Replacement	3	2	2	1	7
TOTAL	**12**	**23**	**9**	**17**	**61**

Figure SA-06. 144: RIIO-ED2 asset replacement - civils due to condition of plant items

Civil works driven by condition of civil items

Substations

5.275. It is important that substation sites and buildings remain secure, protect network assets and provide a safe working environment for staff. Civil activities cover a range of different civil features including:

- Buildings
- Perimeter fences
- Access roads, compound surfaces and drainage arrangements

5.276. Substation land is segregated using different types of fences depending upon the local security requirements. Fences can become damaged and wooden fences can decay. Fence panels may need to be replaced where security is compromised.

5.277. Substation buildings house switchgear and at larger substations will contain protection panels and communication equipment, as well as staff amenities, such as toilets. Defects in substation roofs can lead to water ingress affecting network assets. Damp can also affect roof structures and in some cases require the replacement of the full roof.

5.278. Defective substation doors provide a security risk, particularly where they are subject to vandalism. While the majority of doors are repaired during site maintenance, some need to be replaced.

5.279. Many substation buildings are over 40 years old with electrical wiring for heating and lighting dating from the original installation. Individual components (e.g. heaters) are replaced as part of

building maintenance but in some cases complete rewiring of building services is undertaken where fitments have deteriorated or wiring is found to be in poor condition.

5.280. In some cases, transformers have been enclosed within housings for either fire protection or noise reduction. Over time, these structures can deteriorate and need to be replaced or refurbished.

5.281. Larger substations have access roads which can develop pot holes and deteriorating road surfaces. Large compounds may have cable trenches, where the covers need to be replaced to prevent collapse.

5.282. While rare, there have been occasions where subsidence has undermined concrete plinths causing damage to network assets. Where subsidence is identified, the civil aspects will be rebuilt and equipment re-sited on a new plinth.

Cable tunnels

5.283. Some substations are located on former power station sites e.g. Nechells at Spaghetti Junction in Birmingham that included networks of tunnels for cable runs where these tunnels continue to be used for distribution cables. There are also tunnels where WPD still has a responsibility even though the assets have been decommissioned e.g. the tunnel under Portishead dock near Bristol that was used for a now abandoned 132kV internal pressure gas cable.

5.284. There are no known structural issues with cable tunnels and the forecast is £nil.

Cable bridges

5.285. Cable bridges have been used extensively throughout the West Midlands to cross canals and rivers. Many are constructed from lattice steelwork encased in cladding.

5.286. While they are generally secure, some have been subject to determined attempts of metal theft. Attempted theft can lead to many customers' supplies being affected, especially if several cables are damaged at the same time. Cable bridges will have any defective cladding refurbished or replaced to ensure they remain secure. These costs are included in maintenance of civil assets.

5.287. Where lattice steelwork has corroded, it will be replaced, although there are no known structural issues with cable bridges, resulting in a forecast of £nil.

Expenditure summary

5.288. Figure SA-06. 145 and Figure SA-06. 146 summarises the forecast costs for civils costs driven by the condition of the civil assets.

Civil works driven by condition of civil items					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	6	4	2	2	15
RIIO-ED2 Annual Average (forecast)	5	4	2	2	14
RIIO-ED2 Total (5 years)	27	20	11	10	69

Figure SA-06. 145: RIIO-ED2 forecast expenditure - civil works driven by condition

Civils due to condition of civil assets (£m total ED2)					
	West Midlands	East Midlands	South Wales	South West	Total
Civil Works at HV Indoor Substations	12	8	2	4	27
Civil Works at HV Outdoor Substations	7	5	1	2	16
Civil Works at 33kV Substations	3	3	3	2	11
Civil Works at 66kV Substations	1	0	0	0	1
Civil Works at 132kV Substation	5	4	4	1	13
Cable Tunnel	0	0	0	0	0
Cable Bridge	0	0	0	0	0
LV Street Furniture	0	0	0	0	0
Total	**27**	**20**	**11**	**10**	**69**

Figure SA-06. 146: RIIO-ED2 forecast expenditure - civil works driven by condition, by category

Black Start (Electricity System Resolution)

5.289. There are some programmes where we have been unable to forecast additional costs, because of uncertainties beyond our control. This includes expenditure on enhancing Black Start capability (also known as Electricity System Resolution), which is awaiting government requirements. We expect any future expenditure in this area to be covered by uncertainty mechanisms.

5.290. While highly unlikely, a major disturbance to electricity supply could lead to a partial or even total shutdown of the GB transmission system and the associated distribution networks. The actions required to re-establish normal operation of the electricity network, following such an event, are referred to as a 'Black Start'.

5.291. Successful recovery from a Black Start event requires sections of the transmission and distribution networks to be re-energised and reconnected, in a predetermined sequence. These actions need to be undertaken in a co-ordinated and controlled manner, in order to ensure that the reconnection of load and generation remain balanced.

5.292. Following a series of major blackouts across the world prior to RIIO-ED1, the UK government and the electricity industry, through the Electricity Task Group (ETG) of the Energy Emergencies Executive Committee (E3C), reviewed the resilience of the GB electricity network to a Black Start event. This identified that the recovery time for a Black Start, from a total shutdown of the transmission system, is likely to be in the order of 72 hours.

5.293. Engineering Recommendation G91 ('Substation Black Start Resilience') was issued in 2012. This Engineering Recommendation introduced a requirement for DNOs to ensure that suitable measures are established at major substations, to ensure that adequate protection and control systems are available to permit safe re-energisation of these substations during a Black Start. These measures must be suitable to cater for a partial or total shutdown of the electricity network lasting up to 72 hours.

5.294. During RIIO-ED1, WPD has carried out extensive work to enhance Black Start resilience including:

- Installation of load disconnection schemes as part of the battery systems used at each major substation sites for power system protection and operation of circuit breakers;
- Increasing the capacity of SCADA batteries to ensure that communications at each major substation meet the requirement for a minimum of 72 hours resilience;
- Enhancing the resilience of key communications sites (e.g. communication masts) by enhancing battery capacity or installing backup generation.

5.295. More recent E3C discussions have been considering a number of potential options for changes to Black Start criteria. These are being presented to government and awaiting a ministerial decision. WPD understands that the introduction of a new requirement for a quicker restoration response is more likely than requirements for longer duration resilience. This means that enhancements will be required to enable us to respond more quickly to an event, rather than building additional network / telecoms infrastructure to improve resilience during a longer outage.

5.296. Since the works to establish 72 hour resilience will have been completed in RIIO-ED1, there is no need for allowances and as a consequence, WPD's RIIO-ED2 forecast for Black Start expenditure is £nil. Where government requirements change and there is a new impact on funding, WPD will make use of the Black Start uncertainty mechanism.

Black Start					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	1	1	0	1	3
RIIO-ED2 Annual Average (forecast)	0	0	0	0	0
RIIO-ED2 Total (5 years)	0	0	0	0	0

Figure SA-06. 147: RIIO-ED2 forecast expenditure - black start

Legal and Safety

Background

5.297. We have legal obligations to operate the distribution networks in a safe and reliable manner. There are many aspects of the overall Business Plan that contribute to the achievement of a safe network, including inspection; repair; maintenance; replacement of poor condition assets; and addressing ground and proximity clearance issues on overhead lines.

5.298. In addition, there are a range of specific legal and safety activities that are carried out on network assets in order to protect staff and the general public from the dangers of electricity and ensure sites and assets are secure.

5.299. Our Legal and Safety programme is relatively small but includes new expenditure to deal with safety risks associated with overhead lines that either cross or run adjacent to school playing fields, retrospective fitting of anti-climbing devices to wooden poles and upgrading of the software that monitors security systems and reports alarms.

Major substation security

5.300. Whilst it is virtually impossible to prevent access by a determined thief, enhancing security measures can deter unauthorised access and make it more difficult to force entry.

5.301. Bulk supply substations and primary substations have a concentration of high value plant and assets, where theft poses a risk both to customer supplies and to safety.

5.302. Starting in DPCR4, WPD has undertaken works across its licence areas to enhance the security of all substation sites at 33kV and above. As a minimum, intruder alarms are installed at all primary substations, with CCTV added to higher risk sites and electric fences to very high risk sites.

5.303. Since the majority of the works have been completed, there will be reduced activity in RIIO-ED2. The main activity will continue to be in the West Midlands and East Midlands where further security enhancements are proposed at a number of EHV sites.

Security at distribution substations

5.304. At ground-mounted distribution substations, of which we have over 62,000 locations in the WPD area, it is more difficult to provide a suitable and proportionate increased set of security measures. For these sites, it is more effective to provide measures which deter theft by using higher security fencing and doors.

5.305. At these distribution substations, activity is driven by issues identified during inspections. Evidence of vandalism, trespass or theft is used as to determine which enhancements are required. Since this work is largely reactive, forecasts have been based upon historical activity.

Asbestos management

5.306. Asbestos has been used in a variety of applications in the electricity industry and can be found in the fabric of substations buildings or in electrical equipment.

5.307. Surveys of building during RIIO-ED1 have led to asbestos issues being addressed at the locations affected. The specific action - containment or removal - is informed by the site assessments and the condition of the asbestos. Activity during RIIO-ED1 has addressed a number of the issues; volumes in RIIO-ED2 are expected to be lower.

5.308. As the smart meter roll out has progressed, meter operators have identified issues with service positions, including whether asbestos meter boards are present or service position equipment that has been found to contain asbestos. WPD is aware that some companies have techniques for encapsulating asbestos, but WPD's preferred approach is to remove any asbestos and safely dispose of it, removing the hazard from consumers' premises. As many properties will have been visited by the end of RIIO-ED1, WPD is forecasting lower activity in RIIO-ED2.

School play areas

5.309. WPD experienced an incident in the Gloucester area where an HV conductor was brought down by an oak tree in a field used as a playground by a local primary school. Fortunately, nobody was injured, but this incident highlighted a risk that WPD proposes to address during RIIO-ED2.

5.310. This introduces a new area of expenditure to deal with safety risks associated with overhead lines that either cross or run adjacent to school playing fields.

5.311. WPD has carried out surveys of schools to assess whether there are overhead lines over-sailing playing areas, whether there are pole-mounted or ground-mounted substations in the grounds or near to where children could gather.

5.312. We have ranked the risks and propose to carry out some form of remedial action at locations with high and medium risk during RIIO-ED2. This may mean installing insulated conductors, undergrounding the lines, diverting overhead lines or relocating pole-mounted substations (with associated cable/line works).

5.313. No works are proposed for relocating ground-mounted substations, but security enhancement may be applied where there is evidence of trespass.

5.314. As this is a new area of expenditure, there is no historical activity that can be used as a reference for typical costs per project. A number of schemes have been designed and costed to provide an indication of the range of costs that could be incurred. These indicative costs have been used to generate the cost forecast for addressing the high and medium risk sites as summarised in Figure SA-06. 148.

Movement of school located assets					
	West Midlands	East Midlands	South Wales	South West	WPD Total
Volumes	257	100	139	284	780
Costs (£m 2020/21 prices)	4	2	2	4	11

Figure SA-06. 148: school playing areas - movement of school located assets

Anti-climbing devices

5.315. Anti-climbing devices are designed to be an obstacle to anyone trying to access areas they shouldn't. These devices make access difficult and therefore act as a deterrent. For wooden poles, anti-climbing devices are usually based upon some form of barbed wire wrapping.

5.316. Following an investigation, it was identified that there are a high volume of instances on the network where poles do not have the required anti-climbing devices fitted. WPD has clarified policy with reference to industry guidance outlined in ENA Technical Specification 43-90 Anti-Climbing Measures. This has made it clear that poles with an attachment of a cable or earth wire cover guard are deemed climbable and therefore need some form of anti-climbing device.

5.317. This primarily affects the South Wales and South West licence areas, as interpretation of guidance in the West Midlands and East Midlands has historically been different.

5.318. Changes have been made to the data being collected during inspections to identify where there are missing anti-climbing devices. The volumes of known issues has been used to estimate the scale of the required programme as summarised in Figure SA-06. 149.

Anti-climbing devices					
	West Midlands	East Midlands	South Wales	South West	WPD Total
Volumes	0	0	27,855	37,855	65,710
Costs (£m 2020/21 prices)	0	0	6	8	13

Figure SA-06. 149: anti-climbing devices

Replacing obsolete security systems

5.319. WPD uses alarm systems, closed circuit television (CCTV) and electric fences to provide security at large/vulnerable high risk substation sites. These systems are linked via phone lines to a central alarm receiving centre (ARC) operated within a WPD control centre. This system is currently operated independently of other WPD communications.

5.320. A number of issues have been identified with the system including obsolescence, where some of the functions are operated on legacy software that is no longer supported. We are therefore proposing to upgrade various aspects of the system to make it more reliable and secure.

5.321. At present, CCTV cameras provide analogue output, which is connected via coaxial cable to local data recorders. These data recorders capture hi-resolution images which can be downloaded to discs or USB sticks for interrogation following an incident, but this hi-resolution

data cannot be interrogated remotely. Many of the recorders are using operating systems that are no longer supported and need to be upgraded.

5.322. As part of the upgrades, the data from the cameras needs to be converted into a digital format. While some older cameras will need to be replaced, we are not replacing the cameras and cables in their entirety; instead we are proposing to have analogue to digital converter cards which allow us to retain the existing cameras and adopt a lower cost solution for enabling digital image capture.

5.323. Dedicated PSTN phone lines are used to provide data about alarms to the central command centre. These provide communication of alarms, transmission of lower resolution live images and voice messages. When intruder alarms are received, the command centre can use the live images to observe what is happening on site and use the voice system to warn intruders that they are being watched and monitored and that their trespass is being dealt with. PSTN phone lines are progressively being phased out which means we need to transfer the communication to more reliable and secure network communications. We are therefore proposing to transfer the communication onto WPD's telecoms network, which will provide a greater data bandwidth and will allow the implementation of appropriate levels of security and reliability.

5.324. Upgrades are also required to the electric fence system which on older installations uses antiquated controllers and communication interfaces. These will need to be updated to be able to function properly with new ARC software that has been implemented.

5.325. Figure SA-06. 150 summarises the costs of these security system enhancements.

Security system enhancements					
	West Midlands	East Midlands	South Wales	South West	WPD Total
Costs (£m 2020/21 prices)	3	2	1	2	8

Figure SA-06. 150: security system enhancements

Expenditure summary

5.326. Figure SA-06. 151 summaries forecasted costs for legal and safety.

Legal and safety					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	2	2	1	1	5
RIIO-ED2 Annual Average (forecast)	2	1	2	3	9
RIIO-ED2 Total (5 years)	9	7	12	16	45

Figure SA-06. 151: RIIO-ED2 forecast expenditure - legal and safety

Quality of supply

5.327. Quality of Supply investment aims to reduce the impact of network faults on customers by reducing the number of customers affected and the duration of faults.

5.328. In RIIO-ED1, due to its Fast Track status, WPD was the only DNO to receive allowances for quality of supply activities. In the first six years of RIIO-ED1, WPD has spent an additional 30% above the allowances on Quality of Supply initiatives and the costs cover activities such as:

- Installation of remotely controlled equipment to quickly reconfigure networks once faults occur;
- Reconfiguration of HV and LV networks to provide more interconnection and alternative feeding arrangements;
- The use of mobile generation to limit the impact of new connections work on existing customers.

5.329. The graphs in Figure SA-06. 152 show the proportion of customers interrupted (CIs) and customer minutes lost (CMLs) across the network voltage levels for the period covering 2017/18 to 2020/21. The data shows that the majority of CIs and CMLs arise from the HV network, but that the LV network also contributes to a significant proportion of the CMLs.

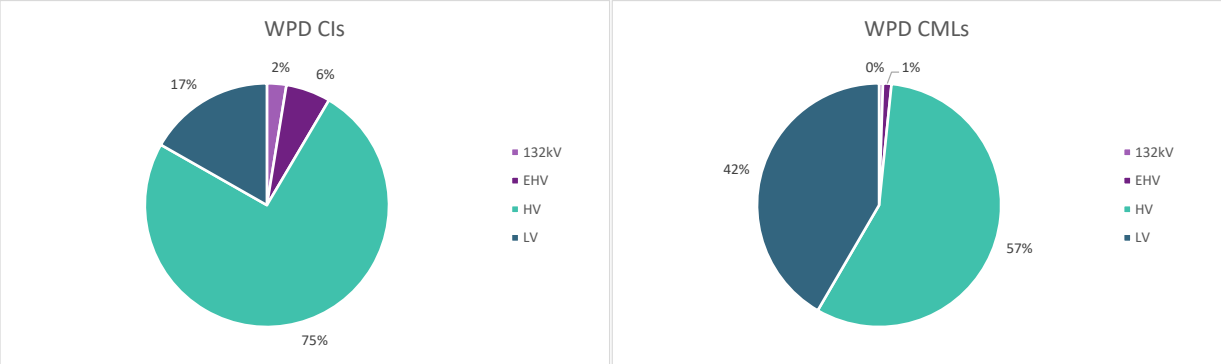


Figure SA-06. 152: Customer interruptions and customer minutes lost by voltage level, 2017/18 - 2020/21

5.330. During RIIO-ED2, we will continue to focus on the HV network and continue our programme of installing automated devices; these allow quick rerouting of power when a fault occurs, limiting the number of customers affected for three minutes or longer. The overall objective will be to ensure there will be a maximum of 1,000 customers not automatically re-supplied (a reduction from 1,500 in RIIO-ED1), when the automatic switching is carried out.

5.331. Furthermore, in the South West licence area there has been a legacy practice of using fuses to prevent faults on the spurs from impacting customers on the rest of the circuit, but these do not operate for certain types of lower current fault. We are therefore proposing to change the protection arrangements to either use automatic sectionalising links or single phase circuit breakers, which will operate for lower current faults and reduce the number of customers impacted.

Identifying the need for investment – HV disaggregated analysis

5.332. Each year, data on HV circuit performance is provided to Ofgem. This provides details about every circuit and includes:

- Number of customers
- Length of overhead line
- Length of underground cable
- Number of faults
- Number of customers interrupted
- Number of customer minutes lost.

5.333. This HV disaggregated data is used by Ofgem to calculate performance benchmarks for target setting under the Interruption Incentive Scheme. The circuits are subdivided into 22 different types, determined by:

- Proportion of overhead network on the circuit
- Length of circuit
- Number of customers

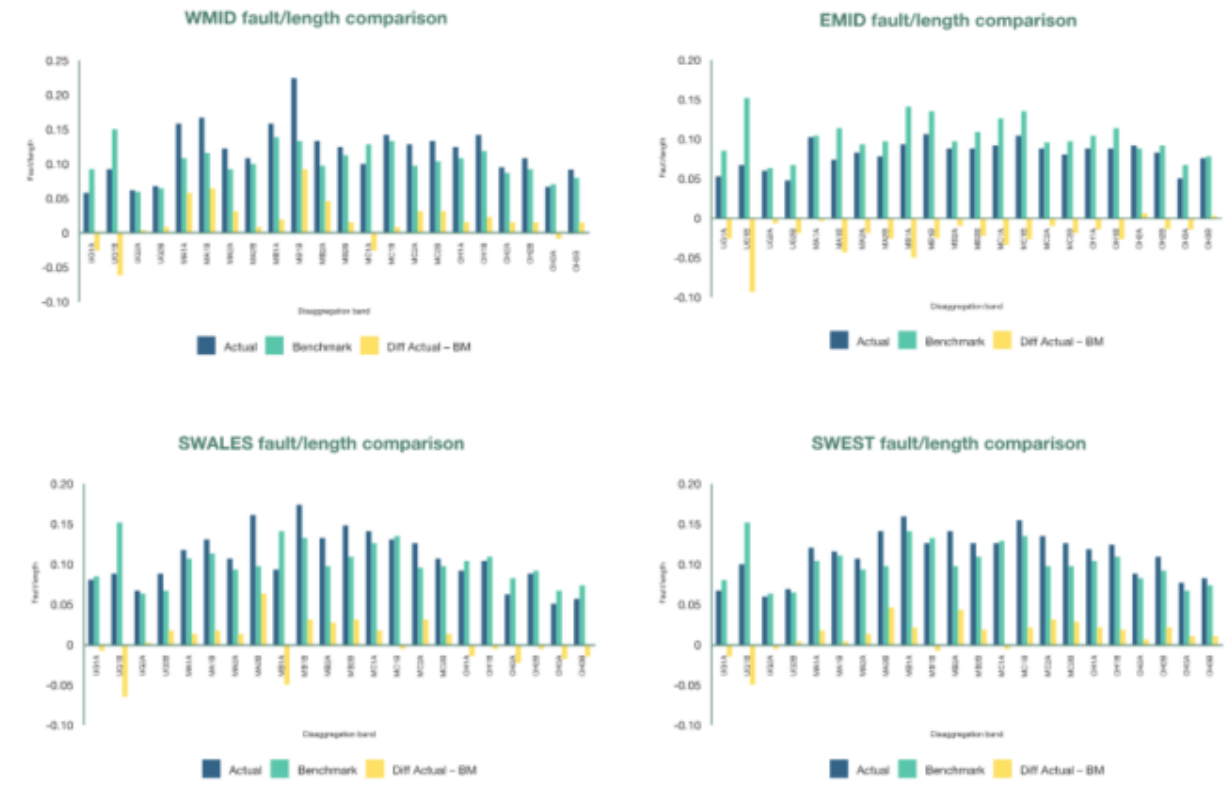
5.334. For each circuit type, Ofgem determines a range of different parameters for each DNO and the industry as a whole. These parameters are then combined, with some elements being based upon DNO values and others being based upon industry values, to derive the benchmarks for each DNO for each circuit type. The comparison of DNO actual values against the benchmarks can identify areas of opportunity for further improvements. Some of the main 'controllable' parameters are:

- Fault rate (the number of faults per length of network)
- Number of customers per fault
- Duration of faults

5.335. The following sections look at each of these three areas.

Prevention of faults (Fault rate)

5.336. Figure SA-06. 153 illustrating HV disaggregation charts (representing the most up-to-date analysis using reported data between 2016/17 and 2019/20) shows that for the West Midlands, South Wales and South West, the fault rate is worse than the benchmark position (based upon industry average). This position is observed for the majority of disaggregation categories and supports the need for continued activities aimed at preventing faults on both underground and overhead circuits.



NB: yellow bars above zero show that actual is worse than benchmark; yellow bars below zero show that actual is better than benchmark

Figure SA-06. 153: Fault rate by length, by DNO 2016/17 - 2019/20

5.337. Figure SA-06. 154 summarises the activities that will contribute to preventing faults arising. These activities do not directly fall under the Quality of Supply category of expenditure (the table provides details of which cost areas these activities are reported under).

Activity	Cost category
Inspection to determine the condition of assets and identify defects that need repair	Inspections
Maintenance programmes to ensure equipment will last for its expected life	Repair and Maintenance
Repairing defects that are identified during inspections	Repair and Maintenance
Refurbishing assets by replacing sub-components or carrying out major overhauls.	Refurbishment (SDI) for NARM related assets Refurbishment (no SDI)
Replacing whole assets which are identified in poor condition	Asset Replacement (NARM) Asset Replacement (non-NARM)
Completing tree clearance programmes to reduce the likelihood of branches and windborne debris affecting overhead lines (including adopting highly accurate LiDAR measurement techniques to better target tree clearance requirements)	Tree Clearance
Providing adequate network capacity (either through traditional solutions or flexibility services) to prevent damage to assets from overloading	Load Related

Figure SA-06. 154: Activities that contribute to the prevention of faults

Reducing customers interrupted per fault

5.338. Figure SA-06. 155 illustrating HV disaggregation charts show that for the West Midlands, East Midlands and South West, customers interrupted per fault are higher than the benchmark position (based upon industry average). South Wales is better than benchmark across the majority of disaggregated bands.

NB: yellow bars above zero show that actual is worse than benchmark; yellow bars below zero show that actual is better than benchmark

Figure SA-06. 155: Number of customers interrupted per fault, by DNO

5.339. HV circuits are mainly designed to operate as radial feeds; this means that the flow of power is from the source primary substation to open points at the ends of the feeder, where the open points are inter-connected to other circuits.

5.340. The main protection device for the circuit is a circuit breaker positioned at the source primary substation, which can interrupt the flow of power when a fault is detected on the circuit. Relying solely on this circuit breaker means that all the customers on a feeder will be interrupted. To reduce the number of customers impacted by a fault, additional protection devices (e.g. reclosing circuit breakers, intelligent fuses) have been installed along the circuits to protect customers upstream of the devices from faults downstream of the devices. Such devices prevent the upstream customers from being impacted by any interruption, including short interruptions.

5.341. Prior to the advent of remote control capability, the reconfiguration of supply arrangements would have required a person to travel to the substations (e.g. at the open points) and carry out manual switching to enable re-routing of power from an adjacent circuit. Advances to remote control communications allow remote operation of switches. The installation of additional remotely controlled devices allows electricity supplies to be quickly rerouted or 'switched'

without the need to send a person to site. These switching operations can be initiated by staff in our control centre or automatically by computer algorithms which allow switching actions to take place without the intervention of a control engineer. The algorithms use information from fault passage sensors to identify which section of the network contains the fault and then communicate with remotely controlled devices to restore supplies to the maximum number of customers possible.

5.342. Reductions in the number of customers affected by HV faults are achieved by increasing the amount of protection stages (by subdividing circuits into smaller zones) and increasing the number of remotely controlled switches which can be operated automatically.

5.343. While investment into remote control and automation during RIIO-ED1 has led to reductions in the number of customers interrupted per fault, the comparisons against benchmarks show that there remains scope for further improvement opportunities by continuing with the programmes (especially within the West Midlands and East Midlands).

5.344. During RIIO-ED1, WPD has addressed the protections zones with more than 1,500 customers. In RIIO-ED2, we propose to address protection zones with more than 1,000 customers. In most cases, this will result in adding an extra remotely controllable device into those protection zones to increase the number of customers that can be restored automatically.

5.345. The majority of expenditure under the Quality of Supply cost category in RIIO-ED2 will be for the reduction in numbers of customers interrupted per fault.

Customers interrupted per fault - Determining the scope of improvements

5.346. During RIIO-ED1, WPD has been working towards having no more than 1,500 customers affected by a fault. This has been achieved by assessing the network to identify the number of customers that would be left affected after all automated switching had taken place.

5.347. Further analysis of this data has identified the number of protection zones where additional remotely controllable devices could be used to reduce the maximum number of customers affected to 1,000.

5.348. Figure SA-06. 156 shows the number of protection zones in customer number bands for each licence area. Those above 1,500 will be addressed during the remainder of RIIO-ED1 and those between 1,000 and 1,500 are proposed to be addressed during RIIO-ED2. For example, in the West Midlands, there are 112 instances of protection zones having between 1,000 and 1,100 customers remaining affected after all automation has operated. The installation of an extra remotely controllable device in these protection zones will reduce the customers affected by half to around 550 (the actual resultant numbers will be dependent upon numbers of customers fed from substations within the protection zone and the location where the additional device is installed).

Number of Protection Zones per Customer Number Banding				
Customers in protection zone banding	WMID	EMID	SWALES	SWEST
0	842	733	189	97
0-100	1442	1907	1200	464
100-200	916	724	536	436
200-300	616	587	366	415
300-400	516	529	339	406
400-500	435	415	259	311
500-600	360	341	199	269
600-700	308	316	153	185
700-800	266	288	103	176
800-900	192	205	67	135
900-1000	180	161	43	100
1000-1100	112	126	36	63
1100-1200	74	85	11	54
1200-1300	30	73	5	58
1300-1400	9	63	5	29
1400-1500	6	42	4	12
1500-1600	1	17	2	12
1600-1700	1	17	1	7
1700-1800	1	13	1	2
1800-1900	1	8	1	0
1900-2000	0	7	0	2
2000-2100	0	2	0	0
2100-2200	0	1	0	0
2200-2300	1	2	0	0
2300-2400	0	0	0	0
2400-2500	0	0	0	0
2500-2600	0	2	0	0
2600-2700	0	0	0	0

Figure SA-06. 156: Number of Protection Zones per Customer Number Banding

Forecast volumes

5.349. The volume of activity in RIIO-ED2 is based upon the number of protections zones with customers affected between 1,000 and 1,500. For each zone, we propose to install an additional remotely controlled device. This gives the following volumes set out in Figure SA-06. 157.

Volumes of additional devices to be installed				
WMID	EMID	SWALES	SWEST	WPD Total
231	389	61	216	**897**

Figure SA-06. 157: Volumes of additional devices to be installed

Forecast unit costs

5.350. The protection zones to be addressed are a combination of urban and rural situations. Rural overhead line circuits can utilise pole-mounted reclosers, while in urban situations ground-mounted switchgear with actuators is used. Analysis of the number of substations in each

protection zone suggests that 85% of installations will be on urban installations and therefore the unit cost used is a blend of pole-mounted and ground-mounted switchgear costs.

South West legacy fusing policy

5.351. Historical practice in the South West has been to install fuses on spurs to prevent faults on the spurs from impacting customers on the rest of the circuit, but these do not operate for certain types of lower current fault.

5.352. In the rest of WPD, greater use has been made of automatic sectionalising links, which operate in coordination with automatic reclosing circuit breakers. We have also been trialling single phase circuit breakers than can be installed in the same fittings used for fuses.

5.353. Both the automatic sectionalising links and single phase circuit breakers are more sensitive to low current faults, which means that they will operate for more faults than fuses, preventing the need to upstream devices to operate. This means that fewer customers upstream of the spur will be affected by faults on the spur.

5.354. We propose to install a mix of both types of devices with 85% being automatic sectionalising links. This will be applied to 25% of the locations with fuses during RIIO-ED2.

Network reconfiguration

5.355. During RIIO-ED1, WPD has carried out an amount of network reconfiguration to enable supplies to be restored where there is no alternative feed. This work has included:

- Installing additional low voltage link boxes to provided interconnection on LV circuits;
- Looping in teed substations at HV, by replacing existing switchgear with a ring main unit and providing an alternative cable feed for the customers;
- Reconfiguring HV overhead line running arrangements to provide interconnection.

5.356. In RIIO-ED2, WPD does not propose to carry out significant amount of these activities, which is why no volumes or costs have been included in the forecast for this activity.

Duration of faults

5.357. Figure SA-06. 158 illustrating HV disaggregation charts show that for nearly all disaggregation bands across all WPD licence areas the duration of faults is better than the benchmark position (based upon upper quartile). As the benchmark is based upon the arithmetic quartile of 14 companies, the charts indicate that WPD is the frontier performer in duration. This means that further improvements will be difficult to achieve.

NB: yellow bars above zero show that actual is worse than benchmark; yellow bars below zero show that actual is better than benchmark

Figure SA-06. 158: Duration of faults by DNO

5.358. WPD is proposing to maintain focus on duration of faults by restoring supplies quickly and will continue to target achieving more than 85% of customers (that are not automatically restored) within one hour. In line with stakeholder feedback, the target will be enhanced to 87% and achievement will continue to be monitored using an internal KPI.

5.359. The costs associated with better response to faults are included within the overall costs in the Faults forecast. Because we recognise that the costs incurred on faults have been high, we have proposed challenging unit costs to drive more efficient ways of delivering the excellent response that we provide.

Expenditure summary

5.360. Forecasted costs for Quality of Supply expenditure are shown in Figure SA-06. 159.

Quality of supply					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	2	2	1	1	6
RIIO-ED2 Annual Average (forecast)	1	2	0	2	5
RIIO-ED2 Total (5 years)	5	8	1	12	25

Figure SA-06. 159: RIIO-ED2 forecast expenditure - quality of supply

Flood mitigation

5.361. The devastation caused by flooding is regularly highlighted in the media, as domestic and business properties are made unusable after being affected by flood water. Flooding can also impact electricity supplies which is why flood defences are installed to prevent flood water affecting electrical equipment.

5.362. Following a number of high profile flooding events in 2005 and 2007, the government established the Pitt Review to establish a coordinated approach to protecting against floods. The electricity industry, through the Energy Networks Association, established Engineering Technical Recommendation 138 which set out risk-based approaches to establishing flood defences. This was originally focussed on fluvial (rivers and coastal) flooding, but has subsequently been updated to reflect the need for pluvial (surface water) flooding caused by heavy rainfall.

5.363. Networks supplied by substations can extend for many kilometres and the loss of power from a substation can have an impact beyond the flooded area. Substations providing supplies for higher numbers of customers are therefore prioritised for flood defences. WPD has been carrying out work since 2010 focussing on primary and grid substations.

5.364. WPD uses data from the Environment Agency in England and Natural Resources Wales to identify the locations that could be prone to flooding. Flood risk data for fluvial (river flooding) and pluvial (rainwater flooding) is overlaid onto network records within WPD's mapping system. This allows for analysis of the likelihood of a substation flooding and the anticipated depth of the flood water. Figure SA-06. 160 shows an example of the mapping records with fluvial flood risk (shown in blue) and pluvial flood risk (shown in yellow and orange).

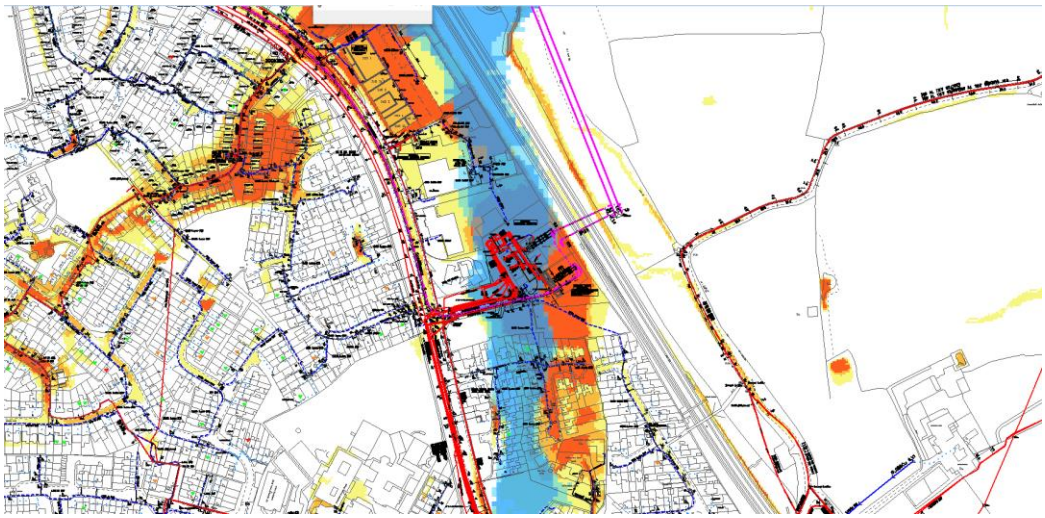


Figure SA-06. 160: Example network mapping records with flood risk data overlays

5.365. Potential sites that are at risk from flooding are identified by analysing data from the mapping system. This identifies any substations located within flood zones. The identified sites are then assessed by local teams to determine whether the anticipated local site conditions might cause an issue for electrical equipment and supplies. The sites which give cause for concern are assessed in more detail with hydrological surveys being carried out. Where the surveys identify that flood defences are required, a range of solutions is considered.

5.366. The types of solutions that can be applied include low cost temporary barriers; protection of individual assets; protection of buildings; or protection of the whole site. WPD has employed a

range of solutions, dependent upon the local requirements. This means that a range of historical costs have been incurred, on which planning forecasts can be based.

Expenditure summary

5.367. The data about fluvial and pluvial flood risk has been used to identify that there are 859 primary and grid sites within flood zones. Local teams have reviewed the requirements and provided analysis that has been used to forecast the number of sites that will require a hydrological survey and those that will need flood protection measures. This has resulted in requirements for flood defences at 157 sites, of which 102 will be addressed in RIIO-ED2. The remainder, all in the East Midlands, will be addressed in RIIO-ED3.

5.368. The forecast of future costs has been informed by the range of different approaches to flood defences that have been implemented during RIIO-ED1. We anticipate that there will continue to be a range of different approaches adopted in RIIO-ED2 as site specific solutions are determined for each location. In order to forecast future costs an average of RIIO-ED1 unit costs across all licence areas has been derived, which is being used to represent the costs of a typical average installation.

5.369. Separate unit costs have been derived for EHV and 132kV substations due to the different sizes of the substations and amount of flood defence work that would be required. The same unit costs at each voltage have been used for all WPD licence areas.

5.370. Only EHV and 132kV sites have been included in the forecast because these impact higher numbers of customers if affected by flood water.

5.371. This analysis has identified the volumes of activity for RIIO-ED2 as shown in Figure SA-06. 161.

Flood defence volumes for ED2				
West Midlands	East Midlands	South Wales	South West	WPD Total
6	60	17	19	**102**

Figure SA-06. 161: Flood defence volumes for RIIO-ED2

5.372. Proposed expenditure is detailed in Figure SA-06. 162.

Flood mitigation					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	0	1
RIIO-ED2 Annual Average (forecast)	0	1	0	0	2
RIIO-ED2 Total (5 years)	1	6	2	2	12

Figure SA-06. 162: RIIO-ED2 forecast expenditure - flood mitigation

Physical security

5.373. The Centre for Protection of National Infrastructure (CPNI) is the government authority for protective security advice to the UK national infrastructure. Its role is to protect national security by helping to reduce the vulnerability of national infrastructure to terrorism and other threats.

5.374. The CPNI has previously identified a number of key electricity infrastructure sites across the UK where more stringent security measures are required. The measures include the installation of enhanced and electrified fences, alarm systems and CCTV systems. Proposed enhanced security measures need to be approved by the CPNI and, once completed, an audit is required to demonstrate that the measures have been completed to the appropriate specification.

5.375. While WPD has a small number of existing CPNI sites, there are currently no identified additional enhanced security requirements at WPD locations. The forecast expenditure in RIIO-ED2 is therefore zero as summarised in Figure SA-06. 163.

Physical security					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	0	0
RIIO-ED2 Annual Average (forecast)	0	0	0	0	0
RIIO-ED2 Total (5 years)	0	0	0	0	0

Figure SA-06. 163: RIIO-ED2 forecast expenditure - physical security

5.376. However, this may change in response to additional CPNI intelligence. WPD is therefore supportive of the Ofgem proposed uncertainty mechanism, which provides the opportunity to request funding during the price control as a result of changed circumstances.

Rising and lateral mains

5.377. The electricity supplies to multi-storey buildings (also referred to as multi-occupancy buildings) have been provided using different approaches. In most cases, the electricity supplies enter into a plant room from which they are distributed around the building. While the incoming cables into the building are owned by the DNO, there is less clarity, and in some cases disagreement, about the ownership of the cables that distribute power around the building.

5.378. Rising and lateral mains are cables or busbars which run within, or are attached to the outside of, a multiple occupancy building. They distribute power from the building intake position to the individual properties. These assets form part of a building network managed by a Building Network Operator (BNO).

5.379. A BNO is defined in ENA ER G87 as “The organisation that owns or operates the electricity distribution network within a multi-occupancy building, between the intake position and customers’ installations. The BNO may be the DNO, another licenced distributor or a third party exempt from an electricity distribution license (e.g. a facilities management company)”.

5.380. The BNO principle was introduced within ENA Engineering Recommendation G87 in January 2010. Since this date, all multi-occupancy building installations have required confirmation of the responsibilities of the BNO and the Distribution Network Operator.

5.381. For installations before January 2010, the ownership and responsibility for the building network has not been routinely identified and in many cases is yet to be established.

5.382. In 2018, WPD started a programme of checking the termination equipment entering into multi-occupancy buildings. The locations were identified through the use of mapping tools and information about MPAN clusters. This identified where multi-occupancy buildings were located and these buildings were visited to complete a survey of the termination equipment to check its condition and ensure that it was safe. Since then, WPD has identified, visited and surveyed the incoming terminations of 690 multi-occupancy buildings.

5.383. Subsequently during 2018/19, in recognition that ownership should be clearly defined for all rising and lateral mains equipment, WPD initiated a survey of multi-occupancy buildings with six or more floors. The surveys recorded all assets at the intake position and WPD sought to establish a connection agreement and site responsibility schedule with each building owner.

5.384. As a result, WPD is in discussions with the building owners to confirm who should be responsible for the electricity network within each building.

5.385. We believe that, once ownership is established, it will be clearer who has responsibility for ensuring that building installations are inspected, maintained and remain safe. Customers will also be able to quickly identify who to speak to should they have any problems with their electricity supply within the building.

5.386. For some buildings, the ownership of the building network is clearly the building owner; for others, there is less clarity about who owns the building network and more detailed investigations are required by both WPD and building owners to resolve ownership and boundary issues. In many cases, the rising and lateral mains cables are of a type not used by DNOs; in other cases, there are labels indicating that installation has been carried out by the DNO, typically a pre-privatisation installation carried out by the contracting arm of an Electricity Board.

5.387. While ownership remains undetermined or in dispute, WPD will ensure that supplies are available by assisting local authority building owners by investigating or replacing assets where the electricity supply has been unexpectedly interrupted. However, as part of this support process, WPD will not be assuming ownership of the building network and will follow due legal process for identification of ownership.

5.388. For the remainder of RIIO-ED1, WPD will be extending this work to consider buildings with less than six floors. WPD will continue to proactively contact building owners of multi-occupancy buildings to build upon the established process for identifying ownership

5.389. For RIIO-ED2, we will continue to work with building owners to identify DNO/BNO boundaries and clarify ownership. Alongside this, we will continue to work with building owners to ensure they are supported with any immediate repairs to building network assets to ensure customer supplies are not compromised until ownership boundaries are clarified.

5.390. Many owners of buildings with risers and lateral mains have welcomed the proactive contact WPD has made. This allows identification of responsibilities so it is clear who has responsibility for the building network and allows the relevant responsible party to implement inspection and maintenance programmes.

Expenditure summary

5.391. It is estimated that there will be a number of buildings with six or more floors that will either become the responsibility of WPD or will require WPD to provide some form of support while ownership is disputed. We have assumed that work will be required at 20 of these taller

buildings during RIIO-ED2. We have also assumed that work will be required at 50 smaller buildings.

5.392. In order to forecast costs, we have used data from a small number of installations where WPD has previously provided fully rechargeable works in support of local authorities refurbishing tower blocks. In these projects, WPD has carried out the mains works to the service position on the ground floor and a contracting company has been used to install lateral mains and services to the higher floors. These projects have enabled estimation of typical numbers of customers and services per building, allowing typical costs per building to be derived.

5.393. This leads to cost forecast which uses a value of around £50,000 per installation for taller buildings and £20,000 for smaller buildings.

5.394. The forecast for rising and lateral mains expenditure is shown in Figure SA-06. 164.

Rising and lateral mains					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	0	0
RIIO-ED2 Annual Average (forecast)	0	0	0	0	0
RIIO-ED2 Total (5 years)	1	1	1	0	2

Figure SA-06. 164: RIIO-ED2 forecast expenditure - rising and lateral mains

Overhead line clearances

5.395. WPD has statutory duties under the Electricity Safety Quality and Continuity Regulations (ESQCR) 2002 to ensure the network is safe, fit for purpose and resilient. Ensuring the safety of the overhead network requires appropriate clearance distances between conductors and the surrounding environment to prevent inadvertent contact.

5.396. Regulation 17 of the Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002 specifies requirements for clearances of overhead lines to the ground (this is to ensure that vehicles passing under the lines have sufficient clearance without the risk of coming into contact with the lines) and Regulation 18 specifies requirements for clearance to structures, such as buildings.

5.397. The industry has developed guidelines in relation to maintaining safe distances which are contained within Engineering Network Association Technical Specification 43-8 (ENA TS 43-8). The required level of safety distance varies according to different factors, including the location or the accessibility of the overhead lines.

5.398. Detailed survey work has identified that there are a number of low ground clearance issues that need to be resolved. The resolution of these issues has been taking place during RIIO-ED1 and the work programme is expected to continue into RIIO-ED3, built around risk-based timescales for resolving the issues.

Clearance issues

5.399. Construction of new overhead lines is carried out in a way that meets current requirements and specifications. Some legacy overhead lines have been constructed to different standards which now fall outside current requirements. In addition, clearance distances can change over time for a number of reasons, such as alterations to buildings and changes to ground level.

5.400. WPD carries out routine overhead line inspections, on a seven year cycle, during which clearances to the surrounding environment are measured. If any clearances are found to be below statutory requirements, the issues are recorded as defects. Defects are classified using a risk-based prioritisation that considers factors such as difference between the actual clearance and minimum requirements, the network voltage, and the location of the line. Each defect type has a timescale for resolution defined in policy, and resolution timescales are automatically applied by the asset management system.

5.401. During the early part of DPCR5, a number of issues were identified with overhead line clearance heights across roads. In agreement with the HSE, WPD developed a programme of road crossing inspections that started in 2013. The agreed approach was to inspect all LV mains and service road-crossing clearances and then remove the resultant defect, with deadlines for resolution dependent upon the height of the conductors. The inspection programme was completed in 2016, and all high risk defects were removed by December 2019. The risk-based deadlines for resolving medium and low risk clearances are December 2026 and December 2029 respectively, and therefore this activity is included in our RIIO-ED2 work programmes.

5.402. Resolution of defects is completed through a number of different activities, such as replacing the conductor with a different type (e.g. aerial bundled conductor), increasing the conductor tension, installing taller poles, or replacing the overhead line with underground cable. The most appropriate resolution will be determined by the issue, and the existing construction and location of the overhead line.

5.403. Rectification of clearance issues can also be undertaken coincidentally during delivery of a wide range of investment programmes, such as the replacement of poor condition assets or increasing network capacity. The investment proposals detailed below represent the investment required in the programme dedicated to resolving overhead clearance issues.

RIIO-ED2 forecast development

5.404. The volume of activity forecast for RIIO-ED2 is based on known issues and an estimate of the number of additional issues that are expected to be identified during future routine inspections.

5.405. The known issues are derived from the defects identified during the bespoke road crossing survey and routine inspection programmes.

5.406. In 2018-19, improved measurement techniques were introduced into routine inspections of all overhead lines and, as a consequence, additional issues are being identified. The volumes of new issues included the forecast are informed by the volumes and types identified during 2020-21. We anticipate that new defects will continue to be found at the same rate as in 2020-21 until a full seven year cycle of inspections has been completed in 2025-26. Since the resolution timescales for new defects can be up to seven years, we expect that the work activity will continue to be required into RIIO-ED3.

5.407. The proportion of defects resolved through other means is determined from the historical proportions for each voltage in each DNO and the remainder forms the volumes of work to be resolved though the OH clearances investment programme. Figure SA-06. 165 compares the volumes of OH clearances completed in RIIO-ED1 to date and the forecast future requirements split by existing issues and new issues.

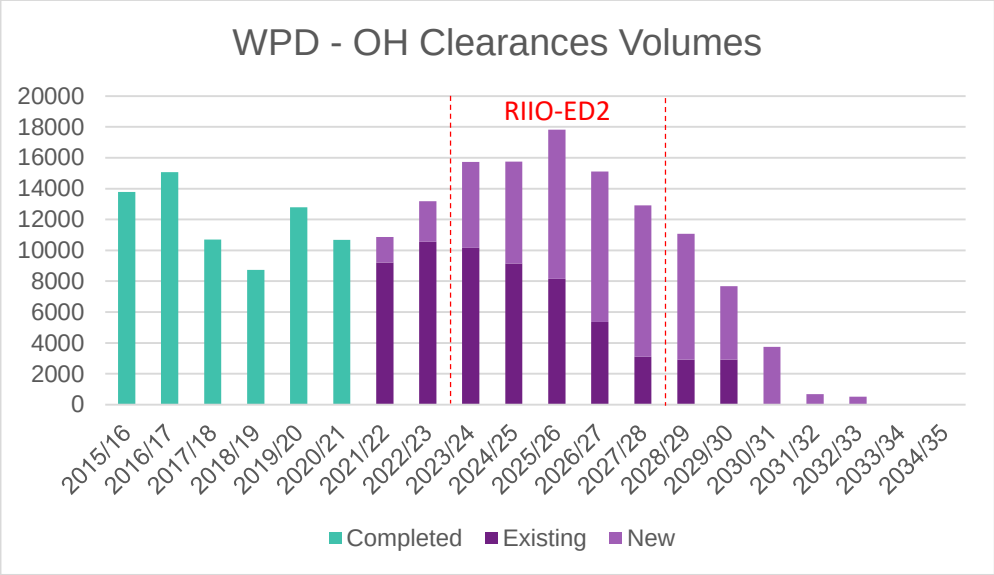


Figure SA-06. 165: WPD - overhead line clearance volumes

5.408. The unit costs for this type of activity have been derived from historical costs. This work has been undertaken for a number of years, and therefore there is a reliable history of unit costs representing the mixture of work undertaken to resolve the clearance issues. A high volume of activity has been carried out in each licence area allowing us to derive licence area specific unit costs which have used to derive the forecast levels of expenditure.

Expenditure summary

5.409. Figure SA-06. 166 compares the average annual expenditure proposed for RIIO-ED2 compared to actual average expenditure in RIIO-ED1.

Overhead line clearances					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	4	4	3	8	18
RIIO-ED2 Annual Average (forecast)	6	3	4	12	24
RIIO-ED2 Total (5 years)	29	17	18	58	122

Figure SA-06. 166: RIIO-ED2 forecast expenditure - overhead line clearances

Worst served customers

5.410. While WPD's network performance is among the best in the industry, there are some customers who experience high numbers of faults. These customers are generally located on the end of long rural circuits or on remote parts of the network, with limited alternative networks available to provide supplies when faults occur. These customers are referred to as 'worst served customers'.

5.411. To enable comparison across the industry, Ofgem has created a specific definition for worst served customers which is changing for RIIO-ED2 and will be based upon customers who experience 12 or more, higher voltage interruptions over a three year period, with a minimum of two in each year. This change in definition increases the number of customers who can be classified as being worst served customers. A comparison of the RIIO-ED1 and RIIO-ED2 definitions is shown in the Figure SA-06. 167.

Criteria for Worst Served Customers		
	RIIO-ED1	**RIIO-ED2**
Voltage level of faults	HV and above	HV and above
Number of faults	12 in 3 years	12 in 3 years
Minimum in any year	three	two

Figure SA-06. 167: Criteria for worst served customers

5.412. Using the new RIIO-ED2 criteria, there were approximately 9,000 worst served customers across the four WPD areas in 2020/21, as shown in Figure SA-06. 168.

Number of Worst Served Customers (2020/21)				
West Midlands	**East Midlands**	**South Wales**	**South West**	**WPD Total**
2,487	1,667	1,459	3,523	**9,136**

Figure SA-06. 168: Number of worst served customers, 2020/21

5.413. By definition, worst served customers are those who have sustained poor network performance. They suffer higher numbers of faults due to a range of reasons. By addressing the causes of the faults or reducing the impact of those faults, the overall network performance experienced by the customer can be improved.

5.414. Some of the solutions that have been adopted during RIIO-ED1 include:

- Network reconfiguration;
- Replacement of poor condition overhead lines;
- Undergrounding of overhead lines;
- Refurbishment of circuit components; and
- Installing additional switching points/protection zones.

5.415. While most of the solutions address the underlying cause of the faults, in some cases, additional protection devices can reduce the impact of faults, especially where protection is applied to spurs which prevent faults on those spurs affecting other parts of the circuit.

5.416. The type of solution adopted in RIIO-ED2 will be informed by analysis of the specific circumstances of each circuit. This will include assessment of the reasons for previous faults, the opportunity for reconfiguration of circuits or preventative works and the scope for additional protection or network subdivision.

Forecast approach

5.417. Network performance on circuits can change from year to year which can cause those customers classified as being worst served to change. This means that new worst served customers will be identified as we progress through the remainder of RIIO-ED1 and into RIIO-ED2. This programme will therefore be dynamic responding to the latest data available when investment is being planned.

5.418. The RIIO-ED2 forecast is informed by the range of activity carried out in the first six years of RIIO-ED1. For unit costs we have taken an average historical unit cost across all of WPD to take account of the wide variety of different solutions that can be adopted.

5.419. In the future, when projects are selected they will be targeted at circuits with higher numbers of worst served customers and vulnerable customers.

5.420. The volume of projects to be carried out in RIIO-ED2 has been informed by stakeholder engagement. Improvements for worst served customers is a core commitment and has been consulted on through various stages of stakeholder engagement. Stakeholders strongly support resolving issues for worst served customers and prefer higher volumes of activity. The original volumes proposed in the first draft WPD Business Plan published in January 2021 were based upon the rate of activity in RIIO-ED1, but have been increased to meet the requirements of stakeholders and deal with some of the additional circuits that will fall into this category during RIIO-ED2

5.421. Across the eight years of RIIO-ED1 we are carrying out 71 schemes and we propose to increase the annual volume of work to deliver 70 schemes across the five years of RIIO-ED2.

Expenditure summary

5.422. Figure SA-06. 169 summarises the RIIO-ED2 expenditure on a per annum basis with comparison to RIIO-ED1.

Worst served customers					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	0	1
RIIO-ED2 Annual Average (forecast)	0	0	0	0	1
RIIO-ED2 Total (5 years)	2	0	2	1	4

Figure SA-06. 169: RIIO-ED2 forecast expenditure - worst served customers

Visual amenity and undergrounding in National Parks and Areas of Natural Beauty

5.423. WPD's geographic area includes numerous National Parks and Areas of Outstanding Natural Beauty (AONBs) e.g. the Isles of Scilly, Dartmoor, Pembrokeshire, the Cotswolds, the Peak District and the Lincolnshire Wolds.

5.424. Electricity supplies in rural areas are predominantly provided using overhead lines. This means that WPD has around 13,000km of overhead lines installed within National Parks and AONBs. Many overhead lines have been in place for a long time, but there are locations, especially at popular tourist sites, where the removal of selective overhead lines can enhance the visual amenity.

5.425. Stakeholders see value in preserving the visual amenity particularly where this benefits local communities and contributes to tourism, but they do not expect expansive undergrounding of all existing lines stating that the focus should be on important areas.

5.426. WPD has established collaborative working groups with National Parks, AONB and appropriate interest group representatives, to identify the areas that would benefit the most from the undergrounding of overhead lines. Regular discussions are held with established steering groups to enable the identification and prioritisation of projects.

5.427. During RIIO-ED2, WPD will continue to undertake undergrounding projects by working collaboratively with stakeholder groups. In RIIO-ED1, we proposed to carry out 55km over the eight year price control period. Over the five years of RIIO-ED2, we propose to underground 50km, an increase in annual rate in response to our stakeholder engagement.

Expenditure summary

5.428. The total volumes have been apportioned across the WPD licence areas broadly in line with the amount of overhead line in AONBs and customers in each licence area.

5.429. Each historical undergrounding project is different and therefore to get a representative cost from the limited number of projects carried out, an average of all the RIIO-ED1 projects across WPD has been used for each voltage level. This means that we are proposing common unit costs across all WPD licence areas at each voltage level.

5.430. The forecast for visual amenity expenditure during RIIO-ED2 is show in Figure SA-06. 170.

Visual amenity and undergrounding in National Parks and AONB					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	0	1
RIIO-ED2 Annual Average (forecast)	0	0	0	0	1
RIIO-ED2 Total (5 years)	2	1	1	2	7

Figure SA-06. 170: RIIO-ED2 forecast expenditure - visual amenity and undergrounding in National Parks and AONB

Losses

5.431. The amount of energy that enters an electricity network is greater than the amount that is delivered to customers. The principal reason for this is that an electricity network uses energy in the process of delivering power. This is known as a technical loss.

5.432. Other reasons for electricity losses occur where a connection has been made to the distribution network without authority (known as theft in conveyance), where metering equipment has been deliberately bypassed (known as illegal abstraction) or where a connection has not been properly registered and no supplier is assigned. The energy used in these circumstances is not metered and does not feature in volumes registered by suppliers. As a result, it is shown as a loss on our network.

5.433. Since 2013, WPD has produced a Losses Strategy which is updated annually and available as a standalone document. The proposals for RIIO-ED2 are a continuation of an ongoing programme of initiatives to reduce the losses on the network. Our key actions are focussed upon using lower loss assets when new transformers and cables are installed.

5.434. In RIIO-ED1, we have been replacing older pre-1958 ground-mounted transformers that were manufacturerd to higher loss technical standards. In the RIIO-ED2 period, we will extend this proactive replacement programme to our pre-1958 pole-mounted transformers.

5.435. In addition, we will be discontinuing smaller sizes of transformers and cables, as these have higher losses than those with greater capacity.

5.436. For transformers, during RIIO-ED1, we discontinued the use of 15kVA single phase and 25kVA three phase transformers, using larger sized assets as the minimum size available. This provided both a losses and capacity benefit. In RIIO-ED2, we will extend this approach and discontinue using 25kVA single phase and 50kVA three phase units. This will mean the smallest units used are 50kVA single phase and 100kVA three phase.

5.437. For cables, during RIIO-ED1, we discontinued using 95mm^2 cable to reduce losses and provide additional capacity for LCT growth. We have evaluated which networks would be best suited to having cable size increased further. The greatest benefit is obtained on LV networks which have high levels of utilisation. This means that we are able to deliver a positive cost benefit on the discontinuation of 185mm^2 cable at low voltage. However, at 11kV and above, where networks are designed to be able to pick up load from interconnected circuits and therefore carry lower normal loads there is limited benefit. We therefore propose to discontinue the use of 185mm^2 LV cable to provide a losses benefit, adopting 300mm^2 as the standard. Using 300mm^2 cable will also provide greater scope for demand increases before additional reinforcement is required.

5.438. The costs associated with using lower loss assets are incremental costs for the prime investment driver and therefore are not included as losses specific costs. The expenditure proposed for losses is for the bespoke programme to remove pre-1958 transformers. Figure SA-06. 171 summarises the proposed expenditure for RIIO-ED2.

Losses					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	1	0	0	0	1
RIIO-ED2 Annual Average (forecast)	0	0	0	0	1
RIIO-ED2 Total (5 years)	1	1	1	1	5

Figure SA-06. 171: RIIO-ED2 forecast expenditure - losses

Environmental activities

5.439. Our environmental activities proposed for RIIO-ED2 are captured in more detail in our Environmental Action Plan.

5.440. We take our responsibility as an operator within wider society very seriously. As such, our stakeholders play a vital role in determining the strategic direction we take to mitigate our environmental impact. Dialogue with our stakeholders has enabled us to approach issues from many different perspectives in order to arrive at a robust strategy and set goals accordingly.

5.441. Our activities are also influenced by environmental legislation. In particular, we are working collaboratively across the industry to remove all polychlorinated biphenyls (PCB) contaminated equipment from the WPD network by 2025.

5.442. Environmental considerations span a range of investment areas, with benefits being derived from asset replacement programmes, the management of the vehicle fleet and the way we manage our property portfolio. In addition, there are a number of activities with a specific focus on achieving environmental improvements which are forecast in the environmental part of the Business Plan.

5.443. Consequently, our Environmental Action Plan and Business Plan core commitments cover a range of activities designed to reduce our environmental impact.

5.444. One of our core commitments relates to our own Business Carbon Footprint (BCF). During RIIO-ED2, we will undertake a range of activities to reduce our BCF and offset any residual BCF to achieve net zero carbon by the end of the price control period.

5.445. Costs which fall within the environmental activities category include oil pollution mitigation schemes for cables, activities related to the removal of persistent organic pollutants, costs associated with the mitigation of SF6 leakage from our switchgear, noise pollution, contaminated land clean up and carbon offsetting.

5.446. Key actions that will be undertaken within RIIO-ED2 are detailed below.

Reducing leakage from fluid filled cables

5.447. The design of very high voltage underground cables has evolved over many years. While our new cables use a solid plastic insulation, older designs of 33kV and higher voltage cables used oil inside the cable. Although these cables are normally very reliable, the oil may leak, if they are damaged or ground movement causes disturbance to joints. The oil is biodegradable in the long-term, but leaks can cause short term environmental damage to land and water courses.

5.448. The cables are monitored remotely in our control centre so that we can respond quickly in the event of a leak. Pressure gauges connected to the cable monitor fluid pressure and send alarm signals to control centres when the pressure falls below set thresholds. When alarms are raised,

staff are dispatched to make arrangements to investigate and top up the oil level. Where the level continues to fall, leak location is instigated.

5.449. Advances in technology have allowed new techniques to be adopted for the location of leaks. WPD has been using perfluorocarbon tagging (PFT) to locate and identify leaks during RIIO-ED1. PFT uses a perfluorocarbon tracer, which is added to the cable fluid, and which can be detected from pavement level should a cable leak occur. Using PFT helps to locate cable leaks quickly and accurately reduce the amount of fluid leaking into the environment and the extent of any related excavation.

5.450. During RIIO-ED2, we propose to continue to apply PFT to cables which cumulatively lose in excess of 40 litres per year.

5.451. In addition, the asset replacement programme will target the replacement of cables that have the highest leak rates and a history of known issues.

5.452. Together, the application of quicker location of leaks and the removal of problematic cables will reduce the amount of oil leaked into the environment. We are committing to reduce leaks by 50% compared to RIIO-ED1 levels.

Persistent organic pollutants

5.453. Polychlorinated biphenyls (PCBs) are a class of organic man-made chemicals which were historically used in some electrical equipment. While they were not used extensively within the electricity industry, some equipment was contaminated with PCBs during the manufacturing process. In 1986, the use of PCBs as an insulating medium in newly manufactured equipment was banned due to its toxic effects on wildlife and the environment.

5.454. UK legislation previously allowed for transformers with a low PCB content to remain in service until the end of their useful life, but more recent EU directives require the removal of any equipment contaminated with PCBs by 2025.

5.455. WPD is focussing on the removal of PCB contaminated equipment and a large proportion of the assets will be addressed during RIIO-ED1. There will, however, be a requirement to continue this work programme in RIIO-ED2.

5.456. An Energy Networks Association working group has led work to determine the different cohorts of transformers that may be contaminated with PCBs and this data has been used to assist with the forecasting undertaken by WPD. Any oil-filled equipment manufactured after 31 December 1986 is assumed to be free from PCBs; data about testing of equipment manufactured prior to 1987 is being pooled to inform a statistical model which determines whether specific manufacturer and models of equipment should be targeted for replacement.

5.457. Costs in this area relate to the testing of oil to determine levels of PCBs, the removal of oil from assets that contain unacceptable levels of PCBs and the wholesale replacement of assets that contain, or are suspected of containing unacceptable levels of PCBs.

Oil changes

5.458. Ideally, all suspect units would be tested and remedial action determined as a result. Tests are only feasible on ground-mounted transformers where there may be oil sampling taps or vents that allow access to the oil without removal of lids.

5.459. Oil changes therefore only relate to ground-mounted transformers where it is possible to test for the level of PCB contamination. The volumes of oil changes that will be required are estimated from the proportion of the population that has been tested to date and found to be contaminated. This means that there is a requirement to carry out over 950 oil changes by 2025, around 40% of which are forecast to be carried out in RIIO-ED2.

Asset changes

5.460. The construction of pole-mounted transformers makes it difficult to test. For this reason, sample data acquired when assets are decommissioned is being pooled and used across the industry to identify the cohorts to remove.

5.461. Once potentially contaminated transformers are removed from the network, they are tested at point of disposal. The results are collated and fed back into the statistical ENA model which allows progressive refinement of the data to determine which manufacturer and models need to be removed from the network.

5.462. Data from October 2021 suggests that there will be a need to replace over 8,700 pole-mounted transformers across WPD licences areas by 2025, with around half of these being replaced in RIIO-ED2.

5.463. These volumes of replacement will be in addition to those proposed for asset replacement and network reinforcement.

SF6 emitted schemes

5.464. Sulphur Hexafluoride (SF6) is a gas which is used throughout the electricity industry as an insulation medium in switchgear. The use of SF6 has allowed switchgear to be designed into smaller packages, reducing the amount of materials used in the production of switchgear and reducing the physical space needed to build a substation. Although SF6 has excellent insulating properties, it is a potent greenhouse gas. There is currently no suitable replacement for this gas at distribution voltages and so it remains in widespread use in the electricity industry.

5.465. We are actively supporting research into the replacement of SF6 as an insulant with the switchgear manufacturing industry. Alternative technologies are being developed, but these will be higher cost and lead to larger equipment sizes.

5.466. During RIIO-ED1, we have been replacing items of switchgear that leak SF6. Throughout RIIO-ED2, we will continue to implement a ‘leak and replace’ regime on 11kV distribution assets and respond more quickly to leaks on higher voltage assets, treating SF6 leaks like network faults. Where necessary, equipment will be degassed and left out of service until components can be obtained to repair leaks. If leaks are not repairable, the equipment will be replaced.

5.467. The costs for replacement of SF6 filled switchgear are included under asset replacement and generally relate to early life failure of equipment that otherwise appears to be in good condition. The costs for repairs to leaking equipment fall under repairs and maintenance.

5.468. The costs forecasted within environmental reporting relate to the provision of SF_6 leak kits and leak management training.

Noise pollution

5.469. Substation assets can be close to residential properties. In some cases, customers find the humming noise from transformers disturbing and this disturbance can be transmitted through

the air or via the ground. Simple solutions, such as installing sound attenuation pads under transformers, can reduce the transmission of noise but sometimes more extensive mitigation might be appropriate such as noise barriers/enclosures/attenuated air vents. Where the equipment is very noisy, asset replacement may have to be carried out especially if poor asset condition is also evident. We are forecasting very low volumes of this activity.

Contaminated land clean up

5.470. WPD has procedures in place to mitigate the impact of leaks from assets on the environment, but occasionally incidents on our network do result in contamination of land requiring remediation. We work with specialist contractors who clean up any immediate impact of a release, which minimises the residual impact on land and water. Having carried out any initial clean up, we then determine the best possible course of action for further remediation.

5.471. The process follows the Environment Agency guidelines on contaminated land remediation, where a desk top study is carried out to identify the potential receptors and produce a risk model of source, pathway and receptors to determine the potential extent of the contamination. This is followed by a ground investigation to verify or adjust the risk model. The model provides a basis for a strategy for remediation, which can be agreed with the Environmental Regulator. Once agreed, the chosen remediation option is implemented and monitored. WPD seeks to achieve closure of the incidents by following these detailed steps and gaining verification of the contaminated land clean up.

5.472. The costs forecast is based upon a very small volume of incidents that may require some form of remedial action.

Carbon offsetting

5.473. Throughout RIIO-ED2, we will reduce our BCF through the adoption of electric vehicles, the purchase and installation of renewable energy for our buildings and substations and reductions to the amount of SF6 leakage. While these initiatives will reduce the BCF, we will not be able to eliminate it all and therefore there will be a residual, albeit much smaller, BCF associated with our direct scope 1 and indirect scope 2 emissions which will need to be offset for us to achieve net zero by.

5.474. We are proposing to use UK-based carbon offsetting, preferably within the regions that we serve, so that the local communities can also benefit from the offsetting expenditure. We forecast that the cost of offsetting the residual BCF will be around £1 million across the whole of RIIO-ED2.

Expenditure summary

5.475. Forecasted costs for environmental reporting are shown in Figure SA-06. 172.

Environmental activities					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	1	1	1	1	4
RIIO-ED2 Annual Average (forecast)	2	2	1	2	6
RIIO-ED2 Total (5 years)	9	8	4	8	29

Figure SA-06. 172: RIIO-ED2 forecast expenditure - environmental activities

6. Network operating costs

6.1. Network Operating Costs (NOCs) are collectively associated with faults, severe weather, inspection and maintenance, and tree cutting activities. In RIIO-ED1, NOCs form about 21% of Totex, but, due to ongoing efficiency initiatives will make up only about 16% of Totex in RIIO-ED2. Figure SA-06. 173 summarises our proposed RIIO-ED2 expenditure on a per annum basis compared to RIIO-ED1.

Network operating costs					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	75	73	35	58	241
RIIO-ED2 Annual Average (forecast)	65	68	36	58	227
RIIO-ED2 Total (5 years)	324	342	179	289	1,134

Figure SA-06. 173: RIIO-ED2 forecast expenditure - network operating costs

6.2. We will continue to challenge costs in this area, while maintaining the high level of service our customers expect.

6.3. We have forecast a reduction of around 20% in fault costs into RIIO-ED2. This is due to progressive reduction in the number of faults as a result of various business initiatives and a focus on reducing unit costs. However, response to faults will remain a high priority, ensuring that customer supplies are restored as quickly as possible.

6.4. WPD will continue with programmes of routine tree clearance and resilience tree clearance. Routine clearance cycles will be carried out across all voltage levels, but there will be a progressive change in the approach to routine clearance at HV and EHV, moving away from the use of contractors to manage clearance requirements to a WPD-directed approach, using data from Light Detection and Ranging (LiDAR) analysis. This will improve the effectiveness of tree clearance and lead to lower costs in the future. Resilience clearance will be focused on EHV networks with completion of all EHV initial clearance in RIIO-ED2.

6.5. In RIIO-ED2, the vast majority of inspection and maintenance cycles will remain unchanged. However, there is an increased requirement for cut-out inspections, as it is expected that DNOs will carry out inspections following the roll out of smart meters (an activity which is currently fulfilled by suppliers and their meter operators). Costs have been included in the forecast for this additional activity.

Faults

6.6. In the first six years of RIIO-ED1, across WPD's four licence areas, we have dealt with an average of around 47,000 network faults each year, incurring an average cost of £112m per annum.

6.7. While network investment programmes seek to minimise the likelihood of faults, there will inevitably still be high volumes of network faults. For many years, WPD has recognised that fast and effective fault response is paramount to minimising the impact of supply interruptions. During RIIO-ED2, response to faults will remain a high priority ensuring that customer supplies are restored as quickly as possible.

6.8. WPD uses network automation and additional network protection to reduce the number of customers affected by faults and the length of time that those customers are without power. These remotely controlled devices and associated communications infrastructure enable fast network reconfiguration and restoration of supplies to parts of the network unaffected by the faults. More details of WPD's plans for additional automation can be found in the Quality of Supply section.

6.9. When faults occur, the priority is the restoration of supply so that customers experience minimal inconvenience. Staff are mobilised quickly and internal target mechanisms (e.g. Target 60 - the WPD target to restore as many customers as possible within one hour of an HV fault) are used to drive improvements in response and restoration. Local teams with local knowledge based at local depots respond quickly to faults.

6.10. Where appropriate, generators and temporary arrangements are provided to restore supplies when a quick repair is not possible.

6.11. WPD carries stocks of replacement items so that, if repairs are required, the network can be rebuilt quickly. Some items are held locally, others within central stores and some specialist items are obtained via subscription to spares clubs.

6.12. WPD has placed a high priority on restoring supplies quickly when faults occur. This places restoration ahead of repair; business processes seek to ensure that as many supplies as possible are restored before repairs are progressed.

6.13. In order to achieve industry-leading restoration times, additional resources have been deployed when faults occur. Where necessary, mobile generation is used to provide temporary supplies where alternative network supplies are not available. As a consequence, these business practices have led to higher historical costs. In RIIO-ED2, we are seeking to maintain and, where possible improve, our response and customer service, while seeking efficiencies in the way we carry out fault response and repair.

Fault volumes

6.14. Fault volumes have remained broadly steady over a number of years, with some annual variations due to year-to-year differences in weather affecting volumes of overhead line faults. Figure SA-06. 174 shows the total volume of faults since the start of DPCR5 (2010/11).

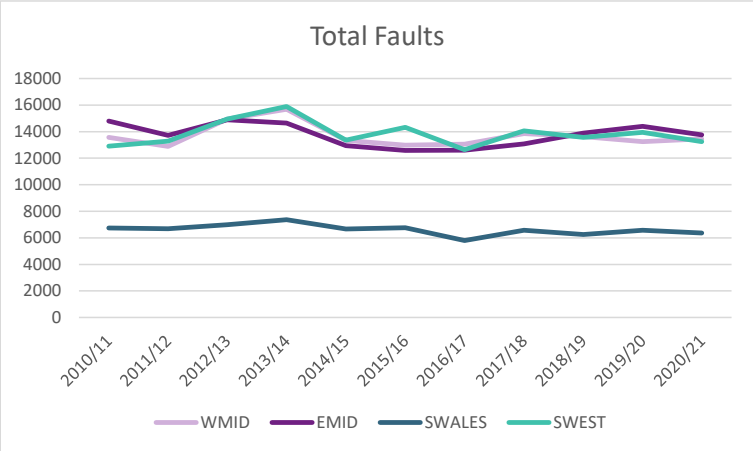


Figure SA-06. 174: Historical total fault volumes by DNO

6.15. The historical trend suggests that volumes of faults remain broadly the same each year. These faults arise for various reasons including:

- Deterioration of assets
- Damage by trees
- Damage due to the weather (wind, rain, lightning)

6.16. In RIIO-ED2, WPD will be undertaking a range of activities that could impact the volume of faults. Assumptions have been made about the impact of these on overall fault volumes. The starting point for these improvements has been derived from an average of the first six years of RIIO-ED1 and percentage improvements have been applied to each year for sub-categories of fault.

6.17. This result is a progressive reduction in the volume of faults that will lead to a 1% reduction in RIIO-ED2 compared to the first five years of RIIO-ED1 as illustrated in Figure SA-06. 175.

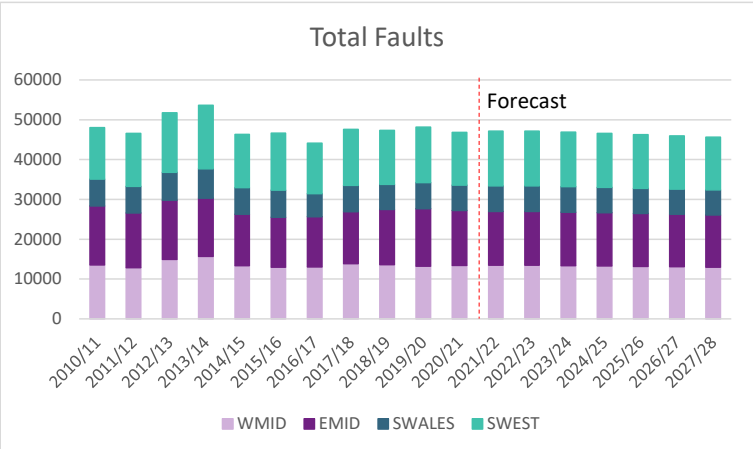


Figure SA-06. 175: Total fault volumes, historical and forecast by DNO

6.18. Figure SA-06. 176 shows the fault categories where improvement assumptions have been built into the forecasts.

Fault Category	WPD Improvement Activities	Improvement in fault rate per annum
LV Services (excluding cut out incidents) - Overhead	Tree clearance	0.5%
LV Network - Supply Restoration by Switching Only (Non Damage Fault)	Smart devices installed on circuits with transient faults converting transient related fuse operation incidents into short interruptions	1%
LV Network - UG Cables (Non CONSAC) - Asset Repair/Replacement Required	Smart devices installed on transients allow identification of faulty locations that are proactively addressed through targeted asset replacement	1%
LV Network - UG Cables (CONSAC) - Asset Repair/Replacement Required	Smart devices installed on transients allow identification of faulty locations that are proactively addressed through targeted asset replacement. Higher volumes of asset replacement in ED2	2%
LV Network - OH Lines - Asset Repair/Replacement Required	Tree clearance. Defect repairs at the same time as other work	1%
LV Network - All Other Switchgear, Plant & Equipment - Asset Repair/Replacement Required	Targeted asset replacement of poor condition LV switchgear through NARMS	1%
LV Network - Plant & Equipment LV link boxes only	Targeted asset replacement of poor condition LV UGB through NARMS	1%
HV Network (11 kV & 20 kV) - OH Lines - Asset Repair/Replacement Required	Tree clearance, enhanced effectiveness of using LiDAR approach	1%
HV Network (11 kV & 20 kV) - Pole Mounted Transformers - Asset Repair/Replacement Required	Replacement of older units for losses and PCB reasons will reduce the older population	1%
HV Network (11 kV & 20 kV) - All Other Plant and Equipment (inc GM transformers) - Asset Repair/Replacement Required	Targeted asset replacement of HV switchgear and ground mounted transformers through NARMS	1%

Figure SA-06. 176: Summary of activities that will lead to improvements in the fault rate per annum, by fault category

Unit costs

6.19. Within regulatory reporting and the structure of the forecast, there are 28 different fault categories, some of which cover a number of asset categories and a wide range of different fault situations. Historical unit costs represent a blend of different costs per fault within each fault category.

6.20. Some categories represent high volumes of activity whereas others have low volumes of faults. We have therefore used different approaches for different fault categories to derive the unit costs used within the forecast.

6.21. For fault categories where there are high volumes of activity, we have taken a three year average unit cost by considering all the costs across the four years of 2017/18 to 2020/21 and all the volumes over the same period. This represents the latest four years of data available at the time of forecasting. This period was taken to give a view of the latest unit costs for an activity, taking into account any recent business improvement changes.

6.22. For fault categories with fewer fault volumes, a longer time period of the first six years of RIIO-ED1 has been taken. This is to incorporate a higher volume of activity to give a more representative unit cost.

6.23. The above values have been derived for each licence area to identify the spread of costs.

6.24. Comparing the unit costs to information available across the industry shows that, in a number of cases, WPD costs are generally higher. We recognise that this is partly due to how we deal with faults, but we pride ourselves on our customer service and use additional resources to restore supplies during faults in order to achieve industry-leading performance.

6.25. For RIIO-ED2, we need to focus on reducing costs and therefore have included cost challenges of over £100 million within the expenditure forecasts. We have taken the upper quartile WPD unit cost and applied that as the standard unit costs across all WPD licence areas. The achievement of these lower unit costs will necessitate the identification of new ways of working to continue to deliver excellent customer service, for a lower cost.

Unit costs – LV mains

6.26. The faults category that contributes the greatest proportion of faults costs is LV underground mains cables faults. There are two types: Consac and Non-Consac. Due to potential boundary issues with classification of faults where both cables are jointed together, we have assessed all LV mains faults as one category.

6.27. In this area, we have carried out more detailed assessments and derived a model that considers typical types of LV mains faults to determine an idealistic view of what the costs could be. This has allowed us to determine the impact of different contractor rates across the four WPD licence areas. While all service contracts undergo competitive tendering processes, the availability of excavation contractors and competition for their services dictates different rates in different parts of the country. We have incorporated these rates into the detailed bottom-up cost model, which has allowed us to determine the relative spread of costs.

6.28. As with the other fault categories, we have determined the upper quartile value but, to take account of different contractor rates, have overlaid the spread obtained from the bottom up model. To make the costs more competitive, we have applied an extra stretch to bring the forecast costs closer to bottom up idealistic view. This results in challenging unit costs that are significantly lower than those incurred in RIIO-ED1.

Expenditure summary

6.29. Forecasted expenditure for faults is shown in Figure SA-06. 177.

Faults					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	33	35	12	24	103
RIIO-ED2 Annual Average (forecast)	25	28	11	22	86
RIIO-ED2 Total (5 years)	123	142	54	108	428

Figure SA-06. 177: RIIO-ED2 forecast expenditure - faults

Severe weather: 1 in 20 event

6.30. The UK's weather is varied. Storms can be caused by strong winds from the Atlantic Ocean, cold conditions from the north or mainland Europe, or lightning when different weather fronts collide.

6.31. Each year, there are periods of poor weather where storms can lead to network damage. Generally, the impact is dealt with quickly, although activity levels often exceed normal daily volumes. While the impact of these storms may be classified as exceptional, the effects are generally dealt with by WPD staff and costs are recorded against faults.

6.32. In rare cases, the magnitude of the storms can be very severe leading to widespread network damage that requires high volumes of additional resources to be drafted in from other DNOs to assist in the restoration of supplies. These more costly, rare events, where volumes of incidents are significantly higher than normal, are known as 1 in 20 year storms.

6.33. Cost forecasts for RIIO-ED2 represent 5/20th of the costs of a 1 in 20 year storm. This is a continuation of the costs forecasts for the remainder of RIIO-ED1, noting that the averages for RIIO-ED1 are lower because no costs have been incurred in the first six years. This approach to cost forecasting is taken so that the costs of an individual event are spread over a number of price controls.

6.34. Figure SA-06. 178 summaries the expenditure forecast for severe weather 1 in 20 events.

Severe Weather: 1 in 20					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	1	1	0	0	2
RIIO-ED2 Annual Average (forecast)	2	2	1	2	6
RIIO-ED2 Total (5 years)	9	9	5	8	31

Figure SA-06. 178: RIIO-ED2 forecast expenditure - severe weather: 1 in 20 events

Occurrences not incentivised (ONIs)

6.35. Occurrences Not Incentivised (ONIs) are situations where WPD staff have to attend site in response to reports from customers made via the contact centre, but where incidents are not related to reportable faults. They include cut-out issues, supply quality issues (such as reports of flickering lights), street lighting faults, call-outs to reports of potential substation break-ins, falling trees that might be near electricity equipment, damaged gates or access doors.

6.36. During RIIO-ED1, there have been around 88,000 ONIs per annum across WPD where some form of site visit was required.

6.37. These activities are sub-divided into two main categories:

- Those related to power system voltage equipment (e.g. emergency disconnections, streetlights, cut-outs, minor asset repairs).
- Those not affecting power system voltage equipment (e.g. security issues and abortive calls).

6.38. Approximately 30% of the volumes relate to abortive calls where once staff visit site, they either identify that the issue relates to the customer's own equipment, metering equipment,

telecommunications networks; or there is no issue at all. However, in the interest of safety, it is important that we investigate the reports.

6.39. We envisage that for most activities the volumes of activity will continue at similar levels, incurring similar costs. For these we have therefore forecast future expenditure requirements based upon the latest RIIO-ED1 three year averages (data for 2018/19 – 2020/21 was the latest available at the time of forecasting).

6.40. We are observing an increase in costs associated with emergency disconnections, primarily in West Midlands and East Midlands. This is associated with an increase in the number of disconnections associated with illegal abstraction, where cut-outs have been tampered with to bypass the meter to provide power for cannabis growing. Due to concerns about safety to staff (following a number of flashovers) there has been a change in WPD practice where policy is now to physically cut the cable outside the property to avoid the risk of injury. We have used the volumes and costs in 2020/21 as representing the latest view of the scale of the issue and the costs being incurred.

6.41. Figure SA-06. 179 summarises the expenditure forecast for ONIs.

Occurrences Not Incentivised (ONIs)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	9	7	3	5	24
RIIO-ED2 Annual Average (forecast)	9	7	3	5	25
RIIO-ED2 Total (5 years)	45	34	17	27	123

Figure SA-06. 179: RIIO-ED2 forecast expenditure - occurrences not incentivised

Tree cutting

6.42. The electricity network includes overhead lines that pass over hedges, through woods and near gardens. Vegetation such as trees and shrubs can grow under or near the lines and come into close proximity.

6.43. We have legal obligations to ensure that the vegetation does not lead to safety issues and that there is resilience to damage from trees. We therefore carry out routine clearance, to ensure that safety clearances are maintained, and resilience clearance, which requires more extensive cutting to prevent storms causing trees to fall into overhead lines and damage them.

6.44. Our delivery of routine clearance is progressively changing at HV and EHV as we move away from using contractors to manage clearance requirements; instead WPD will direct requirements, using data obtained from LiDAR analysis. This will make routine tree clearance more effective and is expected to lead to lower future costs.

6.45. The programme of resilience clearance will continue into RIIO-ED2 and will be focussed on completing resilience clearance of all EHV circuits.

Legal obligations

Routine clearance

6.46. The Electricity Supply, Quality and Continuity Regulations (ESQCR) require that licensees maintain a safe distance between any overhead line and any tree, building or other structure

where persons may be present. The government's expectation (as specified in its guidance document to the ESQCR) is that distribution companies should operate tree cutting programmes with sufficient frequency to ensure that trees do not become a source of danger, for example due to children climbing trees near overhead lines.

6.47. The Energy Networks Association (ENA) has established a technical specification ENA TS 43-8, which specifies the requirements for clearance distances.

6.48. WPD has adopted cyclical clearance programmes to meet the requirements.

Resilience clearance

6.49. Following storms in 2002, the government introduced enhanced tree clearance requirements and updated the ESQCR to require that licensees improve network performance under abnormal weather conditions. The associated regulatory impact assessment suggested that this should apply to clearing 20% of the HV and EHV network over a 25 year period (from 2009 to 2034).

6.50. To guide the prioritisation of resilience clearance, the ENA established an engineering technical recommendation ENA ETR 132, which specifies a risk based prioritisation approach.

6.51. WPD has focused clearance on EHV circuits, using load at risk to prioritise the order of clearance.

Track record

6.52. Our track record with both routine and resilience clearance is detailed within the following sections.

Routine clearance

6.53. WPD has endeavoured to achieve complete cyclical routine clearance of trees across all voltage levels during RIIO-ED1. In most cases, this has been achieved, but has proven to be more challenging at HV and LV, especially where issues with contractors have arisen.

6.54. At the start of RIIO-ED1, WPD used a 'managed span' approach where contractors are given the responsibility for ensuring that the spans issued to them are within management by the end of the calendar year. All spans on a circuit were issued for management, irrespective of whether they had an identified tree issue. Contractor rates reflected the mix of infested and non-infested spans. The spans that had been issued and were therefore within management were then subject to guarantees should additional clearance be required within the five year cycle of clearance.

6.55. During the period, a number of contractors were unable to deliver the contract obligations and ceased to deliver the programmes (in some cases ceasing trading), leaving some spans uncut. This meant that subsequent contractors have, in some cases, had to revisit previously issued circuits to complete the management of spans.

6.56. In order to remove reliance upon contractors managing the clearance, since 2020, WPD has progressively adopted new processes where the identification of spans that need clearance is controlled by WPD staff. Tree proximity and infestation mapping using LiDAR measurements and high resolution photography has been adopted across a number of distribution areas.

6.57. From a commercial perspective, contract tenders have progressed and new detailed contract rates have been implemented which provide different payment rates depending on the amount of tree infestation along the length of a span and whether cutting requires a shutdown or can be carried out with the network live. This means that there is greater alignment between the amount of cutting required and the costs paid per span, compared to the generic 'managed span' rate which paid the same irrespective of whether cutting was required.

6.58. The new targeted approach seeks to ensure that all spans that need clearance are addressed, reducing the potential for trees to cause faults. It is also anticipated that there will be greater control of where cutting is required so that cutting is carried out reducing the requirements for follow up visits where clearance has not been carried out. This will reduce the additional costs of reactive work, which should lead to lower overall costs into the future.

Resilience clearance

6.59. For RIIO-ED1, WPD proposed to achieve resilience clearance five years sooner than suggested by the government's impact assessment, resulting in 20% of the HV and EHV network length being made resilient in 20 years (by 2029).

6.60. WPD has progressed well with this programme, focussing on EHV networks.

6.61. The contractual arrangements for this work are on a time and materials basis, because the amount of clearance required varies depending upon ground conditions, tree species and likelihood of the trees falling into a line during a storm. WPD ensures value for money by assessing all the proposed activity with its arboriculture team, which then approves the work packages.

6.62. Activity to date has focussed on circuits that are more heavily loaded and where there is less tree infestation (and therefore cost per customer is lower). As the programme nears completion during RIIO-ED2, there will be a requirement to clear more densely infested circuits leading to higher costs of clearance.

6.63. In addition, having established initial resilience clearance, there is an increasing requirement to carry out further activity to maintain resilience clearance. The requirement for such activity will grow as more circuits are made resilient.

Routine clearance

6.64. WPD carries out regular inspections of overhead lines. These foot and helicopter patrols identify situations which require attention, such as trees encroaching lines or ivy growing up poles. The situations are recorded as 'defects' against the assets and the completion of the tree clearance work results in the defects being cleared.

6.65. Tree clearance cycles have been adopted across all voltages as summarised in Figure SA-06. 180.

Voltage	Cycle
LV	5 years
HV	5 years (managed)
	4 years (LiDAR)
EHV	5 years (managed)
	4 years (LiDAR)
132kV	5 years

Figure SA-06. 180: Tree clearance cycles by voltage

6.66. At LV, all tree clearance is contracted to third party contractors to manage the circuits that have been issued to them. This requires the contractors to identify the spans where tree clearance is required, carry out the clearance and guarantee the clearance for five years. Where landowners/customers request that restricted cuts are carried out, any repeat visits required are covered by the contractors' rates for managing the spans.

6.67. At HV, while there is a plan to progressively migrate to using LiDAR data, a small number of areas will continue to operate on a managed span basis. This is because contractors' rates in those areas favour the managed span approach.

6.68. At EHV, the situation is similar to HV, but the volumes requiring routine clearance are progressively reducing as more circuits are cleared to resilience standards. LiDAR data will be collected every two years, but the cutting will be spread over a four-year cycle. Data collection in the first two years will be used to direct cutting on 50% of the network. Data captured in the subsequent two years will be used to prioritise clearance on the remaining 50% of the network, with the data associated with the spans cut in the first two years being used to audit the effectiveness of the clearance that has been carried out.

6.69. At 132kV, data collected from various inspections sources is used to identify where clearance is required. Due to this activity being lower in volume and potentially different for each location, clearance is carried out on a 'spot' basis and costs are derived from time and material rates.

Forecasting assumptions

General

6.70. Because of different contractual arrangements in some licence areas, the forecast has been made at a disaggregated distribution area, considering volumes based on local area tree infestation and costs based on local area contract rates.

6.71. These distribution area costs have been aggregated to licence area costs, leading to resultant unit costs that differ across WPD DNOs.

Contractual arrangements

6.72. The contract periods for the West Midlands and East Midlands differ to those for South Wales and the South West. Contracts for the West Midlands and East Midlands were re-tendered at the end of 2019 and contracts for South Wales and the South West were re-tendered in early 2021. The contracts are tendered on a distribution area basis potentially allowing different contractors to operate within the same licence area, taking advantage of better local contractor rates.

6.73. As an example, Figure SA-06. 181 shows the combination of approaches resulting from the tendering process in the West Midlands and East Midlands. This illustrates that some areas

currently remain on the managed span approach. The RIIO-ED2 forecast reflects the contractual arrangements in place for each distribution area.

Voltage	Tree Clearance Contractual Arrangements
LV	Managed span approach extended for 5 years
HV	Prices obtained for both managed span approach and LiDAR. LiDAR prices have 12 different rates for six different infestation levels (A-F) and whether cutting can be carried out with the network live or whether a shutdown is required. Resultant approaches in EMID – six out of eight areas moving to LiDAR. Short term extension to managed span approach in other areas. Resultant approaches in WMID – all areas except one are adopting LiDAR
EHV	Transition to LiDAR
132kV	Time and materials contracts extended for five years Spot cutting in response to defects continues

Figure SA-06. 181: Tree clearance contractual arrangements in the WMID and EMID, example

LiDAR

6.74. Light Detection and Ranging (LiDAR) is a remote sensing method that uses light in the form of a pulsed laser to measure distances and elevations. It is an established technology that is used across various different applications and industries.

6.75. During RIIO-ED1, WPD has procured LiDAR sensing equipment and mounted it on the helicopter fleet. This enables LiDAR data to be collected at the same time as carrying out routine helicopter patrols. This provides additional measurement data to complement the defects observed manually and high-resolution photography also taken from the helicopters.

6.76. We have contracted with an external data processing company to convert the raw data into information that visualises the data and identifies the spans with infestation, the amount of infestation and whether trees are in close proximity requiring an outage to be able to clear the trees.

6.77. This information is used by local teams to instruct the tree clearance contractors on where cutting is required.

6.78. Since the raw data is collected during routine inspections, the costs are embedded within routine inspection costs (not tree cutting). For the RIIO-ED2 forecast, we have assumed that the costs of data conversion to provide useful information can be classified as being tree clearance inspection costs as the process provides similar data to that which would be obtained from a manual inspection.

Inspections

6.79. The cycle of inspection is determined by the tree cutting approach that has been adopted in each distribution area. The cycles for LiDAR are different to those which remain on a managed span approach as shown in Figure SA-06. 182.

Voltage	Inspection Cycle
LV	every 5 years (managed span)
HV	every 5 years (managed span) every 4 years (LiDAR)
EHV	every 5 years (managed span) every 2 years (LiDAR)
132kV	every year (LiDAR)

Figure SA-06. 182: Inspection cycle by voltage

6.80. Volumes per year are derived from the total number of spans divided by the relevant cycle.

6.81. For managed span contractual arrangements, inspection costs form part of the overall cost per span which includes inspections and clearance costs. The unit costs used are based upon an estimation of the part of the managed span cost that relates to span inspection.

6.82. For LiDAR, the data is captured as part of routine overhead line inspections (not dedicated tree clearance inspections) so the costs of data capture will be incorporated in inspection costs. The costs forecast for tree clearance inspection include the cost of the conversion of raw LiDAR data into information about infestation levels and proximity to lines. This results in inspection unit costs that are significantly lower than those for managed span approaches.

Routine cutting

6.83. Within WPD systems, tree infestation is captured as a defect against overhead line assets. The defects provide information about how much of the network has tree infestation. These volumes are used as the basis of the forecast for clearance requirements. Figure SA-06. 183 summarises the forecasting approaches used for different voltages.

Voltage	Forecasting assumptions for clearance volumes
LV	Managed span – volumes based upon the number of infested spans across the network (derived from known volumes of defect clearance) divided by the cycle (i.e. 1/5 of infested spans are to be cleared each year).
HV	Managed span – volumes based upon the number of infested spans across the network (derived from known volumes of defect clearance) divided by the cycle (i.e. 1/5 of infested spans are to be cleared each year). LiDAR – volumes based upon the number of infested spans across the network (derived from known volumes of defect clearance) divided by the cycle (i.e. 1/4 of infested spans are to be cleared each year – noting that the cycle of clearance under LiDAR is shorter than for managed spans).
EHV	The volume of spans requiring routine cutting is reduced by the spans that are equivalent to the length of line that has been made resilient.
132kV	Volumes based upon the number of infested spans across the network (derived from known volumes of defect clearance) divided by the cycle (i.e. 1/5 of infested spans are to be cleared each year).

Figure SA-06. 183: Forecasting assumptions for clearance volumes by voltage

6.84. The unit costs used in the forecast are based upon contract rates for the different contractual arrangements in place. This means that different rates have been used for each distribution area and the aggregate represents the total costs across a licence area.

6.85. For areas using the managed span approach, contract rates per span are used (less the proportion assigned to inspection costs). For LiDAR, the detailed information available about the proportion of issues in different infestation ranges and proximity zones has been used to determine the combination of cutting unit costs that apply to each distribution area.

6.86. As part of migration to LiDAR, WPD is moving from a 5 year cycle under the managed span approach to a 4 year cycle of LiDAR assessments. Since the LiDAR approach allows us to be more selective on which spans need cutting we have applied a LiDAR effectiveness factor to the volumes of cutting activity, which brings the forecast volumes of activity to be broadly in-line with historical volumes.

Additional labour costs

6.87. In addition to the contractor costs incurred for cutting the trees, WPD incurs costs for direct labour to organise shutdowns, connect generators, carry out live-line cutting and respond to customer requests.

6.88. These internal costs equate to 10% of contractor costs at LV and 15% of contractor costs at HV. These costs have been incorporated into the RIIO-ED2 forecasts.

Additional reactive clearance

6.89. While the majority of tree clearance is carried out as part of the routine cycle, situations arise where additional vegetation management is required. This may be in response to urgent issues noted by the helicopter inspections or as a result of customer enquiries.

6.90. Where the issue is covered by contractor guarantees, the relevant contractor is asked to sort it out. However, where the guarantees are not in place (e.g. where a contractor has ceased trading), the issue is resolved by the current contractor. Wherever possible, these are incorporated into planned work programmes, but in some cases these issues are additional and incur additional costs.

6.91. The forecast assumes that 50% of the reactive enquiries from our customers relate to spans covered by contractor guarantees, with the other 50% leading to additional costs.

6.92. One of the benefits of adopting new processes based upon LiDAR data is that the more focussed approach will lead to reduced need for reactive clearance (as priority will already be given to the circuits in greatest need of clearance). We have therefore forecast that there will be a much lower requirement for reactive clearance at HV and have only included an additional 1% of contractor costs to cover these reactive works. At LV, where there will continue to be a managed span approach, we have included additional costs of 5%.

Resilience clearance

6.93. As part of RIIO-ED1 stakeholder engagement, WPD enhanced its resilience tree clearance programme to make 20% of HV and EHV network length resilient in 20 years (rather than 25 years as specified in the government's impact assessment).

6.94. WPD policy in this area is focussed on making EHV circuits resilient, prioritised based upon load loss criticality. The RIIO-ED2 strategy will be to complete the programme and make all EHV circuits resilient. It is recognised that it may be difficult to achieve clearance on all circuits as there could be landowner objections. In these cases, we will seek alternative solutions to make the circuits resilient.

6.95. There are no proposals for resilience tree cutting on HV circuits. We believe that resilience tree clearance at HV has become less important as more automation has been added to the HV network. Faults on the HV network now trigger automatic switching routines that reconfigure supplies reducing the impact of interruptions to customers. It is less likely to have many customers affected for a long period of time and therefore resilience tree cutting at HV is less of a priority.

6.96. There are some circumstances where resilience clearance at HV is warranted, including those involving 'clean' HV interconnectors (with no connected customers) used for transferring demand between EHV substations and HV circuits that provide support to single transformer EHV sites. It is anticipated that these will be the focus areas for resilience tree clearance in RIIO-ED3.

Forecasting assumptions

Resilience clearance

6.97. The programme of resilience clearance has been in place since 2009, since when the amount of overhead line cleared to a resilience standard has progressively increased.

6.98. For RIIO-ED2, we propose to complete the resilience clearance at EHV. Therefore, the forecast volumes are based upon the residual amount of EHV network to be made resilient.

6.99. The amount of work involved to achieve clearance varies depending upon the location. For example, the costs for clearance in heavily wooded areas are higher than for lines that cross arable land. These variances are reflected in historically reported costs. We have assumed that these regional variances will continue to be encountered and based our forecast costs on historical averages for each licence area.

Resilience maintenance

6.100. It is important that once a resilient standard of clearance is established, further clearance is carried out on a regular basis to ensure that the resilient standard is maintained. While resilience clearance incorporates more extensive amounts of cutting (in some cases felling of trees), vegetation can grow back (especially where it has not been fully removed).

6.101. WPD achieves this by carrying out cyclical resilience clearance, which operates in a similar way to routine clearance.

6.102. As more network length is made resilient, the amount of resilience maintenance also increases. The RIIO-ED2 forecast therefore takes account of the need to progressively increase the amount of clearance with volumes based upon historical lengths of circuit made resilient, assuming that half require some form of resilience maintenance.

Expenditure summary

6.103. Forecasted expenditure for tree cutting is shown in Figure SA-06. 184 below.

Tree cutting					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	15	12	9	14	51
RIIO-ED2 Annual Average (forecast)	12	12	10	15	49
RIIO-ED2 Total (5 years)	61	61	50	74	246

Figure SA-06. 184: RIIO-ED2 forecast expenditure - tree cutting

Inspections, repairs and maintenance

6.104. WPD has a legal obligation to maintain the safety and reliability of the assets that constitute the electricity distribution networks. These legal obligations are contained in the:

- Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002;
- Electricity at Work Regulations 1989; and
- Health and Safety at Work Act 1974.

6.105. WPD owns and operates an extensive network of assets that have a long working life, with many lasting over 50 years. These lifetimes are achieved by inspecting and maintaining the assets to ensure that they remain safe and in effective operational condition.

6.106. Inspections are carried out to identify safety issues and assess the condition of assets.

6.107. Maintenance activities aim to ensure that the assets will reach their anticipated life expectancy. This may involve the replacement of consumable items (such as contacts in circuit breakers) or changing insulating oils that may have become contaminated reducing their effectiveness.

6.108. Repairs are carried out where sub-components are replaced or minor issues rectified. These are normally carried out to remedy a defect that has been identified during an inspection and can be carried out at the same time as a maintenance or as a standalone activity.

6.109. WPD's overall inspection and maintenance strategy is to:

- Undertake proactive time based inspection and maintenance interventions;
- Collect and record asset condition data when inspection and maintenance tasks are undertaken;
- Carry out reactive actions to remedy defects identified during inspections;
- Use the data to inform refurbishment and replacement activity.

6.110. WPD's policy seeks to deliver an overall efficient balance between the amount of activity and overall reliability of the equipment. Maintenance activities and their frequencies ensure we preserve asset condition but do not undertake additional unrequired maintenance tasks.

WPD asset management system

6.111. WPD uses an in-house asset management system (called CROWN) to manage the inspection and maintenance for all assets. CROWN also holds site risk data which is used to increase maintenance and inspection frequencies where there are increased risks e.g. evidence of vandalism.

6.112. Condition data and test results collected on site are recorded in the CROWN system, and are used with other asset data to inform repair, refurbishment and replacement requirements.

6.113. When an asset is commissioned in CROWN, the tasks for its first inspection and maintenance visits are generated. This generates the work that needs to be completed and allows forward work programmes to be established. When tasks are completed in CROWN, the next inspection/maintenance task based on policy-defined interval is applied.

Defect management

6.114. WPD uses any defects it identifies to address a range of issues. These may be related to safety or have performance consequences. Defects that are related to safety are allocated a time-period for rectification. Reports from CROWN are used to monitor the number of outstanding defects to ensure that they are completed by the deadlines.

6.115. When staff plan work, it is expected that any defects are addressed at the same time. To assist staff with this, the defect data in CROWN is migrated to the WPD mapping system as illustrated in Figure SA-06. 185. Within the mapping system, there is a facility to overlay the maps with defect data. This places coloured dots indicating the number of defects that are present. Drawing a selection area around the network shows more details about the defects in the selected location. This means that, when staff are planning work in a location, they can also address all the local issues without the need for return visits, thus enabling a more efficient approach to the resolution of defects.

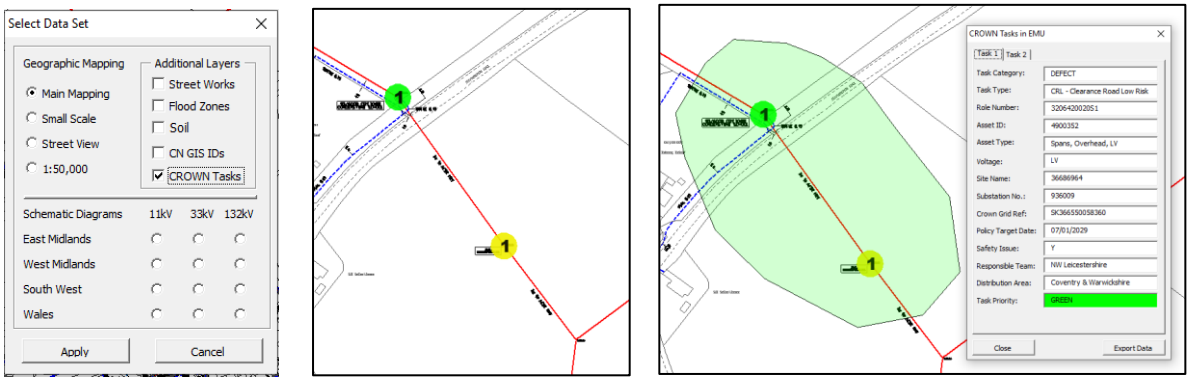


Figure SA-06. 185: Example of how defect data is overlaid into our mapping system

6.116. When defects are cleared, this is recorded in CROWN, which means that data is available on assets defects and when these were addressed. This information on historical activity levels, alongside data on maintenance tasks, has been used to forecast future work requirements in RIIO-ED2.

Changes to inspection and maintenance activity

6.117. There are some activities where changes have been implemented during RIIO-ED1. For example, overhead line helicopter patrols have been extended from every two years to every four years to allow more data to be captured by flying more slowly. The risks associated with a longer interval between inspections is being balanced against having better data (e.g. high resolution photography and LiDAR tree clearance data).

6.118. In RIIO-ED2, the vast majority of inspection and maintenance cycles will remain unchanged.

6.119. There are however a number of areas where practice will change. This includes cut-out inspections.

Cut-outs

6.120. Data about service position defects is currently captured by suppliers and their meter operators when they take meter readings or when they attempt to install a smart meter. There is a requirement under the Meter Operation Code of Practice Agreement (MOCoPA) for the suppliers to provide information to the DNO where defects are observed.

6.121. Electricity suppliers are due to complete the smart meter roll out by June 2025. When the roll out is completed, the suppliers will rely upon the remote reporting functionality for meter readings which means visits to properties will be significantly reduced. As a consequence, DNOs will be required to carry out service position inspections to ensure that the equipment is not defective.

6.122. We have already developed an iPad app for the collection of data at service positions and are collecting data about the service position as work is carried out for other reasons (such as faults). The functionality of the app will be utilised for routine inspections.

6.123. Due to many service installations being inside properties, we are expecting to implement different patterns of work, such as weekend and evening working. This will lead to more efficient costs and improve the likelihood of being able to inspect cut-outs while property owners are at home.

6.124. We are proposing to adopt a 20 year cycle of inspection, which will require around 400,000 cut-outs and service positions to be inspected each year. This will increase inspection costs by around £3.5m per annum across WPD licence areas, but these are offset by efficiencies that have been assumed in other inspection activities.

Expenditure summary

6.125. Forecasted expenditure for inspections and repairs and maintenance is shown in Figure SA-06. 186 and Figure SA-06. 187 respectively.

Inspections					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	4	4	3	4	14
RIIO-ED2 Annual Average (forecast)	4	4	3	4	16
RIIO-ED2 Total (5 years)	21	22	15	20	79

Figure SA-06. 186: RIIO-ED2 forecast expenditure - inspections

Repair and maintenance					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	10	9	5	6	30
RIIO-ED2 Annual Average (forecast)	10	10	5	7	32
RIIO-ED2 Total (5 years)	48	49	27	34	158

Figure SA-06. 187: RIIO-ED2 forecast expenditure - repair and maintenance

Supporting the UK smart meter roll out

6.126. The government mandated smart meter rollout programme is being carried out by electricity suppliers and their meter operators. The rollout was originally due to be completed by 2020, but the deadlines have been extended up to June 2025. While DNOs have no direct responsibility for the rollout, there are consequential impacts and costs that are incurred.

6.127. The main area of work is related to situations where DNOs are required to carry out remedial work to service equipment to allow the installation of a smart meter. Urgent issues are dealt with as emergencies and other defects are programmed for remediation once data flow is received from the suppliers.

6.128. In practice, emergency issues are initially dealt with as Occurrences Not Incentivised and costs are transferred to smart meter related expenditure once the issues are confirmed to be related to the installation of a smart meter. The costs presented for smart meter related defects incorporate this cost transfer.

6.129. Volumes of defect rectification for the remainder of the smart meter rollout programme have been forecast using our RIIO-ED1 defect rate (the number of defects per number of smart meters installed) which has been applied to the forecast number of smart meter installations up to 2025.

6.130. The smart meter rollout programme has an additional impact where there is an increase in interactions between suppliers and WPD staff. Many of these data flows have been automated, but dealing with them leads to some overhead administration costs. Due to the local team-based working approach, the costs of these interactions is part of the overall administration

function and cannot be separately identified, so no specific forecast for these costs has been made, as these are included within Closely Associated Indirect costs.

6.131. Figure SA-06. 188 summarises the costs specifically for resolution of service position defects associated with the smart meter rollout.

Supporting the UK Smart Meter roll out					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	2	3	1	1	7
RIIO-ED2 Annual Average (forecast)	1	1	1	1	3
RIIO-ED2 Total (5 years)	5	5	3	3	17

Figure SA-06. 188: RIIO-ED2 forecast expenditure - supporting the UK smart meter roll out

6.132. There are additional costs associated with smart meters that are included in other parts of the Business Plan forecast. These include:

- The costs associated with the directly remunerated services for smart meter rollout rechargeable services, which we have forecast as £nil at this time.
- Elective services from the Data and Communications Company (DCC), which we have forecast as £nil at this time.
- Smart meter DCC licence costs (which are treated as pass through costs).
- Smart meter information technology costs (which are also treated as pass through).

6.133. During RIIO-ED1, a new regulated organisation, the Data and Communications Company (DCC) was established to manage the systems for communications between the meters and users of smart meter services. It is currently assumed that the fixed charge element will encompass all the DCC licenced entity charges and smart meter communications. These charges have been included in our forecast for Pass Through Costs.

6.134. The availability of data from smart meters will help to inform DNO services, where, for instance, smart meter data about power cuts which will influence reinforcement decisions. For this to happen, new IT systems are being developed and introduced. The cost associated with these systems have been all been forecast as Pass Through Costs.

Other network operating costs

6.135. Other network operating costs include the activities for dismantlement, remote location generation and substation electricity costs.

Dismantlement

6.136. In limited situations, assets are dismantled, permanently removed and not replaced by alternative assets. This can arise where there is no longer a need for an electricity supply or where the progressive development of the network renders other parts unnecessary.

6.137. With the anticipated growth in LCTs, it is highly unlikely that parts of the network will become redundant.

6.138. Expenditure within this category is low. Historical averages have been used to forecast future costs and no forecast increases have been projected. The expenditure forecast is summarised in Figure SA-06. 189.

Dismantlement					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	0	0
RIIO-ED2 Annual Average (forecast)	0	0	0	0	0
RIIO-ED2 Total (5 years)	0	0	0	0	0

Figure SA-06. 189: RIIO-ED2 forecast expenditure - dismantlement

Remote location generation

6.139. There are two locations within WPD where generation is needed to provide security of supply to remote networks.

6.140. In South Wales, WPD contracts with a third party generator to provide security of supply support to the single transformer 33kV substation at Tregaron where there is only limited 11kV interconnection. No change is foreseen here and forecasts have been prepared on the basis of the actual costs seen in RIIO-ED1.

6.141. In South West, a WPD owned generator currently provides security of supply support to the Isles of Scilly, which are connected to the mainland by a single 30km long 33kV submarine cable. This generator operates under exemption from the standard licence condition that prohibits the ownership of generation by DNOs. This is because the generation operates for the purpose of ensuring security of supply to the islands, and the generation assets form part of a facility originally commissioned prior to this licence condition taking effect.

6.142. In RIIO-ED2, there will be a reduction in costs associated with this remote location generation for the Isles of Scilly. The existing generation plant is no longer able to fully support the maximum demand under certain conditions in the event of an outage of the existing 33kV single circuit supply. This gap is projected to increase further over the coming years due to load growth. Our cost benefit analysis has concluded that installation of a 2nd 33kV subsea cable is the most optimum solution to meet the future projected load growth. Therefore, the generation requirement will no longer be required once the 2nd 33kV cable is commissioned. A capital project for this installation has been included in our proposed Reinforcement work programme and the opex costs removed from this activity from the end of 2027 onwards.

6.143. There are no remote location generation costs in West Midlands and East Midlands.

6.144. Figure SA-06. 190 summarises the proposed RIIO-ED2 expenditure.

Remote location generation					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	1	1
RIIO-ED2 Annual Average (forecast)	0	0	0	1	1
RIIO-ED2 Total (5 years)	0	0	0	5	5

Figure SA-06. 190: RIIO-ED2 forecast expenditure - remote location generation

Substation electricity

6.145. Electricity substations use power for lighting, heating and running ancillary equipment such as communications units and battery chargers. Most substations have unmetered supplies and WPD has contracts in place for the electricity consumed at substations.

6.146. The contracts with suppliers are based upon estimated usage derived from the equipment installed at sites. WPD has been undergoing a verification process to make the estimates more accurate; this has involved installing 'check meters' to measure the actual power being used and then compare the measured values to the original equipment based estimates. This work has allowed the contracts with suppliers to be reviewed and based upon more representative usage values. This has resulted in increases in costs during RIIO-ED1.

6.147. Substation electricity costs are also under pressure due to a number of reasons:

- Wholesale electricity prices have increased 25% in the last 12 months
- While Ofgem's energy price cap limits the impact of rising prices for domestic customers, commercial rates for electricity are not subject to the energy price cap, thus exposing WPD to the full wholesale price increases
- Brexit (Carbon Auction – UK not included in EU benefits)
- Covid uncertainty
- Volatility in Gas market
- Increases to Non Energy Commodities (Renewables Obligations, DUOS)

6.148. We have included these unavoidable additional charges into the plan. Forecasts are based upon the latest arrangements in place with suppliers, which have recently been negotiated. We hope prices will fall slightly later in the RIIO-ED2 period, and so have reflected this expectation into our forecast. Our forecasts are shown in Figure SA-06. 191.

Substation electricity					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	2	3	1	1	8
RIIO-ED2 Annual Average (forecast)	2	4	1	2	10
RIIO-ED2 Total (5 years)	11	19	7	10	48

Figure SA-06. 191: RIIO-ED2 forecast expenditure - substation electricity

7. High value projects (HVPs)

7.1. WPD only proposes one high value project for RIIO-ED2.

7.2. The load in Mid East Wales is currently supplied via a 66kV ring network from Abergavenny bulk supply point (BSP), which in turn is supplied by Rassau grid supply point. Due to the projected load growth in Brecon and the surrounding rural area, it is envisaged that Abergavenny BSP will become unable to support the demand required.

7.3. The proposed reinforcement is to install a new 132kV circuit from Rassau to feed a new BSP near Brecon. This will provide an alternative feed into the Mid East Wales ring capable of supplying the substations on the 66kV ring under normal running conditions.

7.4. See EJP182 for additional detail and justification. Figure SA-06. 192 shows our forecast expenditure.

High value projects					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	0	0
RIIO-ED2 Annual Average (forecast)	0	0	6	0	6
RIIO-ED2 Total (5 years)	0	0	30	0	30

Figure SA-06. 192: RIIO-ED2 forecast expenditure – High value projects

8. Engineering management

Overview

8.1. The expenditure for the physical completion of work could not go ahead without the support of 'indirect' activities such as planning, project management, system records and stores. This activity also includes wayleave payments, which are payments made as compensation to landowners and occupiers for losses associated with WPD's apparatus on private land. These costs form about 20% of Totex in RIIO-ED1 and 18% of Totex in RIIO-ED2.

8.2. Figure SA-06. 193 shows our forecast expenditure (excluding wayleaves)[2].

Engineering management					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	64	64	29	46	203
RIIO-ED2 Annual Average (forecast)	69	71	33	50	222
RIIO-ED2 Total (5 years)	343	354	163	248	1,108

Figure SA-06. 193: RIIO-ED2 forecast expenditure - engineering management

8.3. The majority of costs in this activity are labour-related. Savings made during the latter part of RIIO-ED1 are expected to offset some of the costs of increasing volumes of work in RIIO-ED2, which is why we are not proposing radical changes to the core DNO organisational structures in RIIO-ED2. However, there are several areas where we are forecasting change.

8.4. The significant increase in reinforcement activities will require additional indirect activity in areas including detailed project design and project management (covering all phases from project authorisation, work preparation, construction and physical connection through to ensuring all technical records and projects costs are updated). Additional costs have been included in the forecast for these increased activities, including additional roles in primary system design, as well as planners, project engineers, wayleaves specialists, team managers and team supports. We will recruit many of these roles ahead of the start of RIIO-ED2. The costs included in this forecast are for the support of the ex-ante base (Best) view of reinforcement. Where there are significant changes to resource requirements driven by a change to the scale of reinforcement activity we would expect that the associated uncertainty mechanisms adopted for RIIO-ED2 will make provisions for these change.

8.5. We are committed to deliver the new and increased volumes of direct activity, including delivery of net zero targets to facilitate government policy targets. The increased delivery of these additional volumes is reliant on the indirect staff to support this. While the costs will increase, we have built in considerable efficiency assumptions for RIIO-ED2. Our planned costs would otherwise be higher if it was not for the efficiencies in the form of avoided costs that we are embedding in our plan. These efficiencies include a mass market connections self design tool and customer enquiry tracker to free up £189 million of staff time in RIIO-ED2, as well as investing in our business applications and processes to allow staff to work more effectively.

8.6. Many DSO functions and their support will be carried out by teams (DSO team and Electricity System Management teams (ESM)) and processes that form part of engineering management. We are forecasting the need for some additional staff to cover these new processes and fulfil

[2] All the costs presented through this section are before indirect allocations, and so will include costs associated with connections and other activities outside the price control. The reallocation to these direct activities is shown in the row 'indirect allocations' in the summary tables in chapter 2; our approach to allocations is also detailed in this chapter.

our commitments, as well as to support the move towards digitalisation and increasing data policy and management.

8.7. WPD has undertaken a number of internal reviews of specific cost areas in RIIO-ED2 to identify and share best practice across our four licence areas, enabling us to reduce costs in our forecasts. One particular focus has been on overtime and costs booked to engineering management, where we have looked closely at the variations and reasons for this across our network in RIIO-ED1, with a view to reducing this as much as practicable in RIIO-ED2.

8.8. Figure SA-06. 194 summarises the key activities of engineering management that we are forecasting for RIIO-ED2.

Engineering management expenditure RIIO-ED2					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
Network design and engineering	79	81	35	59	255
Project management	80	83	35	44	243
Engineering management and clerical support	93	96	46	66	301
System mapping	11	11	6	9	38
Network policy	14	14	7	13	48
Call centre	15	15	8	13	50
Control centre	34	34	17	28	113
Stores	19	21	10	18	67
Cost recoveries	-2	-1	-1	-3	-6
RIIO-ED2 Total (5 years)	**343**	**354**	**163**	**248**	**1,108**

Figure SA-06. 194: RIIO-ED2 forecast expenditure - engineering management expenditure, by category

8.9. We explain these key activities and the main changes we foresee in the following sections.

Network design and engineering

8.10. This activity covers both the high level planning and detailed project design up to point of approval.

8.11. Specific planning and design necessary for individual projects is by far the greater element of network design and engineering cost. The projects relate to all network activities including the design for new connections, asset replacement, load reinforcement and quality of supply improvements.

8.12. At WPD, these activities are carried out by central design teams for the primary network and locally based planners (11kV planners, planners, and assistant planners and craft planners) who deal with all aspects of secondary network design from substation replacement to new connections for street lights. These planning costs are directly related to the activity volumes. This plan includes additional costs for both primary design engineers and local planners to develop our reinforcement plans for RIIO-ED2. We plan to drive efficiencies through this area which is why the increase in this area is not scaled to the increase in network activity.

8.13. High level planning includes the development of network wide analysis, demand forecasting, network modelling and identification of network deficiencies.

8.14. Many DSO functions will be carried out by teams and processes that form part of this activity. Flexibility and energy management on the network carried out by the newly formed Distribution

System Operator (DSO) team during RIIO-ED1 will continue into RIIO-ED2. We will need to increase the number of employees in this area to fully develop Distribution Future Energy Scenarios (DFES) and maximise flexibility opportunities, as well as supporting external audit activity and governance. We are also committing to drive the development of local area energy plans by proactively engaging with all 130 local authorities each year.

8.15. We are also proposing to introduce 4 community energy engineers to support local community energy projects.

8.16. We are committing to a whole system planning project to accelerate the coordination of energy network planning necessary to develop a national energy plan for Wales. An additional £0.4m of cost per year has been included in our plan in SWALES for this.

Project management

8.17. Project management indirect expenditure relates to the activity of managing network investment projects. It covers all phases from project authorisation, work preparation, construction and physical connection through to ensuring all technical records and projects costs are updated.

8.18. The preparation phase includes the identification of resources, ordering of materials, production of work instructions, liaison with contractors and scheduling of work elements.

8.19. The construction phase requires on-site supervision of staff and contractors, tracking progress against construction timetables, checks on quality of work and liaison with members of the public who may be inconvenienced by the work.

8.20. The physical connection phase includes arranging any shutdowns, issuing of electrical safety documents, organising and carrying out commissioning tests, issuing of completion certificates and coordinating the final connection to the network.

8.21. Following construction, technical closure requires a review of the physical installation and recording of installation details. Financial closure requires the collation of all related costs and correct allocation to budget codes enabling accurate reporting.

8.22. While project management does not include any direct work on the assets, the work would not be able to proceed, or be completed, without it. There is therefore a link between the volume of work and associated project management costs. We plan to drive efficiencies through this area which is why the increase in this area is not scaled to the increase in network activity.

Engineering management and clerical support

8.23. Engineering management and clerical support covers a wide range of office-based activities managing or assisting employees to undertake direct activities, but not directly involved with either planning projects or project managing.

8.24. It includes executive managers, engineering managers, work programmers, resource planners, clerical staff, and street works administration.

8.25. Typical work carried out in this area is:

- Development of strategic network Business Plans, investment priorities, resourcing requirements, work programme planning and budgeting;
- Line management of staff undertaking direct work;

- Operational performance management including site safety and operational checks, quality compliance checks, authorisation of staff and investigation and reporting of incidents;
- Promoting health and safety policy, establishing procedures, maintenance of health and safety records and provision of advice;
- Street works administration, processing notifications, permit applications, liaison for defect repairs and processing of fines;
- Clerical support including processing of time sheets, customer liaison, preparation of shut down notifications, updating asset inventory and condition databases, preparing plans and other general office duties to support direct activity work.

8.26. While the volume of transactions may change in line with the volume of activity on the network, it is envisaged that any increased requirement will mainly be absorbed through process improvements and efficiencies. Additional costs have only been included for some additional team managers and support resources.

8.27. We have also forecast a small increase in commercial resource to support our Flexible Power platform. This resource will support the contractual arrangements and management of Flexible Power where customers with controllable demand or generation are able to provide services to help us manage the capacity of the network.

System mapping

8.28. System mapping is the activity of updating network geographical records. The volume of record updating is related to the level of network investment in overhead lines, cables and new connections.

8.29. While there are some fixed costs such as paying licence fees to the Ordnance Survey, other costs are dependent upon the volume of third party requests e.g. providing copies of records under NRSWA requests. It is assumed that these remain at current levels.

8.30. It is assumed that the impact of any increased requirements will be minimal and, where increases arise, will be accommodated through efficiency savings. The forecast costs for RIIO-ED2 are in line with current expenditure.

Network policy

8.31. Network policy relates to the development and review of environmental, technical and engineering policies that set out what needs to be done and the procedures to follow.

8.32. Network policy can by influenced by:

- changes to legislation;
- improved condition information;
- operational experience;
- investigation of defects;
- learning from incidents;
- development of new equipment and materials;
- research and development;
- changes to contracts.

8.33. Consequently, all WPD policies are reviewed periodically or in response to new issues.

8.34. The activity also includes research and development (innovation) costs that are not funded through mechanisms such as the Network Innovation Allowance (NIA). As part of our continued commitment to innovation, a small amount of additional innovation spending has been forecast to cover projects that will no longer be eligible for funding under the NIA. This includes projects which explore technological advances to network assets, and support community energy projects and non-carbon related environmental benefits.

8.35. We are committed to the rollout of proven innovation in the RIIO-ED2 period. Our plan includes additional investment in extra staff and systems to replicate projects, scale up solutions to a production standard and cover the cost of training/deployment. Every solution we deploy will have direct benefits which will pay back either through budget reductions in other business areas, enhanced performance (e.g. customer minutes lost and customer interruptions) or be recovered through future connection charges.

8.36. There is also a small increase in the number of connections administrators. This has been scaled to accommodate the expected increase in LCT connections when customers seek to change their system access agreement.

Call centre

8.37. WPD distributes electricity to 8 million customers. It is important for these customers to be able to contact us when they go off supply, have a general enquiry or want to complain. The contact centre activity relates to managing the main incoming telephone lines used by customers, taking the initial calls, recording details, providing information and forwarding customers on to the relevant parts of the organisation.

8.38. We have an extremely strong track record for excellent customer service and call centre performance. We have regionally based, in-house contact centres, where we answer calls in an average of 1.91 seconds. We have also expanded our leading Priority Services Register (PSR) in RIIO-ED1 to date, making over 5.3 million proactive contacts to update this.

8.39. We are striving to deliver even more in RIIO-ED2, which is demonstrated in our core commitments (as detailed in Supplementary Annex SA-02 ‘Our Commitments’). To help meet our Priority Services Register (PSR) commitments, we are forecasting an increase in call centre handlers. This increase is in response to an expected growth in the number of customers joining our PSR during RIIO-ED2 and our pledge to make sure vulnerable customers are not left behind in the DSO transition. All other proposed customer service commitments will be delivered within current cost levels.

Control centre

8.40. Control centre activities include the real time operational control and monitoring of the network, outage planning and management, dispatching resources in response to network faults and safety issues, updating network control diagrams, completing fault reports and major incident emergency planning.

8.41. Additional resource is required for the roles of DSO Energy Management Centre (EMC) Engineers and Planning Engineers to transparently and independently operate the provision of network capacity through flexibility services. This covers a number of different tasks, including the real time and ‘day ahead’ assessment of network congestion and dispatch of mitigating actions, maintenance of a Future Network Plan incorporating outages and predicted network constraints, and preparation of proposed network configuration schedules.

Stores

8.42. The majority of work on the network requires the use of a wide range of materials. These can be large items such as transformers, switchgear, underground cable, overhead line conductors and poles, or smaller items such as joints, gaskets, connectors, tapes, rolls of barbed wire and danger notices.

8.43. The materials are held in local depot stores supplied from two central warehouses. Stores activity is supported by storekeepers, stock checkers and delivery drivers.

8.44. WPD also belongs to the 'NGT spares club', a facility provided by National Grid, for low-volume high-value components. Membership is more efficient than holding and managing dedicated stock for items that are needed infrequently.

8.45. The volume of network investment drives the amount of throughput in the stores, but the facilities will not change. As work volumes increase, there may be an impact on deliveries but any increased requirements will be accommodated through efficiencies.

Wayleaves

8.46. Wayleaves are legal agreements which provide WPD with rights to retain, access and manage its apparatus on third-party land. We consider our relationships with landowners to be a critical component of operating our network and work hard to maintain excellent working relationships with landowners and occupiers.

8.47. The majority of our network is secured on wayleaves which oblige us to make annual payments to landowners and occupiers. While this can result in the establishment of long-term relationships, the agreements remain vulnerable to termination by the landowner serving a notice. In certain instances, particularly for assets which have an elevated risk profile, and in particular those which are strategically critical, we seek to secure our assets by purchasing easements instead of wayleaves. Easements are permanent (in that they cannot be terminated) and so offer increased security for our assets, but are significantly more costly and time consuming to acquire. It is for this reason we deploy easements selectively. The conversion of wayleaves to easements is discussed further in EJP016 relating to Diversions.

8.48. We intend to continue with a reliance on wayleaves for the majority of our network throughout RIIO-ED2. When compared with the alternative of purchasing easements, we consider wayleaves to be fit for purpose and offer good value for money for the majority of our strategically less critical assets. For this reason, our RIIO-ED2 proposals include a provision for reactive wayleave to easement purchases (included in the Diversions forecast) but, consistent with our approach in RIIO-ED1, we have made no provision for the cost of proactively converting wayleaves to easements on a broader scale. Our estimates for the costs of annual wayleaves, which is the subject of this section, is constructed on this 'business as usual' presumption.

8.49. Wayleave payments are made as compensation to landowners and occupiers for losses associated with our apparatus on private land.

8.50. Payment rates are negotiated annually by the Energy Networks Association (ENA) with the National Farmers Union (NFU), Farmers Union of Wales (FUW) and the Country Landowners Association (CLA). The ENA recommends the annual settlement for adoption by its members.

8.51. The activity of Wayleaves also includes the activities of substation rents and wayleaves and easements administration, which are both discussed below.

8.52. Forecasted costs for wayleaves during RIIO-ED2 are shown in Figure SA-06. 195.

Wayleaves					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	9	9	5	6	29
RIIO-ED2 Annual Average (forecast)	9	9	5	6	29
RIIO-ED2 Total (5 years)	47	43	25	30	145

Figure SA-06. 195: RIIO-ED2 forecast expenditure - wayleaves

Wayleaves payments

8.53. Figure SA-06. 196 summarises our wayleaves payments costs. This is the biggest element of the activity of Wayleaves.

Wayleaves payments					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	5	5	3	4	17
RIIO-ED2 Annual Average (forecast)	5	5	3	4	17
RIIO-ED2 Total (5 years)	27	24	16	21	87

Figure SA-06. 196: RIIO-ED2 forecast expenditure - wayleave payments

8.54. The majority of wayleave payments are made annually. They are calculated under two primary headings:

Owner payments

8.55. We pay owners an annual sum for the wayleave agreement (or licence) to keep, access and maintain equipment on private land. As a part of the annual round of negotiations between the ENA and landowner/occupier representatives, payments are calculated with reference to statutory compensation principles. Historically, owner payments have been annually reviewed by indexing, using a variety of reference sources such as land values, land rentals, consumer prices index etc. The most recent review was in 2016, which was the last year of an agreement made in 2013 for owner payments to increase by 3.5% per annum for three years. Since 2016, owner payments have remained static.

8.56. Negotiations with the landowner/farmer representatives on 2022 owner payments rates are expected to commence shortly. In anticipation of a potential change in rates as a result of this process, our forecast for owner payments reflects an annual increase of 3.5% per annum, which is equivalent to the uplift applied between 2013 and 2016. The rationale for this is both the precedent which was established by the fixed rate agreement of 2013 and also historical land price increases. Land values historically increase during periods of economic uncertainty, with Brexit and the coronavirus pandemic likely to be such occasions. Landowners may argue that an increase is overdue as no increase in this payment heading has been made since 2016. Savills Research has recorded land values by region over the past 25 years which indicates an annual average increase over the last 10 years of 3.7% throughout WPD's four licence areas.

8.57. The increase that we have applied calculates the 3.5% projected uplift with RPI and CPIH stripped out; Figure SA-06. 197 summarises the increases that have been applied.

	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Forecast RPI/CPIH	1.7%	1.9%	2.2%	1.9%	2.0%	2.0%	2.0%
Owner inflation above RPI/CPIH	0.0%	1.6%	1.3%	1.6%	1.5%	1.5%	1.5%

Figure SA-06. 197: projected owner payment increases

Occupier payments

8.58. Payments are made to occupiers of land to compensate them for the disturbance and losses which arise from our equipment under six headings: Time loss; Area loss; Yield loss; Wasted inputs; Weed control; Health and safety.

8.59. Occupier payments are calculated for two land categories:

- Payments for apparatus on arable land (including temporary pasture and fallow land)
- Payments for apparatus on permanent pasture

8.60. The annual negotiations between the ENA and landowner/occupier representatives involve the calculation of arable payment rates using a farming cost model which was agreed in 2019.

8.61. The method of calculation of pasture payment rates is an extension of the same model and was agreed in 2021.

8.62. The model uses farming data from two to three years ahead of the actual wayleave year (to allow for variances in the timing of publication of certain data). For example, the 2022 payment rates are based on 2019/20 farming data.

8.63. The payment rates which result from the model reflect year to year changes in variable and overhead farming costs. For example, the average increase in the payment for a wooden pole in arable between 2016 and 2022 was 1% p.a., largely due to changes in the costs of operating farming machinery. Farming machinery costs impacted the cost of time loss (i.e. losses arising from delays in negotiating the network obstacle with farming machinery) which, as described below, is a major component of arable and pasture payment rates.

8.64. The following is a summary of factors which are all relevant to the calculation of occupier payments:

Time loss

8.65. A time loss is the cost of losses due to navigating network obstacles in the field.

8.66. In the arable payment rate for wooden poles, time loss accounts for approximately half of the total payment and a quarter in the pasture fields. The capital value of machinery and operator wages are key variables in the calculation for time loss.

8.67. For example, the 2021 time loss payment for a single wooden pole increased 5.4% as a result of a 6.7% increase in the value of machinery capital (from 2017/18 to 2018/19). Rises in the subsequent two years are much less. Total machinery valuation rose by 1.9% (between 2018/19 and 2019/20) and time loss rose by only 3%.

8.68. Adjustments to the valuation model will continue to be applied over the course of RIIO-ED2. In addition, the time loss calculation input data will be reviewed in the next few years. The raw data providing evidence for the times that are used to calculate any delay navigating fixtures is currently being updated, with measurements from a programme of in-field assessments. This will improve the accuracy of the loss payment calculation, but adds to the uncertainty in forecasting rates. Current data used is historic. Many agricultural operations now involve large

and cumbersome machinery, which means it takes longer on average to perform their activities. This is likely to increase time loss costs by slightly more than inflation for the period while the in-field programme continues.

8.69. While the coming two seasons look likely to see a smaller increase in time loss measurements - because machinery costs rose by less in 2019/20 - the rise of machinery costs beyond the rate of inflation has been an overall trend in recent years. We have taken this into account in our planning for RIIO-ED2 (calculated from 2020/21 year) as well as considering the impact of possible difficulties importing components following Brexit/Covid.

8.70. Therefore, we are expecting the contribution of this component to increase disproportionately in the future. The impact of this will be an overall increase in occupier payments at a rate which exceeds the historical trend. An allowance for this has been made in the RIIO-ED2 profile and an explanation of the amount is given in paragraph 6.37 below.

8.71. The cost of labour (which is an important component of several heads of claim) rose in 2019/20, the year used to calculate the 2022/23 wayleave figures. Over the longer term however, we could see wages rise at rates that exceed inflation as skilled farm labour and talented farm mangers are in slightly short supply in some parts of England and Wales. This may be magnified because of restrictions on the movements of people following Brexit and Covid.

Area loss

8.72. An area loss occurs where the farmer cannot grow crops or grass in certain areas due to the obstruction.

8.73. Accounting for 12% of the payment for a single wooden pole in arable land (rising to 23% for large fixtures), assuming the area coefficient for each fixture remains unchanged, and this type of claim varies according to the pre-rent and finance surplus of the crop and its output. Vegetables are a key contributor to this, despite their small area, as they have a very high value output and proportionally large areas affected by network structures. In arable fields, area loss includes additional tramlines required to navigate a structure.

8.74. Area loss is comparatively small in pasture (less than 1% for a pole and rising to 3% for large pylons) as stock can graze up to and within fixtures.

8.75. Area loss is based on the space not cropped and the value of the pre-rent surplus foregone. This is likely to rise in line with inflation in the long term. However, farm commodity values are currently high, suggesting area loss will be high in 2023/4.

Yield loss

8.76. A yield loss is the reduction in crop around the base of the apparatus.

8.77. A fixed yield percentage is taken from an agreed area around each fixture. Its value is calculated for each crop. Overall, this is small for both arable and pasture, ranging from 2% for poles to 6% for large pylons.

8.78. Assuming the area used to calculate the yield lost and the percentage of yield removed, remains unchanged, it will vary according to the crop output. Over the long term, we would expect this to be roughly in line with inflation.

Wasted inputs

8.79. The wasted inputs are the cost of inputs from which no farming benefit can be derived as a result of the apparatus, costing 7-15% of the payment depending on structure and land use.

8.80. This assesses the seed, fertiliser and sprays placed excessively or incorrectly as a result of avoiding network structures. This cost rose for 2022 and is unpredictable (fertiliser and seed). Spray and fertiliser costs have recently risen substantially and we expect this to result in a future increase for this type of claim.

8.81. Evidence shows that costs rise slightly faster than the value of the farm output. This happens as farms become more efficient. Over the long term, we would expect to see this become evident in the wayleave figures.

Weed control

8.82. This is the cost of manually controlling weeds which grow around the base of apparatus.

8.83. Accounting for 7% of the wayleave payment for a single wooden pole in arable land (declining with size), we expect this to remain small and predictable into RIIO-ED2. This type of claim generally reflects wage inflation.

8.84. Weed control is largely a function of the value of labour, the cost of which rose for the 2022 wayleave review. We expect labour rates to adjust to compensate for change in coming years. The farm manager's survey will be repeated next year, after which we will expect a rise.

Health and safety

8.85. These are additional costs associated with managing health and safety as a result of electrical equipment. It is a relatively small component of the arable wayleave rates (12% for pole and 3% for large pylon), but significant component in pasture (60% for pole falling to 12% for a large pylon). As it is the same rate for every fixture, it become less significant for larger fixtures.

8.86. We expect this will vary every three-four years when Defra reassesses average farm sizes. The other key contributors are the value of labour and managerial time.

Overall

8.87. For the purpose of predicting changes in owner payment rates throughout RIIO-ED2, the precedent of year to year changes in RIIO-ED1 are considered to be unsuitable for pasture as they are reflective of the previous valuation model of agricultural costs. Therefore, we consider that it is appropriate to look to outcomes from the 2019 cost model as a more suitable basis for our RIIO-ED2 estimates.

8.88. The model does not include five-year averaging which means figures could go down or up each year depending on the fortunes of agriculture and the costs involved. Over the long term, taking into account the lack of forward knowledge of the relevant variable costs for farming, we would expect owner payment rates to rise roughly in line with inflation, excluding the cost of machinery and new measurements feeding into the time loss calculation.

8.89. It is usual for the cost of machinery (which is an important variable cost) to increase at a rate above inflation. Therefore, based on advice from our external agricultural consultants, and considering the comments above about a likely disproportionate increase in occupier payments because of the future impact of time loss (as the new in-field data is fed into the calculations),

we consider that it is prudent to budget for increases in occupier payment rates for both arable and pasture rates at 1% above inflation per year.

Substation rents

8.90. Figure SA-06. 198 summarises our substation rent payment costs.

Substation rents					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	0	1
RIIO-ED2 Annual Average (forecast)	0	0	0	0	1
RIIO-ED2 Total (5 years)	2	1	1	1	4

Figure SA-06. 198: RIIO-ED2 forecast expenditure - substation rents

8.91. A large number of our substation sites are held on a leasehold basis. As a tenant of these areas of land, we are obliged by the leases to pay rents to our landlords. Many of our leases include a rent review provision; when a rent review is instigated by a landlord, we seek to negotiate a settlement for an amount which is consistent with the terms of the lease. The majority of our existing substation leases which contain a rent review provision prescribe RPI as the basis of the calculation. The use of CPI to calculate increases in new leases continues to be resisted by most landlords, with RPI or open market being favoured which, as a result, is the means by which we usually secure an agreement.

8.92. When a lease comes to an end and our landlord acts to instigate a renewal, we engage in settlement negotiations for a new lease. Our preference is to negotiate freehold purchase although landowners are often only willing to grant a new lease.

8.93. The number of leasehold substations on our network increases as the size of our network expands.

8.94. The net combined effect of all of these factors can be an increase in our total rent liability over time.

8.95. Sometimes, when our lease has expired, our landlord may resist renewing it. Currently, we are experiencing a rise in such cases along with the resultant associated legal costs. This could be because the landlord wants to take back the land for another purpose or alternatively because the situation is being used to apply leverage in negotiations for a settlement. These complications are dealt with on a case by case basis and we use our judgement accordingly. Where the asset is strategically critical, and/or our diversion options are limited, and where it is consistent with our license obligations to do so, we may consider using our statutory powers to protect our network. The costs of these processes are included in the Diversions forecast.

8.96. We do not anticipate any other unforeseen, additional influences bearing on this area of activity during RIIO-ED2. We regard the rent expenditure in year 2019/20 to be an appropriate base forecast for future year forecasts. There will be a small increase in rents in RIIO-ED2 to account for the additional pressure of RPI-linked increases above CPIH.

Wayleaves and easements administration

8.97. Figure SA-06. 199 summarises our wayleaves and easements administration costs.

Wayleaves and easements administration					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	4	4	2	2	11
RIIO-ED2 Annual Average (forecast)	4	4	2	2	11
RIIO-ED2 Total (5 years)	18	19	8	9	53

Figure SA-06. 199: RIIO-ED2 forecast expenditure - wayleaves and easements administration

8.98. The costs incurred in this activity are mainly costs to cover staff who are managing the following processes:

- Obtaining, managing and administering wayleaves, substation rents and easements
- Negotiating new wayleaves
- Managing wayleave terminations
- Administration of existing wayleaves, including the preparation of payments
- Negotiating termed wayleaves for wooden poles in gardens
- Provision of legal services relating to wayleaves and easements

8.99. These costs are an established activity and no future changes are foreseen, except for a small increase in the number of wayleaves specialist roles to negotiate new wayleaves and easements associated with the increased reinforcement programme.

9. Corporate activities

Overview

9.1. Corporate activities (also referred to as core business support) include a number of central functions provided for all licence areas, including HR, finance and regulation, procurement, corporate communications, legal services and executive functions. Corporate costs are generally allocated broadly on the basis of network scale on a 30:30:15:25 ratio between the West Midlands, East Midlands, South Wales and South West respectively (see paragraph 2.13).

9.2. WPD's strategy to operate a low overhead business will not change as we enter RIIO-ED2. Corporate activities account for about 4% of Totex. Our forecast expenditure is shown in Figure SA-06. 200[3].

Corporate activities					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	15	15	8	12	50
RIIO-ED2 Annual Average (forecast)	18	18	9	15	60
RIIO-ED2 Total (5 years)	90	89	45	76	300

Figure SA-06. 200: RIIO-ED2 forecast total expenditure - corporate activities

9.3. Although there will be increased requirements in some of these areas as we expand DSO capability and carry out additional reinforcement programmes, where possible these will be absorbed within existing resources, thanks to process improvements and efficiencies.

9.4. Figure SA-06. 201 summarises the key corporate activities that we are forecasting for RIIO-ED2.

Corporate activities expenditure RIIO-ED2					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
Human resources and non-operational training	18	19	9	15	62
Finance and regulation	60	59	30	50	199
Executive function, legal services and communications	16	16	8	14	54
Other income	-4	-4	-2	-4	-15
RIIO-ED2 Total (5 years)	**90**	**89**	**45**	**76**	**300**

Figure SA-06. 201: RIIO-ED2 forecast total expenditure - corporate summary, by activity

9.5. We explain these key activities and the main changes we foresee in the following sections.

Human resources and non-operational training

9.6. The expenditure on human resources covers all the costs associated with the human resources function including development of HR policy and procedures, employee relations and payroll management.

[3] All the costs presented through this section are before indirect allocations, and so will include costs associated with connections and other activities outside the price control. The reallocation to these direct activities is shown in the row 'indirect allocations' in the summary tables in chapter 2; our approach to allocations is also detailed in this chapter.

9.7. Non-operational training include the preparation and provision of non-engineering training courses and IT and telecoms training.

9.8. We have forecast a minimal increase to help achieve gold accreditation within Investors in People by the end of RIIO-ED2. We are also committed to improving levels of diversity within our business and publishing an annually updated Diversity and Inclusion Activity Plan. This will be achieved using current resources in the team.

9.9. We also forecast that the new Health and Social Care Levy, recently announced by the government in September 2021, will cost us an additional £25 million in RIIO-ED2. As a result of the late timing of the announcement, we have included this as an additional cost in the activity of Human Resources only, rather than including across all activities where labour costs are incurred.

Finance and regulation

9.10. Finance and Regulation expenditure covers a wide range of activities that are grouped into four main categories:

- Finance;
- Network regulation;
- Procurement;
- Insurance.

9.11. Finance activities include statutory and regulatory accounting, management reporting, taxation and treasury. The scale and demands of reporting continues to grow. We aim to minimise the impact on resource requirements by investing in and continuing to enhance our robust systems and processes to make the extraction of data and population of data templates and accounts less resource intensive, allowing more time for analysis and reporting.

9.12. There are some additional governance costs that we will need to undertake including external and internal audit and so an additional £0.9 million of costs have been included in this Business Plan.

9.13. Regulatory obligations change with each price control but, once set, they remain broadly unchanged. The role of the regulatory function is to ensure there is compliance with requirements and that obligations are met. Work is also carried out on the development of price control mechanisms through industry working groups to gain a better understanding of performance and establish new mechanisms for future price controls.

9.14. There are no expected major changes to the requirements for procurement. The same structure and processes will continue into RIIO-ED2, managing contracts and materials tendering.

9.15. We will invest in our skilled labour force and plan to provide opportunities for a small number of graduates to train for accountancy qualifications and develop their talents by contributing towards the evolution of the wider WPD business through RIIO-ED2.

9.16. To deliver our core commitments, we also forecast some additional expenditure in our regulation activity for increased social outreach projects for vulnerable customers. We will continue to offer fuel poverty advice, in addition to new projects to protect vulnerable customers in a smart future.

Insurance

9.17. Insurance includes the costs of insuring against events and the claims against DNOs for any damage that may have been caused during routine work activities. WPD works hard to ensure that customers are not inconvenienced and deals with genuine complaints and claims quickly. This avoids the need for protracted negotiations and the additional costs involved.

9.18. Additional insurance premium costs of £18 million have been included in the Business Plan. These primarily relate to Directors and Officers Liability insurance and cyber insurances, but there are also some small increases in other activities. Our forecast insurance premium costs have been provided independently in a report from our insurance broker, Gallagher[4]. This report provides in detail evidence for the insurance premiums we have included in our plan.

9.19. As well as insurance premiums, the activity of Insurance reported in the BPDTs includes the activities of handling, processing and managing claims, the costs of managing the insurance function and other payments made to third parties. Figure SA-06. 202 shows the costs we are forecasting in the BPDTs for Insurance, with insurance premiums separately identified. No other increases have been assumed in our Insurance forecast.

RIIO-ED2: Insurance forecasts						
£m, 20/21 prices	2023/24	2024/25	2025/26	2026/27	2027/28	Total RIIO-ED2
WMID	5	5	5	5	5	25
EMID	5	5	5	5	5	24
SWALES	2	2	3	3	3	12
SWEST	4	4	4	4	4	21
WPD	**16**	**16**	**17**	**17**	**17**	**82**
Insurance premiums included in Insurance	12	13	13	14	14	66
- includes increases from RIIO-ED1	3	3	4	4	4	18

Figure SA-06. 202: Insurance forecast

9.20. The increases in insurance premiums have been derived from the summary table in the Gallagher report[5]. We have identified the Directors and Officers (D&O) and Cyber insurance which are new costs for us, and also factored in the other increases in other types of insurance from the last year of RIIO-ED1.

Executive function, legal services and communications

9.21. The expenditure classed under this activity includes executive function costs, company secretarial costs, legal services, corporate communications and community awareness.

9.22. There are some additional DSO governance costs (£0.1m per annum) that we will need to undertake which includes the establishment of an independent DSO scrutiny panel.

9.23. Additionally as detailed within the Finance and regulation section above, we are forecasting some additional expenditure for increased social outreach projects for vulnerable customers. We will continue to offer fuel poverty advice, in addition to new projects to protect vulnerable

[4] Gallagher (September 2021), WPD Business Plan 2023-2028 Insurance Premium Projections
[5] See page 24 in the Gallagher report

customers in a smart future. This will be part funded under Finance and Regulation and partly in this activity.

9.24. We also have an extensive school safety programme. In RIIO-ED2, we are committing to sending electrical safety packs to every primary school in WPD's region and educating at least 80,000 children per year via direct learning. There is a very small incremental cost included in the plan for this.

Other income

9.25. Other Income represents the recharging of some corporate costs that support the running of other WPD businesses (such as South Western Helicopters and WPD Telecoms) to those businesses. Administration costs associated with the operation of WPD pensions schemes are also recharged to the pension schemes, with the credit reported in Other Income.

10. Workforce resilience

Introduction

10.1. Working and operating on the electricity network requires a strong awareness of potential dangers. Staff need to be trained and competent to undertake the required activities following prescribed procedures.

10.2. In addition to the specific training received when staff first join WPD, the introduction of new equipment or revised procedures requires that we also provide regular updates and refresher training to our staff.

10.3. As staff change roles, their responsibilities also change, which may call for additional operational and upskill training to allow them to fulfil a wider range of responsibilities.

10.4. The costs of attending training courses and the provision of trainers, course materials and training centres are therefore dependent upon the level of recruitment and the need for refresher and upskill training.

10.5. Routine recruitment and training of new staff is managed on the basis of periodic assessment of the numbers of staff who are predicted to leave the business in the next three to four year period.

10.6. New apprentices, students and skills trainees are appointed into training schemes so that they are competent and ready to fill these predicted future vacancies as and when they arise.

10.7. Predominantly, our craft staff (jointers, fitters and overhead line staff) are trained through our apprenticeship scheme.

10.8. We have recruited 388 apprentices so far in RIIO-ED1 (2016-2021).

10.9. We invest in further education and training for staff who have the potential to fill more technical roles and we operate trainee engineer and planning and design schemes to meet identified succession plans.

10.10. Staff required for technical roles requiring a degree come from our graduate development programme utilising the Institute of Engineering and Technology (IET) ‘Power Academy’ summer placement scheme, combined with our own in-house training.

10.11. We recruit a number of staff as skills trainees who generally replace staff that have left the business unexpectedly. These trainees will undertake reduced training compared to that received by craft staff. They will initially become operators with a number having the opportunity to progress to become craft staff over a period of time and in line with their development plan.

10.12. Using this simple methodology, WPD has a proven track record of successfully managing workforce renewal since 2012. In the last five years from 2016 to 2021, WPD has recruited and trained 1081 new staff to replace retirees and natural wastage.

10.13. These staff were all trained in craft, operations or planning skills at our own training facilities.

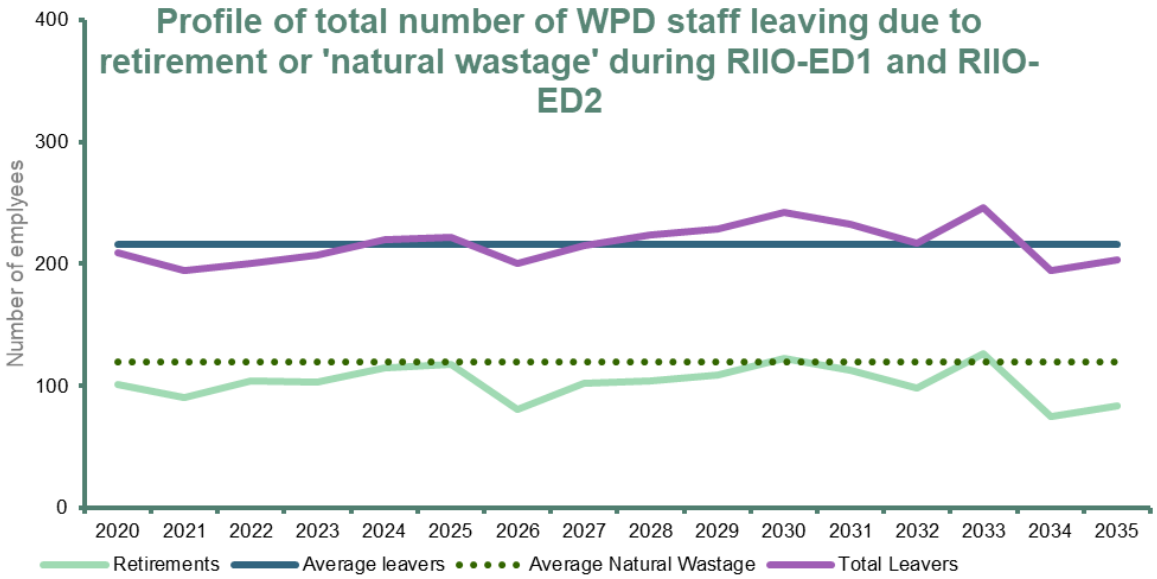
Overall planning

10.14. WPD staff resource planning looks ahead to both RIIO-ED2 and into the early years of RIIO-ED3. This is to ensure that we recruit sufficient numbers of new staff through RIIO-ED2 and train them to ensure we have the right number and combination of craft and technical skills for RIIO-ED2 and into the early years of RIIO-ED3.

10.15. In addition to specific changes in workload volumes, there are two key sources of data that are regularly reviewed in respect of workforce numbers;

- The forward age profile of staff across our business and the skill sets that they possess (allowing the future anticipated number of retirees to be assessed);
- The long run average number of staff who have left WPD through natural wastage with any forward adjustment for significant known events e.g. an 'Olympic Park' type development. (At this stage, we do not anticipate any major change in our natural wastage numbers going forward and the line is therefore flat throughout RIIO-ED2).

10.16. These requirements are combined to establish the staff resource requirement and are used to feed into our recruitment and training plans. Figure SA-06. 203 highlights our prediction for the number of staff leaving the business against the actuals we have seen.



The dark blue line is the sum total of retirees and staff who leave through natural wastage. The dashed line represents the average number of staff that leave through natural wastage.only

Figure SA-06. 203: Profile of staff leaving due to retirement or 'natural' wastage during RIIO-ED1 and RIIO-ED2 - WPD total

10.17. In total, we need to recruit and train 206 operational staff on average per annum (1030 staff through the RIIO-ED2 period) to allow us to maintain our current RIIO-ED1 staff numbers.

10.18. Throughout RIIO-ED1, we have provided upskill training to an average of 87 staff per year (predominantly training craft staff to technician or technician to specialist/team manager roles). This number will remain constant throughout RIIO-ED2.

10.19. Our graduate recruitment volumes will increase compared to that in RIIO-ED1 in part due to the recruitment of non-engineering graduates in areas like finance, data sciences and information resources.

10.20. All of these staff will be appropriately trained in the skills sets appropriate for replacing those who have left, who are forecast to leave, or for new roles within WPD.

Skills planning

10.21. To ensure the overall business has the right numbers of staff with the right skill sets, the overall analysis is broken down further to determine the skills of the staff due to leave through retirement.

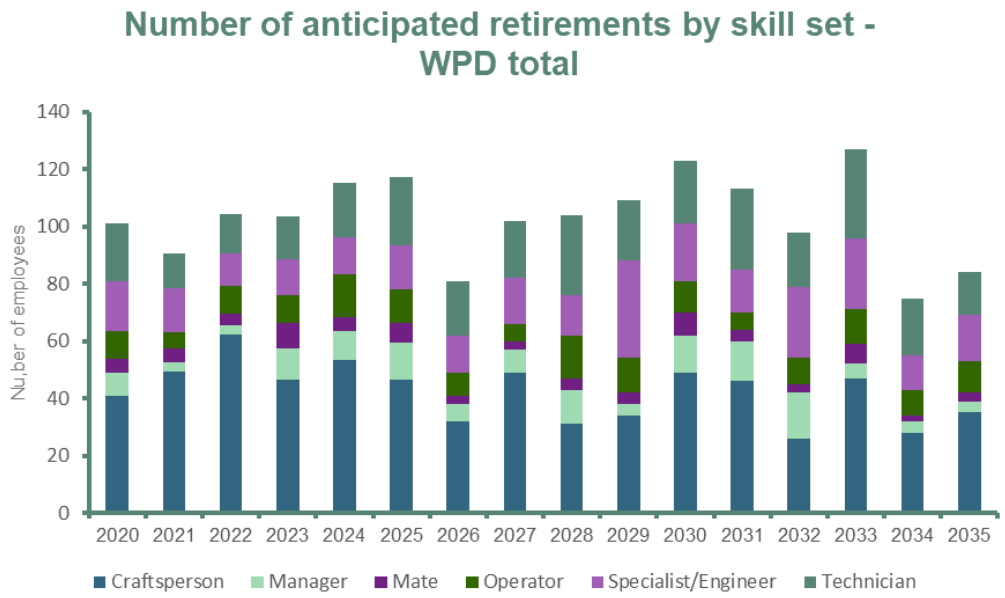
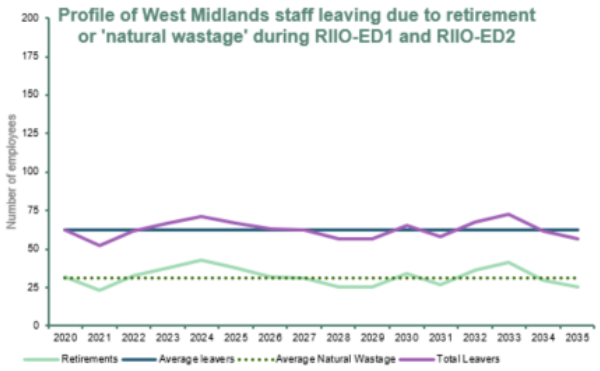


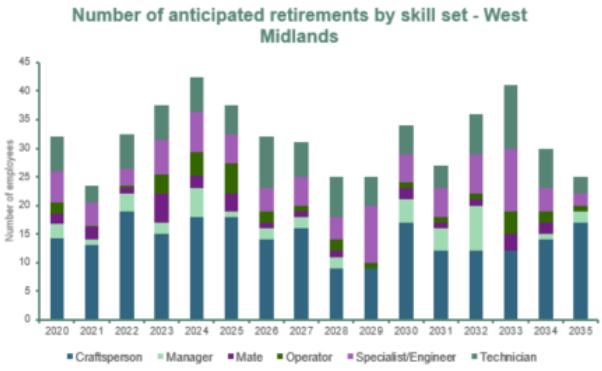
Figure SA-06. 204: number of anticipated retirements by skill set during RIIO-ED1 and RIIO-ED2 - WPD

10.22. Our recruitment plans are also checked to take account of any regional variances across our four areas. We have completed analysis on an individual WPD licence basis to ensure that there are no specific skill sets or staff number issues that would give rise to the requirement for any special or area specific training.

10.23. Our analysis highlights that each licence area will have a rise in the number of staff who could retire after the RIIO-ED2 period (2029-2034). The peak retirement periods are different for each licence area and will be managed through targeted recruitment.

10.24. The graphs in Figure SA-06. 205 by DNO reflect the anticipated regional retirements by skill set and profile of retirements due to natural wastage.





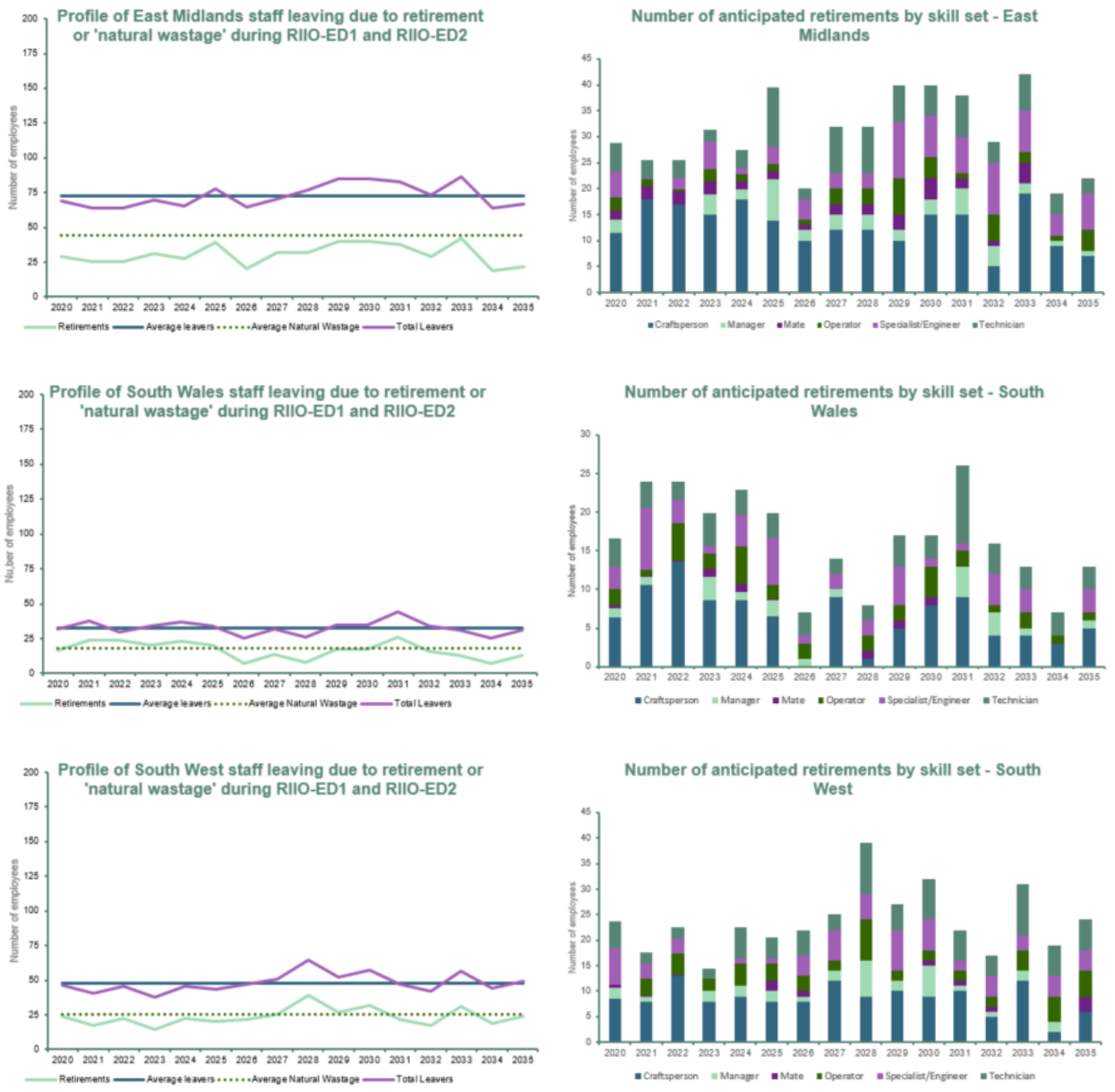


Figure SA-06. 205: Profile of staff leaving due to retirement or 'natural' wastage (LHS) and number of anticipated retirements by skill set (RHS), during RIIO-ED1 and RIIO-ED2 by DNO

Impact on workforce renewal requirements due to workload changes

10.25. As well as ensuring we have sufficient resources to align with the number of retirees and natural wastage, we must also consider any changes in workload demand placed on resources as we transition from RIIO-ED1 into RIIO-ED2 and RIIO-ED3. Our plans are established against the following scenario.

10.26. To calculate our future workforce requirements, we use the Distribution Future Energy Scenario model developed for our Business Plan, referred to as the WPD 'Best View' scenario. This Best View scenario sets out the position that WPD has established as the most likely to occur over the RIIO-ED2 period. From this, we are able to establish the forward workforce requirements for all categories of work including the impact of Low Carbon Technology (LCT) uptake.

10.27. By analysing the scenarios, we can establish the staff resources required to ensure we can deliver the workload demands irrespective of the eventual uptake of LCTs in RIIO-ED2.

10.28. For this scenario, we have also factored in the requirement of the continued 'one-off' activity of the smart meter rollout.

10.29. The rollout of smart meters requires electricity suppliers to offer to install a new meter in the premises of every domestic customer. These new meters allow significant additional functionality compared to the types of meter currently installed. The installation programme commenced in 2015 and should be completed by 2025.

10.30. This programme has created additional workload for DNOs as a result of issues found at service positions in properties. This workload was higher than the normal rate of work due to the shortened timeframe to complete all meter installations (as compared to the traditional meter change programme of approximately 20 years).

10.31. Based on knowledge of our assets at the meter position, we made the decision during RIIO-ED1 that a more accurate forecast of locations requiring remedial work would be 2%. This would equate to a requirement equal to an additional 60 cable jointers if this activity were to be undertaken in isolation.

10.32. We have not needed to recruit the additional cable jointers during RIIO-ED1 so far and have met the additional workloads through a combination of contracted resources in certain areas and efficient working practices within our local teams.

WPD 'Best view' scenario

10.33. Our 'best view' analysis of asset replacement, general network reinforcement and LCT reinforcement required during RIIO-ED2, combined with the relatively small impact of smart metering and other business support functions, results in a resource demand that increases indirectly costed staff by 121 during the remainder of RIIO-ED1. A further 279 will be needed in RIIO-ED2, amounting to an additional 400 employees within the business. Figure SA-06. 206 summarises the additional employee requirements by activity.

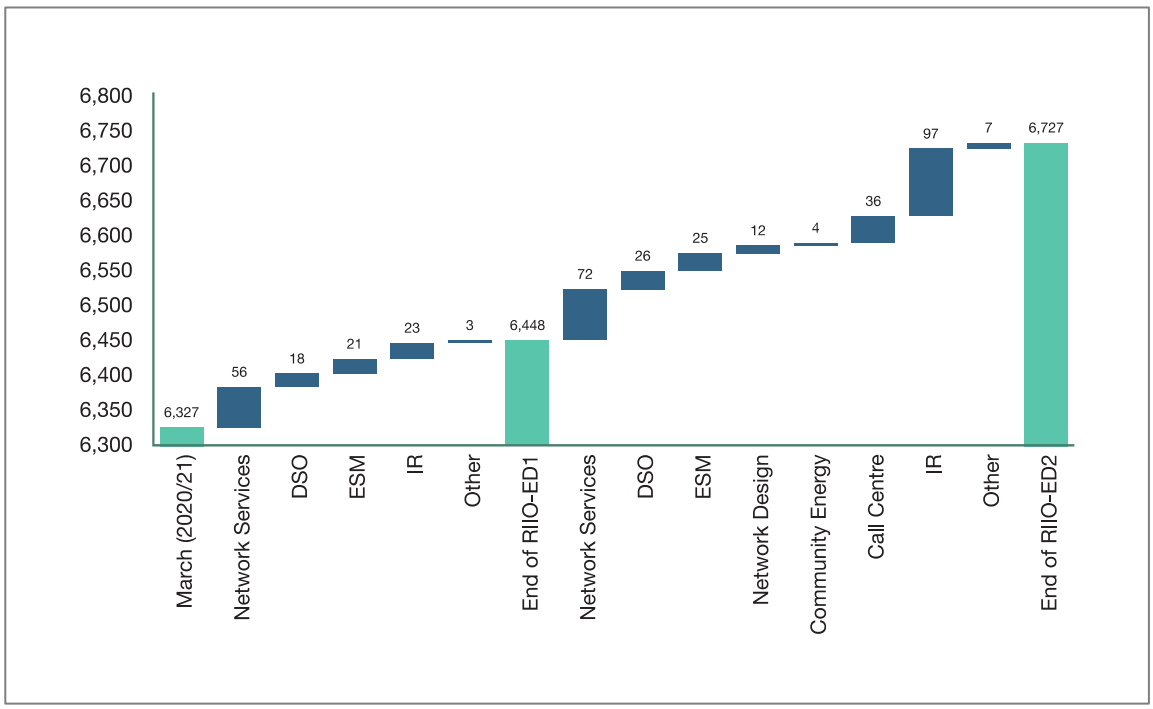


Figure SA-06. 206: Additional employees required to meet network demands by the end of RIIO-ED2 compared to present, 2020/21

10.34. There will be some increase in phasing of work, towards the latter years of RIIO-ED1, based on the LCT workload. This coincides with the completion of the ESQCR works required to ensure horizontal safety clearances to buildings.

10.35. It should also be noted that the level of upskill training will increase due to opportunities introduced for existing employees to join our formal training programmes through RIIO-ED2.

10.36. We will use degree level apprenticeships in data science and other emerging areas to upskill our workforce to meet the future challenges of increased data and digitalisation of our network on our journey to net zero.

10.37. The additional recruited employees will be graduates, subject matter experts and others and trained on a two year development programme.

10.38. We are seeing an increase in the amount of notification from electric vehicle installers which is driving increased network studies on our LV networks. We are increasing network planning resources within the remainder of RIIO-ED1 by 56 employees.

10.39. Continued increases in Low Carbon Technology (LCT) enquiries and the need for subsequent network design studies will lead to the recruitment of an additional 72 network planners throughout RIIO-ED2.

10.40. Flexibility and energy management on the network performed by the Distribution System Operator (DSO) team during RIIO-ED1 will continue into RIIO-ED2. We will need to recruit another 26 employees to fully develop Distribution Future Energy Scenarios (DFES) and maximise flexibility.

10.41. Digitalisation and innovation are at the heart of WPD's transition to building a smart and efficient energy system and underpins our RIIO-ED2 strategy. To ensure this success we will need to recruit and expand our ESM team.

10.42. In order to support the expected higher load related expenditure being driven by UK governments 2050 net zero target WPD will lead to the recruitment of 12 additional Network Design engineers.

10.43. Four community energy advisors are being recruited to ensure the best possible advice is provided to our local Distribution Managers when they are interacting with local authorities regarding their Local Authority Energy Plans (LAEP) and other local enterprises.

10.44. We are striving to deliver even more in RIIO-ED2, which is demonstrated in our core commitments (as detailed in Supplementary Annex SA-02 'Our Commitments'). To help meet our Priority Services Register (PSR) commitments, we are forecasting an increase in call centre handlers. This increase is in response to an expected growth in the number of customers joining our PSR during RIIO-ED2 and our pledge to make sure vulnerable customers are not left behind in the DSO transition.

10.45. With the increase in data being made available to our stakeholders and the increased risk to the business from unauthorised access to operational technology, we are recruiting 97 new employees dedicated to cyber related duties and the wider information resources department over the first three years of RIIO-ED2.

10.46. Where there is uncertainty regarding the volume of works, for example the unbundling of LV services, we will monitor the observed and expected volumes of work and may choose to outsource the works instead of increasing our direct workforce.

Recruitment

10.47. Recruitment is undertaken in three main ways:

- Apprentices - via the WPD apprenticeship scheme;
- Graduates - generally via the IET Power Academy; and
- Skills trainees - via local recruitment initiatives.

10.48. In addition to external recruitment, we also ensure existing staff are given opportunities to develop within the business and to develop new skills and capability.

10.49. We have opened all of our formal training programmes to applications from existing employees with three or more years' experience within the business, making allowances for academic qualifications and providing routes to improve their English and maths skills.

10.50. We are introducing a formal training programme for external applicants who have very low or no recognised qualifications to join our business. The initiative aims to help the most disadvantaged within our local communities in the post pandemic years.

Apprentices

10.51. WPD has consistently recruited apprentices throughout the last two decades, as illustrated by Figure SA-06. 207. Since 2012, WPD has recruited over 750 new staff as apprentices. This has ensured that we have retained the ability to train and deliver motivated and competent craft staff into our business.

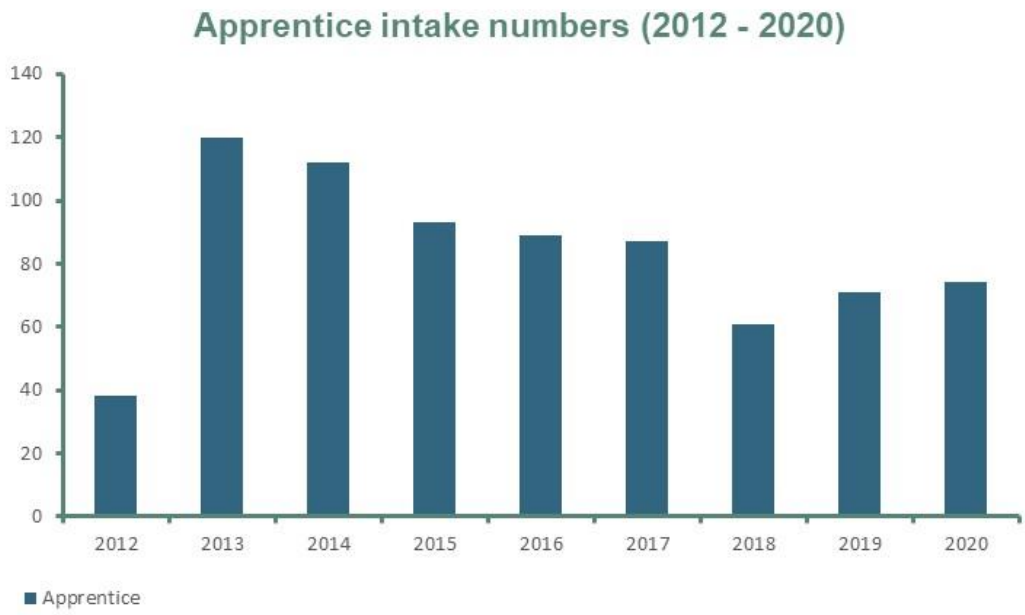


Figure SA-06. 207: Apprentice intake numbers, 2011/12 - 2019/20

10.52. We are listed on the Register of Apprentices Training Providers (RoATP) as an Employer Provider and utilise the Power Network Craftsperson Standard for our apprenticeship scheme. As an Employer Provider, we are subject to external verification of the quality of our provision by the Office for Standards in Education, Children's Services and Skills (Ofsted).

10.53. Our approach to the apprenticeship scheme is to make sure that it meets the needs of our business by ensuring our learners are at the heart of what we do. Following an initial induction

programme, which includes an introduction to the business, health and safety training, customer service awareness and a week-long practical community project (to develop team building and social skills awareness), our apprentices go through a series of formal training courses.

10.54. These formal training courses are interspersed with hands-on practical experience on the distribution network working under the guidance and supervision of our experienced craft staff. The apprentices' knowledge, skills and behaviours are developed over time as they complete a series of relevant practical tasks in the field while continuing to work under the guidance of experienced staff.

10.55. During this time, apprentices are required to log all of their work through a diary-based record application which allows their progress to be monitored on a weekly basis. They are also required to complete a series of formal reports to demonstrate the work that they have done. These reports include details of both the practical aspects of that work and also how it relates to specific safety, policy and procedural requirements.

10.56. Apprentices are assigned to a WPD team, with a mentor and a team manager who conducts weekly reviews of the apprentice diary sheets and task reports. Distribution managers conduct reviews with their apprentices on a quarterly basis or more frequently if additional guidance or help is required. 'Diaries' and 'task reports' are reviewed and assessed by our internal assessment team to ensure they achieve a level of consistency. Appropriate support is provided to all of our apprentices as required.

10.57. When our apprentices have completed their tasks and reports, they are tested using a computer-based test before moving into a craft development role. This gives the apprentice an opportunity to continue to develop their skills as part of a WPD team but also to receive further hands-on training in preparation for their End Point Assessment.

10.58. When apprentices are judged to have reached a suitable standard, they can apply to be tested via an End Point Assessment. Apprentices who are judged to have sufficient skills, knowledge and behaviours then progress into a craft role.

10.59. We have facilitated visits by other DNOs, engineering based companies, HSE representatives and Ofgem to demonstrate our approach and to discuss our philosophy to apprentice training.

Graduates

10.60. WPD recruits between five and 10 graduates each year to fill highly technical roles within the business. These staff are generally candidates that we have sponsored within the IET Power Academy. We have also sought out candidates directly through universities.

10.61. The graduate development programme consists of formal training-school courses interspersed with practical field experience where graduates are able to gain an appreciation of the nature of the works undertaken within the business.

10.62. Graduates will also spend significant time working under the guidance of experienced electrical engineers who are typically based in one of our three major offices at Bristol, Tipton or Castle Donington. In addition, they will spend time with the project engineers who have responsibility for delivering EHV major projects.

10.63. We are expanding our graduate programmes to include subject areas that have not been traditionally recruited within our business. This includes finance, data science and civil engineering.

Skills trainees

10.64. In addition to the development of staff through our apprenticeship programme, we also recruit a number of new staff to fulfil lower skilled support roles such as operators or mates. In these roles, staff undertake a more limited range of hands-on skills work and provide support to the craft staff (including being a trained to provide immediate assistance on site as required during live working operations).

10.65. Generally, we use our internal recruitment team to source our skills trainees.

10.66. We appoint the new recruits on fixed term contracts initially. Following satisfactory service and performance, they are then interviewed and, if successful, move to a permanent position within the business.

10.67. This recruitment process provides an effective and efficient source of new staff and is a way of providing us with a low risk, low cost process for employing people who are right for our business.

Training resources

10.68. To support the employees being recruited and upskilled, it is important that WPD has sufficient trainers and training facilities.

Trainers

10.69. Figure SA-06. 208 shows the number of WPD trainers, their skill and their base location as at 2020/21.

Number of training staff		
Skill	**Taunton**	**Tipton**
Overhead	4	5
Fitting	3	3
Jointing	3	4
Metering / Other	1	2
Operations	3	3
TOTAL	**14**	**17**

Figure SA-06. 208: Number of training staff as at 2020/21 - WPD

10.70. Training for new staff is generally delivered by one trainer per group of eight trainees. Each trainer is capable of delivering approximately 40 weeks of training per year.

10.71. Each trainer is therefore effectively capable of delivering 320 (8 x 40) ‘trainee weeks’ per year.

10.72. New craft staff require approximately 28 weeks of formal training; graduates require seven weeks; and trainee engineer and planning and design trainees require up to 23 weeks.

10.73. RIIO-ED1 highlighted the need for six additional trainers above the average number employed in DPCR5 to meet the requirements for the Ofgem Reference Case. In fact, we met the requirements by introducing greater flexibility, delivering training at local depots which reduced travel time as well as limiting unproductive time within the field teams.

10.74. We also analysed where our trainers were based and how training could be delivered to focus consistently on the core components. This enabled some of the programmes to be streamlined, again increasing productivity while continuing to provide high quality training.

10.75. We will continue to monitor our trainer resources against demand, and to be aware that we may have to flex our resource to meet demand, if LCT works increase beyond the WPD Best View scenario.

10.76. WPD has a successful track record of recruiting trainers from within its existing skills base and will deliver the additional trainer resources required for this scenario in sufficient time to meet the required output.

Facilities

10.77. WPD currently operate two principal training centres based at Taunton in Somerset and Tipton in the West Midlands. These principal sites are supplemented by additional satellite training facilities located within our region.

Taunton training centre

10.78. The facilities at Taunton cover an area of approximately 3.8 hectares and are owned and maintained by Western Power Distribution. The facilities include:

- 14 class rooms;
- jointing workshops;
- metering and small wiring workshops;
- fitting workshops;
- an outdoor operational network for 33kV, 11kV and LV operations training;
- an indoor overhead line training facility;
- an outdoor overhead line training field.

Tipton training centre

10.79. The facilities at Tipton cover an area of approximately 4.6 hectares and are owned and maintained by Western Power Distribution. The facilities include:

- 16 class rooms;
- jointing workshops;
- metering and small wiring workshops;
- fitting workshops;
- a 33kV, 11kV and LV operations training network;
- an overhead line training field.

10.80. Both the Taunton and the Tipton facilities include a fully operational electricity distribution network allowing for full operations training up to and including 33kV for technicians and other operational staff.

10.81. Both training centres are therefore able to deliver all of the skills training of jointing, fitting and overhead line works, together with operational training utilising directly employed trainers.

Other remote training facilities

10.82. There are a number of smaller, satellite training facilities which are used to maximise the efficiency of training delivery by allowing locally-based skills training. These facilities are parts of existing operational sites and therefore make efficient use of available accommodation. These facilities include:

- **Dunkeswell** training facility in East Devon - the 3.4 hectare facility at Dunkeswell operates as a satellite to our main Taunton site. This facility is utilised for the heavy construction, hot glove and trade test courses within our overhead lines training programme.
- **Cwmbran** in South Wales - use is made of the WPD Central Plant Unit for the training of fitting skills, and a local primary substation and adjoining field is used for overhead line training.
- **St Mellons**, Cardiff - WPD owns a one hectare field which allows us to effectively deliver 33kV and 11kV 'heavy construction' overhead line training for our Welsh apprentices.
- **Norton**, Worcester - a primary substation is used for the delivery of EHV plant, fitting and operational training courses.
- **Fenton,** Stoke on Trent - during RIIO-ED1, we modified the use of our existing operational depot in Fenton. The site allows us to complete overhead training on a purpose built overhead line and has expanded our jointing workshops and classrooms.

10.83. These facilities allow us to minimise the travel time for staff. This is of particular benefit for short duration courses and refresher training. For these short duration courses, it is more efficient to relocate the trainer to a smaller, local site rather than asking trainees to travel longer distances to Taunton or Tipton.

10.84. Throughout RIIO-ED1, we have embraced technology and now deliver select refresher courses using virtual classrooms, meaning the delegates can now attend a training course without leaving their home address or local depot. Where a programme has a practical element or an employee is exposed to an activity for the first time, we continue to run these courses at one of our facilities or the local depot.

Resource and Expenditure Summary

10.85. We recognise that an increased amount of activity requires increases in resources to deliver the work. Where appropriate, we will be seeking to increase the number of internal resources, thus retaining knowledge and expertise.

10.86. Our experience shows that having in-house specialists enables fast resolution of issues and encourages greater ownership and enthusiasm for innovative developments. As we enhance and develop our DSO functions, we will require additional specialist resources to create new systems, processes and better ways of interacting with customers and flexibility providers

10.87. There are, however, certain aspects of the increased workload where alternative approaches may be more appropriate for delivery of the work. For example, where there is some uncertainty about the volumes of activity or where different working arrangements are required, we are proposing to use contractor resources. This will allow us to deal with short term increases, while determining a more appropriate sustainable level of ongoing resource requirement. It will also allow us to look at alternative ways of working (e.g. weekend and out of hours working) for high volume, low cost activities, such as cut out inspections and unbundling of services

10.88. Based on the WPD 'best view' scenario, we will need to recruit and train 279 additional indirectly costed staff in RIIO-ED2 over and above those we are planning to recruit to replace retiring staff or those who have left through natural wastage.

10.89. Any additional trainer requirements associated to delivering our best view business plan will be absorbed as part of our efficiency improvements.

10.90. We have already made provision to adapt existing facility space quickly to create a further five workshops and classrooms if and when required.

10.91. The additional workshop and classroom space allows us to train an additional 900 fitting or jointing staff over current levels. Our Dunkeswell facility allows us to train 360 additional linesman with the option to train a further 180.

10.92. We have a proven record of being able to recruit and 'train the trainer'. The creation of a further six trainers will be a straightforward process.

10.93. Our track record of dealing with routine staff replacement is proven. We have maintained a significant apprentice programme throughout the DPCR3, DPCR4, DPCR5 and RIIO-ED1 timeframes.

10.94. Our existing apprenticeship, skills trainee, graduate and technical staff trainee programmes have ensured that the business has maintained the right numbers and combination of staff to deliver our programmes of work successfully.

10.95. In addition, we have demonstrated our ability to manage any specific step change in workload with the addition of 265 staff required to deliver the ESQCR programmes of work commencing in DPCR5.

10.96. Our current planning and early action will ensure that we continue to match our recruitment and skills training to deliver the skilled staff required to meet the WPD 'Best view' scenario.

10.97. Figure SA-06. 209 summarises how much will be spent on operational training over RIIO-ED2 with spend broadly in line with annual average RIIO-ED1 expenditure at a WPD total level.

Workforce resilience					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	8	9	6	7	30
RIIO-ED2 Annual Average (forecast)	8	10	5	8	31
RIIO-ED2 Total (5 years)	38	51	27	39	154

Figure SA-06. 209: RIIO-ED2 forecast total expenditure - workforce resilience

11. Information technology and telecoms overview

Introduction

11.1. The core function of information technology and telecoms (IT&T) departments within WPD is to support and enhance the delivery of business work programmes by providing highly available, secure, cost effective, reliable and resilient systems that are aligned with business goals and the delivery of stakeholder commitments and customer expectations. WPD's IT&T systems underpin the effective operation of the electricity network.

11.2. Various teams within the WPD business contribute to the overall IT&T function, as detailed in Figure SA-06. 210.

Information Resources (IR)

The IT department is structured into the following six service areas and provides the majority of IT services and support functions to the business through robust and well established business processes and systems and experienced knowledgeable staff:

- IT management
- Application development and support
- Desktop computing
- Server and database hosting
- Voice and data networks
- Cyber security

WPD Telecoms

WPD operates an extensive in-house telecoms network that delivers inter-office data communications, mobile voice communications and supervisory control and data acquisition SCADA between electricity assets and control centres across WPD's four licence areas.

Electricity systems

Responsible in part for WPD's IT control systems by developing and implementing operational and SCADA systems to support a smart flexible network and the associated data, strategies, policies and innovation activity. Specific teams include:

- Control systems – Support the systems used by our control room, dispatch, local offices and our field staff. The main systems supported include GE ADMS (PowerOn), PowerOn Mobile, iHost, and Kelvatek
- Digitalisation and data – Support WPDs digitalisation and data strategy to build a smart and efficient energy system supporting the UK's clear commitment to net zero carbon emissions by 2050.
- Innovation – A team of engineers dedicated to implementing WPDs Innovation Strategy
- Systems and solutions – Support the operational business and work management systems

DSO

WPD has created a DSO department which is segregated from our DNO teams to ensure independence and to negate perceived conflicts of interest. This team's responsibility includes identifying future network needs, looking at how the capacity will be provided and operating our Flexible Power services.

Other business units

Third party applications software is administered directly by business units. These include WPD's records department which is responsible for the delivery and support of mapping applications and WPD's finance teams which are responsible for WPD's Enterprise Performance Management Systems and financial management systems.

Figure SA-06. 210: The teams that make up our IT&T function

11.3. WPD has an excellent track record of delivering cost efficient and reliable IT and telecoms systems. The RIIO-ED1 IT&T strategy was primarily focussed on the growth and consolidation of WPD IT provision following the acquisition of the two Midlands licence areas.

11.4. WPD aims to deliver an efficient, highly resilient and available function, based on a flat and lean business structure, without key reliance on contractors or outsourcing.

11.5. IT&T services and systems have until recently been aligned to support the activities of a Distribution Network Operator (DNO), responsible for operating, maintaining and repairing the electricity network, providing a safe and reliable electricity service to eight million customers.

11.6. A key driver of WPD's RIIO-ED2 IT&T strategy is the continued Distribution Network Operator (DNO) to Distribution System Operator (DSO) transition.

11.7. WPD was the first DNO to publish a costed DSO strategy in 2017; this has been updated to reflect changing requirements and industry developments. The latest version is available on our website at https://www.westernpower.co.uk/smarter-networks/network-strategy/dso-strategy

11.8. The UK's electricity network has undergone a rapid period of change as distribution network customers invest in generation and alter their consumption behaviours to achieve a lower carbon future. To enable a greater volume of demand, generation and storage to be connected, our networks are becoming smarter and more active, requiring WPD to continue developing our DSO capabilities throughout RIIO-ED2.

11.9. All DNOs, including WPD, have the challenge of managing different power flows across the distribution network, requiring the evolution of systems and processes for forecasting and managing the network.

11.10. As well as the development of DSO capabilities, WPD's IT&T strategy for RIIO-ED2 has additionally been influenced by the drivers below which are discussed further in Supplementary Annex SA-03 'Delivering a smart and flexible electricity network'.

- **Net zero** – WPD is committed to delivering a network which meets future energy requirements, enabling the transition to a smart, flexible and low carbon energy system in support of the UK government's commitment to achieving net zero by 2050. To support these new ways of working, WPD's IT&T strategy will need to evolve

- **Digitalisation strategy[6] –** Digitalisation is at the heart of WPD's transition to building a smart and efficient energy system and underpins our RIIO-ED2 strategy. Digitalisation is the process of using digital technologies to fundamentally change how the network is operating. Over the course of RIIO-ED1, WPD has gradually been increasing the amount of digital technologies on the network – from automation to monitoring equipment. This process will accelerate during RIIO-ED2**.**

[6] https://www.westernpower.co.uk/smarter-networks/digitalisation-and-data/digitalisation-strategy

- **Network visibility strategy[7] –** Critical to the successful operation of new DSO systems and processes is good quality, reliable and timely data relating to the state of the network. WPD will significantly increase sensing and monitoring on the distribution network over the course of RIIO-ED2 to support this requirement.

- **Smart meter strategy[8] –** The installation of smart meters will allow WPD to gain much greater visibility of the operational state of the Low Voltage (LV) network and as a result will enhance core business activities, including fault management, network planning and asset management. To ensure the data from smart meters can be used effectively, additional IT systems will be developed.

- **Innovation Strategy[9] –** WPD's Innovation Strategy is updated on an annual basis and focuses on the long term development of distribution assets, network operations and customer service in response to changing system and customer needs. IT&T strategy will adapt to accommodate the drivers identified in the Innovation Strategy.

- **Cyber resilience –** as resilience on IT systems and technology has increased, so unfortunately has the volume and sophistication of cyber-attacks and the associated risk of potential security breaches to DNOs' IT&T systems. Delivering cyber secure systems will be a key requirement of our IT&T strategy, particularly as networks become increasingly digitised. Further details of our Cyber Resilience IT and OT (Operational Technology) plans can be found in Supplementary Annex SA-02 'Our Commitments'.

11.11. During RIIO-ED2, WPD will focus on:

- Transformation, enhancements, upgrades and/or replacements of existing systems, technologies and applications to ensure the delivery of a future smart and flexible electricity network.
- Development and/or purchase of new systems, technologies and applications that are capable of supporting the future smart and flexible electricity network requirements of an evolving business.
- Improvements to the accessibility and flexibility of data, systems and applications through the greater use of Application Programming Interfaces (API) capabilities; this includes, amongst other things, the development of online work schedules, self-service connections and automated data mastering.
- Ensuring our operational and information technology systems, controls and processes have the investment and focus required to meet and mitigate ever increasing cyber security risks.

11.12. Investment in new technologies and methods of working will benefit customers, ensuring that networks remain reliable, resilient and functional.

11.13. IT&T costs have been forecasted by:

- Consultation with internal business units to understand and include business driven initiatives to improve functionality and effectiveness.
- Understanding stakeholder requirements and expectations.
- Review and identification of technology refresh cycles for major IT/Telecoms components.
- Engaging with external IT experts.
- Reviewing existing base cost profiles and allowing for planned and expected growth.

[7] https://www.westernpower.co.uk/smarter-networks/network-visibility-strategies

[8] https://www.westernpower.co.uk/smarter-networks

[9] https://www.westernpower.co.uk/innovation/innovation-strategy

- Reviewing existing framework agreements with existing suppliers and contractors.
- Discussions and quotations from suppliers and contractors.
- Identifying opportunities for making efficiency savings.

11.14. IT&T costs have been allocated across WPD's four DNOs using our corporate allocation methodology split 30:30:15:25 (West Midlands, East Midlands, South Wales and South West) or by specific DNO, where more appropriate.

11.15. To meet RIIO-ED2 challenges and drivers, WPD will need to significantly increase investment in our IT&T infrastructure and services over the remainder of RIIO-ED1 and throughout RIIO-ED2.

11.16. Information Technology (IT) and telecoms costs form about 7% of Totex in RIIO-ED1 and about 12% of Totex in RIIO-ED2. Our expenditure forecasts, as summarised in Figure SA-06. 211, show that we will invest £856m (2020/21 prices) over the course of RIIO-ED2, an increase on the average spend per annum of 117% compared to RIIO-ED1.

Information Technology (IT) and Telecoms costs					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	24	23	12	20	79
RIIO-ED2 Annual Average (forecast)	47	52	30	43	171
RIIO-ED2 Total (5 years)	233	258	151	214	856

Figure SA-06. 211: RIIO-ED2 forecast total expenditure - Information technology and telecoms

Summary of IT&T expenditure

11.17. IT&T expenditure has been broken down into three reporting categories in line with regulatory reporting requirements as set by Ofgem.

- **Operational IT & Telecoms** – this expenditure reflects the systems and equipment used primarily in the real time management of network assets, but does not form part of those network assets. This can include systems and equipment associated to substation RTUs, marshalling kiosks and receivers, communications for switching and monitoring, control centre hardware and software, cyber resilience associated to operational technology (OT) and monitoring equipment.

- **Non Operational IT & Telecoms** – this expenditure reflects the systems and equipment not primarily used in the real time management of network assets. These include IT hardware, infrastructure and application software development, inclusive of initial costs relating to IT security, and cyber resilience associated to information technology (IT).

- **Business Support IT & Telecoms** – this expenditure reflects the operating and maintaining of the operational and non-operational computer systems, telecommunications systems and applications.

11.18. Forecast RIIO-ED2 expenditure by IT&T cost category are detailed in Figure SA-06. 212 to Figure SA-06. 214.

Operational IT and telecoms					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	5	5	2	3	16
RIIO-ED2 Annual Average (forecast)	11	15	9	12	47
RIIO-ED2 Total (5 years)	56	75	44	61	235

Figure SA-06. 212: RIIO-ED2 forecast expenditure - operational IT and telecoms

Non Operational IT & telecoms					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	6	6	4	7	23
RIIO-ED2 Annual Average (forecast)	14	16	11	13	54
RIIO-ED2 Total (5 years)	71	78	54	65	269

Figure SA-06. 213: RIIO-ED2 forecast expenditure - non operational IT and telecoms

Business Support IT & telecoms					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	12	12	6	10	40
RIIO-ED2 Annual Average (forecast)	21	21	11	18	70
RIIO-ED2 Total (5 years)	106	105	53	88	352

Figure SA-06. 214: RIIO-ED2 forecast expenditure - business support IT and telecoms

11.19. The remaining IT&T sections within this annex will provide a high level overview and justification of ED2 projects and activities. Further, more detailed justifications, can be found within the EJPs; the approach to these is detailed in Supplementary Annex SA-11 Investment Appraisal.

11.20. To further aid understanding of each IT&T expenditure, section information has been broken down into three separate sub sections:

- Information Technology expenditure (including operational technology (OT) and information technology (IT) systems)
- Telecoms expenditure
- Cyber resilience expenditure (including cyber resilience OT and cyber resilience IT expenditure)

11.21. Each sub section follows the RRP reporting structure and will highlight overall expenditure, new expenditure drivers and detail individual project/activity expenditure.

Information Technology expenditure

Operational IT costs

11.22. WPD uses a dedicated communications infrastructure and network management system to monitor the loads flowing through the electricity network, in order to understand its operational state and also to remotely control assets.

11.23. Operational IT incorporates the network management system and remote data collection systems.

11.24. WPD utilises the GE Advanced Distribution Management System (ADMS) application to manage the electricity networks across the four licence areas. WPD has four instances of this application, one per licence area.

11.25. GE ADMS (formally PowerOn Advantage) offers a suite of products including the below business modules.

- **Electricity Network Monitoring and remote control System (NMS) –** Using WPD's in house SCADA (supervisory, control and data acquisition) network to communicate to substations, generators and other key points on the network. The NMS includes functionality to automatically reconfigure the network in the event of faults to rapidly restore supplies. It also provides our safety management for all work on the network.

- **Outage Management System (OMS) –** This system processes and groups data on power cuts using feeds from the NMS and customer call logging. The system directly integrates with WPD's no-supply telephony systems and is the main system used by our call handlers. The OMS helps WPD prioritise and direct field crews to enable rapid restoration of supplies.

- **Reporting –** The reporting environment provides suites of reports for operational, management and regulatory purposes. The system is capable of producing reports that can be published online or sending data to external systems (e.g. live power cut map).

11.26. Over the course of RIIO-ED2, we have forecasted additional expenditure on Operational IT in the following areas:

- Network management and control systems as a result of the requirement to expand and develop our DSO capabilities.

- Sensing and monitoring equipment fitted on the network as a result of, and to facilitate, the requirement to expand and develop our DSO capabilities. This is critical to the successful operation of new DSO systems and processes which require good quality, reliable and timely data relating to the demand on the network.

11.27. Figure SA-06. 215 summarises how much will be spent on Operational IT over RIIO-ED2.

Operational IT					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	3	3	1	2	**9**
RIIO-ED2 Annual Average (forecast)	8	11	6	9	**33**
RIIO-ED2 Total (5 years)	40	53	30	43	**166**

Figure SA-06. 215: RIIO-ED2 forecast expenditure - operational IT

11.28. Our expenditure forecasts show that we will invest £166m over the course of RIIO-ED2, an increase on the average spend per annum of 273% compared to RIIO-ED1.

11.29. Further details of specific systems and projects driving RIIO-ED2 costs are detailed below.

Operational control systems

11.30. WPD's core network management system will require continued investment and improvement in RIIO-ED2 to ensure it continues to align with the changing electricity landscape, providing high system availability and the ability to exploit the latest product releases.

11.31. We are proposing a number of significant enhancements to existing control systems. Some of these will be enhancements to the existing applications and others will require development of new systems that will interact with the existing control systems. This will require changes to hardware as well as changes to the applications.

11.32. Additionally to support WPD's DSO transition and capability requirements, additional operational control systems investment will be required.

11.33. Further detail on WPD's DSO strategy can be found in Supplementary Annex SA-03 'Delivering a smart and flexible electricity network'.

11.34. WPD will deliver a range of projects during RIIO-ED2.

PowerOn Core IT server hardware refresh

11.35. The hardware used by our control system typically has a five year life. We refresh the hardware estate every five years; the last hardware refresh for our Control System was in 2018. The next is due in 2023, with another due in 2028 during RIIO-ED2.

11.36. See EJP076 for additional detail and justification.

PowerOn application enhancements

11.37. PowerOn is continually enhanced to ensure it remains capable of delivering outstanding network performance. Expenditure will support emerging needs and enhanced functionality.

11.38. There are a range of PowerOn enhancement projects that will be implemented during the ED2 price control. Some of these enhancements are already known, whereas others will emerge as additional functionality requirements are identified.

11.39. See EJP077 for additional detail and justification.

Technology refresh of early ANM systems

11.40. Active Network Management (ANM) provides a low cost alternative for new connections to be made quickly and for a lower cost, avoiding the cost of reinforcement. These systems have been evolving since being trialled during DPCR5 and early implementations are installed on bespoke hardware, some of which is stand-alone.

11.41. WPD is rolling out ANM to all areas which calls for an enterprise-wide solution.

11.42. Also, while some of the ANM systems are linked into our control systems via an ICCP link, there is only simple ANM functionality available. There is a need to improve the integration with our control systems and ensure that all ANM schemes can communicate with the Network Management System.

11.43. It is proposed that there will be an Advanced Distribution Management System that will act as an orchestration layer sitting above and directing a number of systems. This will integrate with the Demand Side Response system, System Voltage Optimisation and the ANM systems to ensure that network actions are coordinated and conflicting sub-system requirements result in appropriately balanced actions.

11.44. See EJP084 for additional detail and justification.

Distributed Energy Resource Management system (DERMs) hardware

11.45. During RIIO-ED2, we are expecting increased requirements for existing applications as communication expands to more devices on the network. We also expect an expansion of the range of different applications that will require to interface to the NMS to support further real time analytics, optimisation and control.

11.46. At present, these applications perform certain functions (such as demand side response) or collect specific data (such as cable low pressure alarms and earth fault indicator alarms) and link to the NMS via a system called ihost. As the current installation of ihost has limited capability, new hardware is required for the NMS related applications.

11.47. We propose to use more powerful hardware to consolidate a range of existing separate servers onto a single platform. The new hardware will use a process of virtualisation to allocate memory and processing capability from the main server to individual applications. This will enable greater flexibility for the applications, because more memory and processing can be easily provided as it is required. It will also support both Linux and Windows applications, enabling a larger range of applications to be interfaced to the NMS.

11.48. See EJP085 for additional detail and justification

Homogenisation of our control systems

11.49. WPD operates a network management system across all four licence areas. However, the nomenclature and symbols used differ, due to legacy approaches being retained during previous company acquisitions.

11.50. These differences limit the ability of staff who are familiar with a specific system in one licence area to work on the systems in other areas.

11.51. This project proposes to homogenise the diagrammatical representations, operating processes and data structures between the systems by redesigning the application and database architecture. This will provide three main benefits:

- Greater staff flexibility, giving better coverage between control rooms (especially during storm situations) and opportunities for efficiencies through changing working arrangements.
- Greater efficiency with the simplification of technical support, with standardisation meaning that upgrades or patches need only be tested once, rather than numerous times for each instance.
- Common data architecture for interoperability, allowing easier import and export capability which is currently made difficult by having four different data structures.

11.52. See EJP087 for additional detail and justification.

Time Series Data Store (TSDS) enhancements

11.53. WPD's Time Series Data Store (TSDS) module has the ability to store operational data taken from other modules such as the Network Management System. The way that data is stored within TSDS enables rapid access to operational data at a granular level of detail. This gives control engineers quick access to the data and enables automated processes to operate quickly.

11.54. As new functionality is required for operating the network (e.g. growth in LV monitoring), there will be a need to make incremental enhancements to the TSDS system.

11.55. The architecture of the TSDS is not suited to extracting or analysing large amounts of data over many years for investment purposes. These functions are being implemented in a separate data historian.

11.56. See EJP101 for additional detail and justification.

Control systems technology support

11.57. To ensure WPD's network management system operates efficiently and effectively on a daily basis and to ensure future business requirements are met, WPD deploys a technology support team. This support will be critical for the continued operation in RIIO-ED2.

11.58. This team supports the systems which are used by our control room, dispatch, local offices and our field staff. The main systems we supported include GE ADMS (PowerOn), PowerOn Mobile, iHost, and Kelvatek.

Replacing and growth of Remote Terminal Units (RTUs)

11.59. RTUs are microprocessor devices installed at substations to collect data from transducers that are fitted to substation equipment, enabling the data to be communicated back to control systems. As electronic devices, RTUs have a relatively short life compared to the electricity network assets.

11.60. During RIIO-ED2, we propose to modernise 1897 substation RTUs that have reached the end of life.

11.61. Additionally, to enable the DSO transition, WPD has an ongoing programme of works to build and refurbish substations. These works are taking place in RIIO-ED1 with an average of 59 new RTUs installed each year in new or refurbished substations.

11.62. WPD will continue the building and refurbishment of substations in RIIO-ED2. We are planning works on 74 substations per year during this period. Without RTUs in a substation, WPD has no visibility or remote control of that substation. Accordingly, these substations works will require installation of RTUs.

11.63. RTU devices will be an Internet Protocol (IP) enabled RTU, providing enhanced two way data traffic that will increase system monitoring capability and allow remote administration of system upgrades. The IP-enabled RTU will also be 'plug and play' ready for the next generation of IP-enabled switchgear and production relays.

11.64. RTUs will be installed with Intrusion Protection Systems (IPS) for telecommunications to ensure cyber resilience. Details and costs are included in the below Cyber Resilience section.

11.65. See EJP035 and EJP037 for additional detail and justification.

System Voltage Optimisation rollout (SVO)

11.66. The technique of System Voltage Optimisation (SVO) was initially developed as part of WPD's Low Carbon Network Fund Equilibrium project. It showed that capacity for generation and demand can be created by changing the voltage on the primary 33kV network. During the first three years of RIIO-ED2, the SVO system implemented as part of the LCNF project will be replaced with an enterprise scale platform which will be fully integrated with our Network Management System. This will allow the expansion of SVO to any area within WPD as required.

11.67. See EJP089 for additional detail and justification.

Demand Side Response (DSR) replacement and scaling up

11.68. Demand Side Response (DSR) is a new/enhanced customer facing system which will be used for WPD's Flexible Power arrangements including contracting, monitoring, dispatch and settlement.

11.69. It will be used for the dispatch of curtailment (for ANM) or other flexibility actions when authorised by the DSO control team. It will also take information from the DER, such as alerts or alarms which declare the DER unavailable; these will be passed through an interface to our Network Management System for immediate awareness to control engineers and for the proposed Future Network Viewer tool in our control systems to inform outage planning and near-future flexibility requirements.

11.70. This project is for the enhancement or replacement of the existing Kiwi Flexible Power Application Programming Interface platform with a system capable of managing more DER and having more functionality and features.

11.71. See EJP107 for additional detail and justification.

LV geo-schematic representation in PowerON

11.72. Our network management system currently does not incorporate visibility of the LV network.

11.73. This project will develop the schematics of each distribution substation and link the data to the HV layer in our control system. It will also provide the geo-schematic background to show how the LV network is interconnected.

11.74. Once in place, this will enable data about the LV network to be displayed to control engineers. This will include the information being directly monitored at distribution substations as well as pseudo analogues where monitoring has not yet been installed.

11.75. See EJP083 for additional detail and justification.

ICCP & visibility portal

11.76. This project relates to the development of an enterprise scale Inter-Control Centre Communications Protocol (ICCP) and visibility portal required for data sharing with ESO and other market participants.

11.77. We expect that some of these links will use ICCP, an international standard for control systems enabling data transfer capability between control centres for different organisations.

11.78. Organisations which require less inter-operability will make use of our third party integration data digitalisation platform.

11.79. See EJP086 for additional detail and justification.

Development of Future Network Viewer (FNV) forecasting system

11.80. A prototype tool for looking at the state of the network in the future was developed under the Electricity Forecasting and Flexibility System (EFFS) innovation project.

11.81. The Future Network Viewer project will implement an enterprise-wide system that will give visibility of the network configuration and operation for up to a year in the future. This will

provide short term information about upcoming outages, as well as a slightly longer term view of network requirements to accommodate known future work activity or availability of DER.

11.82. See EJP088 for additional detail and justification.

11.83. Figure SA-06. 216 details spend by project/activity over RIIO-ED2.

Operational Control Systems					
	West Midlands	East Midlands	South Wales	South West	WPD Total
[redacted]					

Figure SA-06. 216: Operational control systems expenditure by project / activity in RIIO-ED2

Sensors and monitoring

11.84. In July 2021, WPD published a Sensors and Measurement Strategy, which identifies the monitoring requirements to be able to develop smart networks, improve network design and improve network security.

11.85. Critical to the successful operation of these new systems is good quality, reliable, and timely data relating to the state of the network. The achievement of this depends upon a significant amount of work to upgrade WPD's data acquisition capabilities.

11.86. WPD will significantly increase and enhance sensing and monitoring on the distribution network during RIIO ED2.

11.87. Further detail on WPD's DSO strategy can be found in Supplementary Annex SA-03 'Delivering a smart and flexible electricity network'.

11.88. WPD will deliver a range of projects/activities during RIIO-ED2.

LV monitoring (Open LV)

11.89. Installing LV monitoring devices will improve the quality and increase the quantity of data that which we can share with our community and commercial organisations. Data visibility creates opportunity for all. Making data available to new market players, innovators, academics, and communities will stimulate new business models, new system management tools and new insights which can drive positive transformation for all network users. We identified through the Open LV Project that communities and commercial organisations were able to leverage value at a local level from the information provided

11.90. Emerging technologies such as LCTs and solar panels are becoming more prevalent on our network. This means that monitoring at LV will increasingly be required to understand the network's response to these changes.

11.91. With the increasing adoption of LCTs within communities, it is vital WPD helps accommodate this uptake. By improving LV monitoring capabilities, we will be able to collect and provide more granular data to local communities. This will enable a better understanding of the capacity of our network and in turn allow for long-term planning with respect to LCTs.

11.92. See EJP109 for additional detail and justification.

11.93. We anticipate that the improved and more accurate data will enable better management of reinforcement activity, allowing some to be deferred. Deferral of £87 million of reinforcement has been included in the Business Plan.

LV network monitoring

11.94. Domestic customers are increasingly adopting low carbon technologies (LCTs) such as rooftop solar panels, electric vehicles, and heat pumps. Electric vehicles, in particular, have the potential to add very large levels of demand coincident with existing periods of maximum demand. Our forecasts for the adoption of Low Carbon Technologies predict that up to 25,000 distribution substations could exceed their demand capacity by the end of the RIIO-ED2 period. This level of demand growth will lead to a requirement for reinforcement of the LV network, but opportunities should be taken to verify the requirement and prioritise the work. Based on our existing knowledge of heavily loaded circuits alongside analysis of smart meter data, we have identified the 15,500 highest priority substations to be fitted with monitoring equipment during RIIO-ED2.

11.95. Traditionally, there has been very limited monitoring of the LV network with, at best, very basic maximum demand indictors being used that were read manually during substation inspections. During RIIO-ED1, WPD has started to install additional monitoring for LV networks to better understand load profiles and gather information.

11.96. Monitoring at LV will provide greater visibility of the loads, allowing proactive measures to be taken in real time and providing a more accurate view of reinforcement requirements, deferring the requirement at some sites. It will also provide verification of modelled information, enabling improvements to the modelling assumptions.

11.97. See EJP110 for additional detail and justification.

Distributed Energy Resource (DER) SCADA monitors

11.98. Traditionally, distributed energy resources (DER) were allowed to connect without a need for remote monitoring and control because the network was passive in its design. As more DER has connected to the network and the management of the network becomes more active, there is a need for improved visibility of the operating regime of DER.

11.99. During RIIO-ED1, WPD commenced a programme of retro-fitting telemetry to customer points of connection where significant distributed generation or other flexible distributed energy resources (DER) are located.

11.100. Additionally, following the low frequency event of 9 August 2019, and subsequent BEIS investigation, there is a requirement for telemetry and control to be fitted to all significant (>200kW) DER. This programme has now begun and, during RIIO-ED1, will address 132kV,

66kV and 33kV connected DER along with locations where there are clusters of 11kV distributed generation.

11.101. WPD estimate there will be over 1000 DER installations, of which the majority are associated with smaller 11kV DER, where the work will be delivered during RIIO-ED2.

11.102. See EJP082 for additional detail and justification.

11.103. Figure SA-06. 217 details spend by project/activity over RIIO-ED2.

Sensors and Monitoring					
	West Midlands	East Midlands	South Wales	South West	WPD Total

Figure SA-06. 217: Sensors and monitoring expenditure by project / activity in RIIO-ED2

Non Operational IT costs

11.104. WPD also requires investment in systems and equipment not primarily used in the real time management of network assets. These include IT hardware, infrastructure and application software developments, inclusive of initial costs relating to IT security and cyber resilience.

11.105. Over the course of RIIO-ED2, we have forecasted new expenditure within non operational IT associated to hardware and infrastructure costs and application software development costs to support the continued development of our DSO capabilities which includes data and digitalisation and network analysis requirements.

11.106. Expenditure has also been forecast associated to the replacement, and/ or enhancement, of the existing IT infrastructure and devices, as part of the ongoing 'business as usual' asset replacement refresh cycle programmes.

11.107. Figure SA-06. 218 summarises how much will be spent on non operational IT over RIIO-ED2.

Non Operational IT					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	5	5	3	5	**17**
RIIO-ED2 Annual Average (forecast)	10	10	5	9	**35**
RIIO-ED2 Total (5 years)	52	52	26	43	**173**

Figure SA-06. 218: RIIO-ED2 forecast expenditure - non operational IT

11.108. Our expenditure forecasts show that we will invest £173m over the course of RIIO-ED2, an increase on the average spend per annum of 101% compared to RIIO-ED1.

11.109. Further detail of specific projects and activities driving RIIO-ED2 costs are detailed below.

Operational control systems

11.110. In order to support WPD's DSO transition and capabilities requirements, additional IT systems investment will be required.

11.111. WPD will deliver the below project/activity during RIIO-ED2.

Hardware for DSO systems

11.112. To support new DSO systems, there will need to be further investment in servers and other peripheral hardware to ensure fit for purpose, high system availability and the ability to exploit the latest product releases.

11.113. See EJP108 for additional detail and justification.

11.114. Figure SA-06. 219 details spend by project/activity over RIIO-ED2.

Control Systems					
	West Midlands	East Midlands	South Wales	South West	WPD Total
Hardware for DSO systems	1	1	1	1	**4**
TOTAL	**1**	**1**	**1**	**1**	**4**

Figure SA-06. 219: Operational control systems expenditure by project / activity in RIIO-ED2

Network analysis for DSO

11.115. Traditionally, DNOs have analysed and planned the network against a set of relatively certain external parameters such as future load growth. A DNO would develop an infrastructure solution based on these requirements. However, the range of scenarios for future growth of electric vehicles, heat pumps and distributed energy resources means that there is a requirement to carry out multiple sets of network analysis against the range of future energy scenarios.

11.116. The DSO has a suite of smarter or flexibility-based solutions which could be used instead of, or in conjunction with, traditional grid infrastructure upgrades. This kind of optioneering and optimisation will be supported in RIIO-ED2 by a new set of IT hardware and applications.

11.117. WPD will deliver a range of projects/activities during RIIO-ED2.

Strategic analysis and investment planning software

11.118. This expenditure relates to the automated analysis of large areas of networks for combinations of loading scenarios, faults and planned outages. The behaviour of load management schemes, such as ANM and DSR, will be taken into account.

11.119. As the complexity of our network and the interaction between load management schemes and other automation grows, it becomes increasingly impractical to study network behaviour by traditional manual methods. Automation will enable our engineers to spend more time on detailed design work instead of crunching numbers.

11.120. Our existing automated analysis techniques will be extended to cover new types of load management scheme, customer behaviour and network equipment. These will be rolled out to more engineers to enable automatic analysis to be used in more situations including closer to real-time operations.

11.121. Benefits delivered include comprehensive and accurate assessment of networks for both engineering and commercial purposes. Outputs will be used to inform 'materiality headroom',

improving the accuracy of data included in our published maps of network constraints and headroom.

11.122. See EJP102 for additional detail and justification.

Stability analysis

11.123. Stability analysis is the detailed analysis of the behaviour of electricity networks over short timescales following disturbances, such as faults.

11.124. As we increase the utilisation of our network through load management schemes such as ANM and DSR the ability of our network to respond correctly to faults and then recover normal operation may no longer be presumed, even though fault infeeds from the transmission system are expected to fall. Stability analysis will allow us to identify instances of these problems, and test potential solutions such as reactive compensation.

11.125. We will purchase licences for the dynamic and stability analysis routines of our EHV network analysis software, as well as taking advantage of training courses from the software provider. Tools and techniques for modelling the dynamic characteristics of our network and our customers' equipment will be developed and implemented.

11.126. This will help us to identify and plan mitigation for stability issues before they occur in real life, avoiding CIs, CMLs and plant damage.

11.127. See EJP103 for additional detail and justification.

Distribution Future Energy Scenarios (DFES) data architecture and systems

11.128. Distribution future energy scenario work completed by WPD uses data from local authority and other key stakeholders in the local energy transition, supplements it with market information on technology rollout and allows national energy system predictions to be regionalised, informing WPD investment plans.

11.129. As the importance of this data increases within the business, and our desire to share this information grows, a productionised data architecture needs to be adopted to ensure the information is stored securely, accurately and accessibly. Electricity distribution licence condition changes require DFES-style analysis to be used as part of the Network Development Plan, requiring data transparency.

11.130. Improvements in the existing DFES data architecture and systems allows for more bespoke reporting of DFES-related data for end users in the business and external stakeholders. As part of the suite to develop representative customer behaviour modelling for power and energy analysis (part of the DFES process but also related to customer behaviour project below), further computing hardware infrastructure and systems to store and analyse time series data may be required.

11.131. This will deliver the improved ability to provide data to internal and external stakeholders and improve the accuracy of medium to long term forecasting.

11.132. See EJP104 for additional detail and justification.

System architecture for secondary trading of flexibility services

11.133. Current DSO flexibility services create contracts between the DSO and the counterparty with limited flexibility on which assets provide the service. This work would facilitate secondary trading of the contracted obligations potentially allowing for more optimal outcomes, while also reducing the risk borne by providers.

11.134. To facilitate secondary trading, new systems are needed to ensure that each new provider of the obligation has the technical capabilities to deliver on them. This must be done simply, to avoid high transaction costs, but also reliably as the obligations are needed to help secure the network.

11.135. A platform will be developed to facilitate secondary markets. This will validate third party trades, and interact with internal operational systems to ensure we maintain visibility and control of the service obligation.

11.136. The systems will deliver the capability to deliver secondary trading of DSO flexibility services, while ensuring network reliability and operational resilience. Functioning, liquid secondary markets should reduce risk and therefore costs for both buyers and sellers of flexibility services.

11.137. See EJP105 for additional detail and justification.

Demand disaggregation, consumer behaviour and flexibility

11.138. Currently, HV and EHV demand and generation customer behaviour is normally assessed at an aggregated level. There is a limited breakdown of the constituent customer assets and their associated behaviour. This work would build a disaggregated view of existing customer behaviour to enable more accurate forecasting of future changes in behaviour; this includes flexibility and DSR.

11.139. We will collate and analyse available data to determine existing customer behaviour. This will be broken down into the necessary technology and sub-technology categories to improve forecasting accuracy. Models and assumptions for each category will need to be created and periodically updated to include the latest available data. These models will include the impact of electric vehicles, heat pumps and flexibility.

11.140. Developing processes to understand and quantify expected behaviour of customers will improve shorter and longer term forecasting accuracy.

11.141. See EJP106 for additional detail and justification.

11.142. The below table details spend by project/activity over RIIO-ED2.

Network Analysis for DSO					
	West Midlands	East Midlands	South Wales	South West	WPD Total
Strategic analysis and investment planning software	2	2	1	2	**6**
Stability analysis	1	1	0	1	**3**
Distribution Future Energy Scenarios (DFES) data architecture and systems	1	1	1	1	**4**
System architecture for secondary trading of flexibility services	1	1	0	1	**3**
Demand disaggregation, consumer Behaviour & flexibility	2	2	1	1	**5**
TOTAL	**6**	**6**	**3**	**5**	**22**

Figure SA-06. 220: Network analysis for DSO expenditure by project / activity in RIIO-ED2

Data and digitalisation

11.143. Our digitalisation activity is driven by our commitment to create a smarter energy system that embraces our vison of the role data and digitalisation can play in transforming our business and delivering net zero for our customers and stakeholders.

11.144. For us, the term digitalisation means using digital technologies to fundamentally change how we develop and operate the network to deliver an economic and efficient service for customers.

11.145. WPD is a leading advocate of the benefits available to customers from opening energy data. During RIIO-ED1, our innovation programme has shown how data can be used to drive better use of network capacity, for example, through the publication of flexibility needs and out work with energy communities. Modern IT solutions, such as cloud computing and web services, have the potential to reduce the cost of running our own business, as well as making it easier to optimise across the whole energy system through secure sharing of information.

11.146. Our digitalisation activity will be delivered across three core pillars, which have been developed through ongoing internal and external stakeholder engagement, of improved data management, increased network insight and operation and delivering for stakeholders.

11.147. This focus will enable us to work towards delivering the key recommendations of the Energy Data Taskforce report. We will continue to work to these recommendations to ensure systems, solutions and data are developed in a way that maximises their value, benefit and longevity

11.148. To support the transition to a fully digitalised organisation, we will rationalise and modernise our systems. This will include replacing and upgrading legacy applications, embracing and investing in new technologies, integration tools and common data platforms presumed open data.

11.149. Further detail on WPD's digitalisation strategy can be found in Supplementary Annex SA-03 'Delivering a smart and flexible electricity network'.

11.150. WPD will deliver a range of projects/activities during RIIO-ED2.

Low Voltage connected data

11.151. During ED1, WPD is developing an Integrated Network Model (INM) for EHV and HV assets. The INM connects directly to our three main systems: the enterprise asset management system (CROWN), network management system (PowerON) and geospatial information system (Electric Office). The model identifies discrepancies in data between these systems and, through an automated process, creates a single version of our network, the assets and connectivity.

11.152. Building on the EHV and HV INM, development the LV INM will be required during ED2 to implement advanced LV modelling approaches and facilitate direct LV data provision routinely to customers and interested third parties. This will also enable the automation of appropriate data for external applications such as self-service LV design tools and dynamic capacity maps.

11.153. See EJP093 for additional detail and justification.

Internal data platform

11.154. During RIIO-ED1, WPD is developing a data catalogue to document the types of data held within systems.

11.155. This project, which is an extension to the data catalogue, will create a central WPD data platform that will be a single location for WPD data and external data used by WPD staff. This will ensure a single source of the truth and drive value from this data.

11.156. This covers both WPD created data sets and third party externally provided data sets (such as weather forecast, local area planning proposals, etc.) that support existing or future decisions.

11.157. It is anticipated that efficiency benefits will be derived by minimising the time and effort spent collating data from different sources to facilitate tasks, such as network design, maintenance and operational activities.

11.158. See EJP094 for additional detail and justification.

Machine learning applications and data analytic services

11.159. As the operation of distribution networks becomes more complex, more automated processes will be required. The adoption of AI and machine learning techniques is anticipated to drive value from data platforms.

11.160. See EJP091 for additional detail and justification.

Open Cloud data platform

11.161. WPD recognises that providing customers with access to data will provide the opportunity for new processes, services and network activities to be developed.

11.162. This project will develop and implement an open data platform, enabling customers to access raw data or WPD processed data. It will also have the functionality for customers to develop their own specific data sets from disparate data sources using data dictionary information.

11.163. The platform will include the functionality for direct Application Programming Interfaces (API) for customers, other DNOs, National Grid and other third parties. The API facilitates automation for users pulling data without the need for manual intervention and can be specified to operate on a routine basis, in real-time, hourly, weekly etc. (machine-to-machine).

11.164. See EJP096 for additional detail and justification.

Self-serve connections

11.165. WPD has been facilitating increased competition in connections, working with customers and third party providers to make it easier for others to assess whether connections can be made.

11.166. This solution would utilise the data within the open platform to facilitate self-serve connections on at least the LV and HV networks, enabling:

- Individuals or third parties to be able to generate budget and firm quotes for demand and generation new connections, diversions and alterations.
- Optimised locations for connections to be derived over a particular region, for example community or local authority level.
- Optioneer output to provide information of maximum and minimum capacity availability.
- Customers to be provided with options for services associated with existing and proposed connection and associated costs / benefits.

11.167. See EJP090 for additional detail and justification.

Data mastering solution

11.168. Data improvements enable better and more accurate decisions to be made.

11.169. This system is proposed to develop automated data improvements. It builds on manual and semi-automated data mastering, such as the INM system, to continuously and autonomously improve the data within internal master data systems.

11.170. As an example, if data for an asset is found to be missing from the master data system, the automated data mastering solution will identify whether the data is available in other systems and automatically update the master system. The system would use machine learning to identify whether the value being proposed for the missing data is a reasonable and reliable data value.

11.171. See EJP098 for additional detail and justification.

Innovation Hub

11.172. The Innovation Hub is an online facility to drive innovation.

11.173. Throughout ED2, innovation projects, trials and new analysis will generate a significant number of beta data sets from a variety of internal and external sources, such as our continuing innovation programme, artificial learning developed output and third party data sets utilising our data as their source. Enabling access to this new data externally through the Innovation Hub will allow other innovators to take the data and drive additional innovation by building on it.

11.174. The Innovation Hub will allow the sharing of little-understood and unstructured data for further investigation and analysis. It will also be used to share work in an open format so multiple organisations can input and collaborate.

11.175. The benefits will include the facility for collaborative working on data science challenges.

11.176. See EJP095 for additional detail and justification.

Online work schedule viewer

11.177. Third parties want to understand when WPD will be carrying out work to help them coordinate works or understand network improvements and to enable them to make informed decisions about their own investments.

11.178. This online viewer would provide customers, stakeholders and other utilities information about WPD's planned work.

11.179. See EJP097 for additional detail and justification.

Work scheduling management solution

11.180. As more data about the network is collected and machine learning/artificial intelligence methods improve, there is an opportunity for automatic scheduling of work activity based on the results of the automated analysis. Initially, this automation could be rules-based but, as more data is analysed, the machine learning can be used to refine the decision parameters.

11.181. Separate functionality would also be provided to extend the value of the self-serve connections solution to include the booking of available work slots, which in turn would link to WPD's workforce management system.

11.182. See EJP099 for additional detail and justification.

Data historian

11.183. Currently, data used for network planning purposes is held within a data-logger, which stores half-hourly load readings for HV feeders and some half hourly metering data. The growth in availability of different types of data requires more storage capability, along with an enhanced capability to interrogate the different sources of information.

11.184. The data historian will be an implementation of a specific database and tools for time series network data obtained from the network management system and other data such as smart metering data obtained via the Data Communications Company Adaptor. The historian will be integrated with various network analysis applications to improve the robustness of longer term network planning.

11.185. See EJP101 for additional detail and justification.

Planning state estimation

11.186. State estimation is used to provide a view of the network configuration and operational status, informed by a set of measurements and data. Within a planning context, it is used to determine representative characteristics of the network to allow network planning and development decisions to be made.

11.187. Increased network monitoring and new sources of data mean that there is greater scope to improve state estimation for planning purposes and also that various data sources can be used to cross-check each other and identify data anomalies.

11.188. This project this will seek to merge the data streams from more accurate real-time monitoring, current and historical network configuration topologies and alternative sources of network data to improve state estimation in network planning.

11.189. Inconsistencies, errors and inaccuracies can be identified through state estimation modelling and fed back into the core systems to improve data quality.

11.190. See EJP092 for additional detail and justification.

Smart meter data for planning operation

11.191. As more smart meters are installed, there is scope to use the information to improve assumptions about load profiles and usage patterns. The smart meter data will help to refine the usage profile templates that are currently used for network planning considerations.

11.192. While the data will be provided at LV, it can also be used to inform assumptions about HV and EHV behaviour. In particular, it can be used to confirm/refine HV level data at substations by aggregating the LV information. For example, it can be used to show the impact of embedded distributed generation on network demands along a HV feeder.

11.193. Various different analytical approaches will be adopted including data aggregation, statistical analysis, machine learning and Artificial Intelligence (AI) technology to inform better assumptions about demand profiles. These actions will be carried out in accordance with WPD's Smart Meter Data Privacy plan.

11.194. See EJP100 for additional detail and justification.

11.195. Figure SA-06. 221 details spend by project/activity over RIIO-ED2.

Data and Digitalisation					
	West Midlands	East Midlands	South Wales	South West	WPD Total
Low Voltage connected data	3	3	2	3	**10**
Internal data platform	0	0	0	0	**1**
Machine learning applications and data analytic services	2	2	1	1	**5**
Open cloud data platform	1	1	0	1	**3**
Self-serve connections	1	1	0	1	**3**
Data mastering solution	0	0	0	0	**2**
Innovation hub	0	0	0	0	**1**
Online work schedule viewer	0	0	0	0	**1**
Work scheduling management solution	1	1	0	1	**2**
Data historian	1	1	0	1	**3**
Planning state estimation	1	1	1	1	**4**
Smart meter data for planning operation	1	1	0	1	**2**
TOTAL	**10**	**10**	**5**	**9**	**35**

Figure SA-06. 221: Data and digitalisation expenditure by project / activity in RIIO-ED2

Information Resource (IR)

11.196. In addition to delivering additional RIIO-ED2 strategy initiatives, non-operational business activities (together with user numbers, locations and service levels) determine non-operational IT&T costs and investment requirements.

11.197. The core function of the IT department is to support and enhance the delivery of business work programmes by providing highly secure, cost effective, reliable and resilient systems that are aligned with business goals and the delivery of stakeholder commitments and customer expectations.

11.198. IT services and systems have to date been aligned to support the activities of a Distribution Network Operator (DNO), responsible for operating, maintaining and repairing the electricity network, providing a safe and reliable electricity service to eight million customers.

11.199. IT services within WPD are currently provided by various in-house teams. Application support for finance systems, mapping and the PowerOn Control systems are provided by business specific teams. All other application, server infrastructure and Local Area Network (LAN) support is provided by the IT department.

11.200. Operating an in-house IT delivery model that is closely aligned to business function enables WPD to quickly react to industry, regulatory or business change. It has also facilitated the development of WPD specific IT systems that support and are aligned to business processes. Other significant advantages of the in-house model include:

- Control of system upgrade cycles and outages windows i.e. system downtime.
- IT support staff are not only IT experts in the systems they support but they also have a high degree of business acumen.
- The same skilled resource supports the IT systems and users out of hours.
- WPD prioritises its IT resources as it chooses.
- WPD controls infrastructure and hardware specifications and the utilisation of any shared resources (storage, memory, CPU etc.).

- Maintaining and supporting our own in-house applications such as CROWN, WPD's enterprise resource planning (ERP) system, rather than using much more costly third party solutions.

11.201. This model of IT delivery has a proven track record of delivering cost effective, highly resilient, secure, fit for purpose IT services and solutions within WPD.

11.202. The IT department is structured into the following six service areas and provides the majority of IT services and support functions to the business through robust and well established business processes and systems and experienced knowledgeable staff:.

- IT management
- Application development and support
- Desktop computing
- Server and database hosting
- Voice and data networks
- Cyber security.

11.203. The function of the IT department is to provide the following high level activities for both new and existing systems.

- System design/architecture
- System development
- System installation/implementation
- System maintenance
- System support
- System security

11.204. The ongoing strategy for delivering IT systems into RIIO-ED2 and beyond is underpinned by five key IT principles as summarised in Figure SA-06. 222.

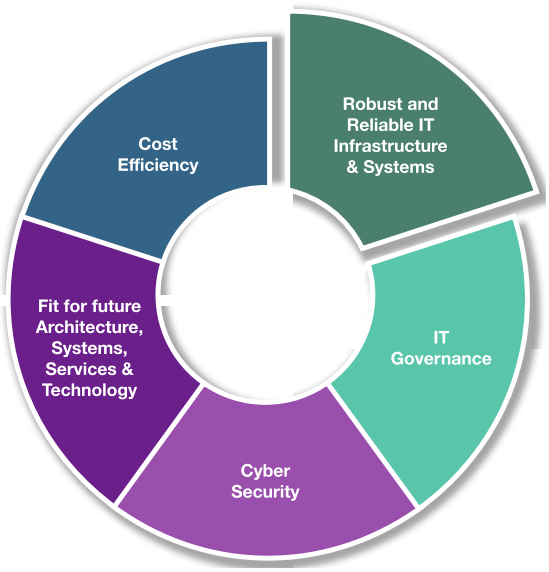


Figure SA-06. 222: Five key IT principles underpinning our ongoing strategy for delivering IT systems

11.205. The key IR investment drivers for RIIO-ED2 can be summarised as follows:

- New technologies and services to support business drivers.
- New technologies and services to support IT systems and processes.
- Replacement of end-of-life systems, hardware and devices.
- Leveraging enhanced capabilities from existing systems and infrastructure.
- Staying in the supported world.
- Cyber security across operational technology and information technology systems. See Supplementary Annex SA-02 'Our commitments' for further detail on our cyber plans.
- Increased resource to support new technologies and ways of working.

11.206. WPD will deliver a range of projects/activities during RIIO-ED2.

IT Network provision

11.207. ED2 expenditure will be required for technology refreshes (due to technology reaching end of life during ED2), upgrades and capacity requirements associated with:

Voice/data switches – WPD currently has 894 data switches and 559 voice switches, with the preference being to only purchase switches that have an expected support life cycle of at least seven years although this may not always be possible. Work programmes cover multiple years due to the associated volumes and the work required to refresh. Data switches associated cabling is also upgraded as part of planned refresh programs.

Firewalls – WPD currently has 142 firewalls, with the preference being to only purchase firewall models that have an expected support life cycle of at least seven years although this may not always be possible. Work programmes are multiyear programmes due to the associated volumes and the work required to refresh.

Voice and control room telephony refresh/upgrade programmes –

- Handset (eight year refresh cycle);
- Mediatrix (10 year refresh cycle);
- Core & primary site OSB/SBC hardware (five year refresh cycle);
- Secondary site OSB hardware (five year refresh cycle);
- Tertiary site OSB Hardware (five year refresh cycle);
- Production IPT node (three year refresh cycle);
- Dev IPT node (three year refresh cycle);
- Production OSCC (three year refresh cycle);
- Dev. OSCC (three year refresh cycle);
- Session Border Controller (SBC) (two year refresh cycle);
- Production Voice Recorder Application (three year refresh cycle); and
- Dev Voice Recorder Application (three year refresh cycle).

Voice and control room telephony new systems/technology implementations –

- SBC provision for SIP security per core and primary site
- SBC provision for SIP security per secondary and tertiary sites
- SIP security for homeworkers and licencing
- Homeworking SIP gateway provision for production
- Integration of SIP control telephony into OSV
- Replacement of ISDN at core and primary sites
- Replacement of ISDN at secondary and tertiary sites
- Replacement of ISDN with SIP per IVR (Prod & Dev)
- Replacement of control telephony system with SIP system
- Possible replacement of national 105 service provider

IT servers support/ services

11.208. During ED2, expenditure will be required for technology refresh, upgrades and growth/capacity requirements associated with:

- Virtualization/Intel hosting;
- Data storage/back-up (five year refresh cycle);
- IBM power hosting - (five year refresh cycle);
- Oracle/Microsoft/Middleware;
- PowerOn Environment (refresh cycle due in 2027/28); and
- Disaster Recovery (DR) data centre replacement with the proposed investment designed to ensure the continued safe and reliable operation of the network.

IT clients support/ services

11.209. During ED2, expenditure will be required due to technology refresh and capacity requirements associated with.

- PC/laptop refresh programs (four year refresh cycle);
- Printer refresh programmes (four year refresh cycle);
- Field tablet device refresh programmes (three year rolling refresh cycle); and
- Videoconferencing expansion and refresh programme.

IT environmental control systems

11.210. During ED2, expenditure will be required due to technology refresh requirements and includes:

- An air condition (A/C) refresh programme based on an eight-10 year refresh cycle dependent on manufacturing replacement part availability and condition. Five of WPD's data centres are due to have their A/C refreshed in RIIO-ED2.
- Uninterruptible Power Supplies (UPS) refresh programme based on an eight-10 year refresh cycle dependent on manufacturing replacement part availability and condition. A number of WPD server rooms and data centres UPS devices are due to be refreshed during RIIO-ED2.
- Motioning equipment refresh programme including cameras and climate monitors etc. with one refresh cycle planned in RIIO-ED2.

IT applications

11.211. Information Resources are required to support multiple WPD business system applications, all of which require ongoing investment and upgrades to maintain business efficiency and to ensure they are fit for purpose.

11.212. Applications include those associated with network services, finance, logistics teams in their day to day business operations, as well as the requirement to support web development to provide real-time data communications to the corporate website, various stakeholders and customers.

11.213. WPD currently utilises 372 IT applications to support the day-to-day operation of its business. These applications are mix of in-house developed and 3rd party provided applications and vary in size, complexity and criticality to the business. 267 of these IT applications are also supported in-house by various WPD teams.

11.214. Throughout RIIO-ED1, the majority of these IT applications have been subjected to numerous vendor driven upgrades, security and business driven enhancements. Key changes to

underlying IT technologies has also resulted in a significant amount of IT application change, such as the upgrade from Microsoft's Windows 7 Desktop Computing Operating System to Windows 10 Desktop Computing Operating System.

11.215. A significant number of the RIIO-ED2 business plan initiatives will require the further development of existing IT applications, development or purchase of new IT applications increasing existing workloads and expenditure in relation to the operation and support of business IT applications. Further upgrades in RIIO-ED2 of Desktop OS's and other underlying IT technologies (i.e. databases, middleware, etc.) will also have a similar impact on the number of IT application related changes and expenditure as RIIO-ED1. However, this will be supplemented by the increasing requirement for enhanced IT application related cyber security controls in RIIO-ED2.

11.216. Figure SA-06. 223 details spend by project/activity over RIIO-ED2.

Information Resources					
	West Midlands	East Midlands	South Wales	South West	WPD Total
IT network provision	4	4	2	4	**15**
IT servers support/ services	8	8	4	7	**27**
IT clients support/ services	8	8	4	7	**28**
IT environmental control systems	2	2	1	2	**6**
IT applications	11	11	6	9	**37**
TOTAL	**34**	**34**	**17**	**28**	**113**

Figure SA-06. 223: Information resources expenditure activity in RIIO-ED2

11.217. Additional detail and justifications on Information Resources expenditure can be found in EJP009 to EJP115.

Business support IT costs

11.218. WPD's Information Resources (IR) Department is responsible for both the management and the operating costs of all non-operational computer and telecommunications systems within WPD. This specifically includes purchasing, development, installation, security, support and maintenance of all IT infrastructure, applications and software.

11.219. Forecast expenditure has been built up by:

- Reviewing the base load historical spend and allowing for planned and expected growth.
- Identifying the business requirements for new IT systems and services.
- Identifying opportunities for making efficiency savings in the delivery of existing IT systems and services.
- Listening to stakeholders' requirements and expectations.
- Defining the 'fit for future' IT strategy.

11.220. Over the course of RIIO-ED2, we have forecasted additional expenditure on business support IT in the following areas:

- IR infrastructure hardware and software maintenance and support costs associated with the development of our DSO systems and capabilities.
- Business applications hardware and software maintenance costs associated with continued growth in applications.
- Headcount required to ensure the continued ability to meet the increasing demands for more complex and timely IT systems in a cost efficient and reliable manner.

11.221. Figure SA-06. 224 summarises how much will be spent on business support IT over RIIO-ED2.

Business Support IT					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	8	8	4	7	**27**
RIIO-ED2 Annual Average (forecast)	13	13	6	11	**42**
RIIO-ED2 Total (5 years)	64	63	32	53	**212**

Figure SA-06. 224: RIIO-ED2 forecast total expenditure - business support IT

11.222. Our expenditure forecasts show that we will invest £212m over the course of RIIO-ED2, an increase on the average spend per annum of 58% compared to RIIO-ED1.

11.223. Associated expenditure activities are detailed below.

Staff costs

11.224. Staff costs includes those associated with the following IR teams:

- IT management
- Application development and support
- Desktop computing
- Server and database hosting
- Voice and data networks

Cyber security staff costs are included in the cyber resilience expenditure section and therefore excluded from this section.

11.225. Staff costs include an increase to headcount (x36) to ensure the continued ability to meet the increasing demands for more complex and timely IT systems in a cost efficient and reliable manner.

IR infrastructure

11.226. IR infrastructure costs includes the day to day hardware and software maintenance and support requirements of WPD. Infrastructure costs are forecast to increase as we transition towards RIIO-ED2 as a result of increasing data storage requirements, vendor changes to licensing models and growth/business expectation for more computer processing power/performance.

11.227. This also includes DSO hardware and software maintenance and support which is expected to increase as we continue to develop our DSO infrastructure and capabilities.

Business applications

11.228. Business applications costs include licensing, support and maintenance for applications used by the business. WPD expects continued growth in business application and subsequently application vendor support costs throughout ED2.

PowerOn applications

11.229. PowerOn application costs include licensing, support and maintenance associated with the PowerOn suite of applications. WPD expects increasing costs associated to the additional functionality planned throughout ED2.

Business telephony

11.230. Business telephony costs include employee home telephone and broadband allowances as well as mobile usage and rental expenditure.

Network provision

11.231. Network provision includes IP telephony costs, ISDN costs, contact centre voice systems and business telemetry and protection costs. Costs are expected to increase as we transition to RIIO-ED2 due to increasing WAN bandwidth (BT) driven by data and system requirements.

11.232. Figure SA-06. 225 details spend by activities over RIIO-ED2.

	West Midlands	East Midlands	South Wales	South West	WPD Total
Staff costs	21	20	10	17	**68**
IR infrastructure	13	13	7	11	**44**
Business application	12	12	6	10	**39**
PowerOn application	5	5	3	4	**17**
Business telephony	3	3	2	3	**10**
Network provision	6	6	3	5	**19**
Other business IT allocated costs	4	4	2	4	**14**
TOTAL	**64**	**63**	**32**	**53**	**212**

Figure SA-06. 225: Business support IT expenditure by activity

Telecoms expenditure

11.233. WPD operates an extensive in-house telecoms network that delivers inter-office data communications, mobile voice communications and supervisory control and data acquisition (SCADA) between electricity assets and our control centres across WPD's four licence areas.

11.234. The WPD-owned and operated approach has proven to be cyber secure and highly reliable compared to services offered by third party telecoms providers.

11.235. The ongoing strategy for delivering telecoms systems into RIIO-ED2 and beyond is underpinned by the following principles;

- Reliability, resilience and availability
- Security
- 'Fit for future'
- Cost effective
- Governance

11.236. Telecoms and control and monitoring technology within the electricity industry has experienced minimal change over the last 20 years.

11.237. The focus has been on customer service to ensure customer minutes lost and customer interruptions are minimised through effective control and monitoring of higher voltage networks. However, the electricity industry is facing huge technological changes as a result of increased monitoring to support its DSO transition, as well as supporting low carbon technology with digital strategies that will gather increasing volumes of data from our connected assets across all voltage levels.

11.238. Our objective is to start meeting these increasing demands of the future during ED1 while maintaining our excellent standards of reliability, in terms of resilience to power failure and cyber risk. This means keeping the lights on or getting them back on swiftly, not only in normal circumstances, but also during any high impact, low probability events.

11.239. The WPD telecoms infrastructure must therefore be reinforced and expanded to meet these demands while also playing an important role in our net zero commitments. To this end, we want to be able to carry out more activities remotely, including patch updates, network switching, protection setting application and monitoring, without using field staff to travel to our remotely placed assets or adding additional vehicle congestion to towns and cities in our licence areas. This will move us towards the energy network of the future supported by a resilient, reliable and cyber secure telecoms network.

11.240. Further detail on WPD's Telecoms strategy can be found in Supplementary Annex SA-03 'Delivering a smart and flexible electricity network'.

11.241. We have also produced a Telecoms Strategy which is updated annually and available as a standalone document[10].

Operational telecoms costs

11.242. The operational telecoms submission focuses on future proofing the remote control and monitoring of our telecoms infrastructure alongside our evolving electricity network.

11.243. Figure SA-06. 226 summarises how much will be spent on operational telecoms over RIIO-ED2:

Operational Telecoms					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	2	2	1	2	**7**
RIIO-ED2 Annual Average (forecast)	2	3	2	3	**10**
RIIO-ED2 Total (5 years)	10	16	11	14	**51**

Figure SA-06. 226: RIIO-ED2 forecast total expenditure - operational telecoms

11.244. Our expenditure forecasts show that we will invest £51m over the course of RIIO-ED2, an increase on the average spend per annum of 53% compared to RIIO-ED1.

11.245. Further detail of specific projects/activities driving RIIO-ED2 costs are detailed below.

LTE network build and growth

11.246. We are proposing to modernise WPD's radio based telecoms system during RIIO-ED2

11.247. The existing radio telecoms system used for the control and monitoring of the electricity network is becoming restricted due to limitations caused by the number of connected assets and the small amount of throughput data it can handle.

11.248. The radio infrastructure for our future will be able to overcome these limitations and be scalable for future network growth and data demands, but will remain privately owned and maintained to ensure effectiveness in operation, be resilient to power failure and to be at the point of need i.e.

[10] https://www.westernpower.co.uk/smarter-networks/network-visibility-strategies

located at the site of the electricity assets, all aspects that are not provisioned by third party commercial telecoms operators.

11.249. The capability of the infrastructure is widely recognised and has led to a review of a modernised Long Term Evolution (LTE) radio system which is currently being conducted by OFCOM, with BEIS and OFGEM oversight. All UK gas and electricity network operators collectively agree that an LTE solution is urgently required to support net zero objectives. An LTE solution will have 100 times more capacity than the current radio system and will be quicker and more cost effective to deploy.

11.250. If regulatory consent is given, we propose to change WPD's radio based telecoms system to an LTE solution to enable improved, resilient and secure communication capability. This will overcome bandwidth constraints and be scalable for future network growth and data demands.

11.251. See EJP032 for additional detail and justification.

11.252. WPD are proposing this project under a bespoke Price Control Deliverable (PCD). Additional detail of this proposal is provided within Supplementary Annex SA-07 Managing uncertainty.

Automation communications equipment migration

11.253. There are a number of smaller RTUs installed on 11kV switchgear to assist in the monitoring and control of the electricity network. These devices use a different form of telecoms to report back into the Electricity Management System.

11.254. These telecoms make use of unlicensed frequencies between the RTU and base station. Other users are also permitted to use these frequencies which causes interference that results in loss of communications to the RTU. It is proposed to migrate the worst performing devices onto a new licenced network resulting in improved communications to the RTU.

11.255. See EJP033 for additional detail and justification.

Protection circuits communications equipment

11.256. Legacy telecoms equipment including Plesiochronous Digital Hierarchy (PDH) and Synchronous Digital Hierarchy (SDH) telecoms apparatus, along with other vintage bespoke items, will not support the modern IP requirements of future electricity network systems.

11.257. WPD's proposed replacement of these devices will seamlessly enable remote operations to continue but also manage the enhanced two-way data communicating to and from field-based assets.

11.258. See EJP034 for additional detail and justification.

11.259. Figure SA-06. 227 details spend by project/activity over RIIO-ED2.

Operational telecoms					
	West Midlands	East Midlands	South Wales	South West	WPD Total
LTE network build and growth	9	14	9	12	**44**
Automation communications equipment migration	1	2	1	1	**5**
Protection circuits communications equipment	0	0	0	0	**2**
TOTAL	**10**	**16**	**11**	**14**	**51**

Figure SA-06. 227: Operational telecoms expenditure by project / activity in RIIO-ED2

Non Operational telecoms costs

11.260. Non Operational telecoms focuses on the core telecoms infrastructure which supports control and monitoring assets (Operational IT&T).

11.261. Figure SA-06. 228 summarises how much will be spent on non operational telecoms over RIIO-ED2:

Non Operational Telecoms					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	2	2	1	1	**5**
RIIO-ED2 Annual Average (forecast)	3	4	5	4	**16**
RIIO-ED2 Total (5 years)	15	21	26	18	**79**

Figure SA-06. 228: RIIO-ED2 forecast total expenditure - non operational telecoms

11.262. Our expenditure forecasts show that we will invest £79m over the course of RIIO-ED2, an increase on the average spend per annum of 190% compared to RIIO-ED1.

11.263. Further detail of specific projects/activities driving RIIO-ED2 costs are detailed below.

New fibre deployment and refurbishment

11.264. WPD uses a combination of fibre optics and microwave for communications across our telecoms network. We will continue to use a combination of these but will increase the number of fibre optic installations, as these provide greater bandwidth.

11.265. WPD is proposing to expand the fibre optic network by taking advantage of outages and excavations for RIIO-ED2 planned overhead and underground asset replacement work.

11.266. This will enable new fibre connections to be made to strategic electricity assets. This work will be an efficient approach to extend and connect more fibre as an alternative to radio communications. This approach also affords a reduction in procured services from third party telecoms operators.

11.267. In addition, we manage a fibre network of 2,443km of overhead and underground fibre across our four licence areas. Fibre's unique properties, such as its reliability, security, speed, and scalability, make it the most effective communications medium to serve WPD's connectivity requirements.

11.268. Our fibre network is made up of a large number of interconnected overhead and underground fibre cables. Many of these assets are reaching their End of Life (EoL) or have been damaged over the years. Therefore, we have a rolling programme to refurbish parts of our network that are in the poorest condition.

11.269. See EJP018 and EJP019 for additional detail and justification.

Telecom sites

11.270. The expansion of data acquisition and control will require the construction of additional telecoms sites to enable communications coverage where this does not currently exist. This will include:

- New communication sites for fibre networks
- New radio communication sites

11.271. Some existing sites will be refurbished to modernise the associated plant for enhanced cyber security and resilience to power failure. This will include:

- Communication tower replacement and refurbishment
- Communication site building replacement and refurbishment

11.272. See EJP020 to EJP026 for additional detail and justifications.

Backhaul upgrades

11.273. WPD's backhaul communications network uses a mixture of microwave links and fibre that includes IP networks and firewalls.

11.274. Some devices on the network need to be upgraded because they are either no longer supported or require a cyber-security enhancement.

11.275. In other cases, extending the reach of the telecoms network will also require additional backhaul telecoms links to be installed.

11.276. See EJP029 to EJP031 for additional detail and justifications.

Readiness for the PSTN switch off

11.277. WPD currently use the BT Openreach Public Switched Telephone Network (PSTN) to provide fixed voice communications in our substations. These assets include fixed line handsets and connections for CCTV monitoring.

11.278. In 2025, the Openreach PSTN network will be switched off. This is part of the migration of services from traditional copper lines and onto fibre networks. The first phase of these works is migrating traditional voice services to Internet Protocol (IP) solutions; these are commonly referred to as Voice Over Internet Protocol (VOIP) services.

11.279. In WPD, there are currently 1,400 connections using the PSTN network, to provide fixed voice handsets in substations and broadband connections for CCTV monitoring. These connections must be replaced prior to the PSTN switch off in 2025.

11.280. See EJP036 for additional detail and justification.

11.281. Figure SA-06. 229 details spend by activity over RIIO-ED2.

Non Operational Telecoms					
	West Midlands	East Midlands	South Wales	South West	WPD Total
New fibre deployment	7	10	12	6	**34**
Fibre refurbishment	1	1	1	1	**4**
Telecoms sites	5	7	8	7	**27**
Backhaul upgrades	2	3	4	3	**11**
Readiness for the PSTN switch off	0	0	0	0	**1**
Other expenditure	0	0	0	0	**2**
TOTAL	**15**	**21**	**26**	**18**	**79**

Figure SA-06. 229: Non operational telecoms expenditure by project / activity in RIIO-ED2

Business support telecoms costs

11.282. During RIIO-ED2, the telecoms network will increase in size. Additional network monitoring and control equipment will also be installed during the remainder of RIIO-ED1, all of which will incur annual licences and annual support costs.

11.283. While there is a plan to reduce the amount of leased in fibre and sites, these extra costs will lead to an increase in the annual business support telecoms costs.

11.284. Stringent maintenance and replacement programmes will remain in place during RIIO-ED2 covering the fibre network, radio network and communications sites. Radio networks are maintained at least every two years. All sites are subject to six monthly maintenance visits, which cover site security, building integrity, fire safety, air conditioning, backup power (both battery and generator backed) and communication tower integrity. All maintenance tasks are subject to key performance indicators.

11.285. Figure SA-06. 230 summarises how much will be spent on business support telecoms over RIIO-ED2.

Business Support Telecoms					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	4	4	2	3	**14**
RIIO-ED2 Annual Average (forecast)	4	4	2	4	**14**
RIIO-ED2 Total (5 years)	22	22	11	18	**72**

Figure SA-06. 230: RIIO-ED2 forecast total expenditure - business support telecoms

11.286. Our expenditure forecasts show that we will invest £72m over the course of RIIO-ED2, an increase on average spend per annum of 7% compared to RIIO-ED1.

Cyber resilience expenditure

11.287. WPD's business operation is no longer solely that of a Distribution Network Operator (DNO), operating, maintaining and repairing the electricity network with the aim of keeping the lights on. RIIO-ED1 has seen the UK's electricity system undergo a rapid period of change as network customers invest in generation and alter consumption behaviours.

11.288. WPD's move to become a Distribution System Operator (DSO) calls for the development of more efficient and smarter networks to manage power flows across the distribution network.

11.289. As a result of the changing use of the electricity network, traditional IT boundaries between IT (corporate systems), OT (operational technology) and customer-owned devices are also changing to become more interconnected. This has led to an increase in the number of end-points (PCs, smart meters, Remote Terminal Units (RTUs), etc.) that WPD has to maintain and secure.

11.290. Continuing to deliver cyber secure, reliable and resilient Operational Technology (OT) systems and Information Technology (IT) systems is a key part of the RIIO-ED2 Business Plan.

- OT systems include technology that communicates and interfaces with business systems and physical assets and includes systems such as our communications system which allows us to interact remotely with sensors and monitors on the physical distribution network.

- IT systems are ‘business as usual’ computer and telecommunications systems and applications. Expenditure in this area ranges from purchasing new PCs to maintaining IT server equipment and communications equipment.

11.291. As reliance on IT systems and technology has increased, this has been matched by the growing volume and sophistication of cyber-attacks from exploiters such as Nation States, organised crime and hackers. This, in turn, has increased the risk of a possible future security breach to the electricity distribution network via its IT or OT systems. It is now more essential than ever that WPD protects its IT or OT systems and data from the threat of cyber-attacks which could cause significant network disruption together with associated financial and reputational damage. Detailed plans and processes are also required to be able to respond and recover in the event of a cyber-attack.

11.292. To assist DNOs, and protect customers from the threats posed by cyber-attacks, the Network and Information Systems (NIS) directive came into force in 2018. These directives and standards must be adhered to by operators of essential services and have resulted in a number of enhancements to the way WPD secures, maintains, supports and operates its IT systems.

11.293. WPD expects cyber security risks to continue to grow during the RIIO-ED2 period, resulting in not only ongoing changes to NIS regulations to introduce further improvement actions on access control, intrusion detection and attack recovery, but also changes in cyber stance

11.294. Our customers and stakeholders rightly place a strong emphasis on the resilience of our service. Our stakeholder workshops in 2020 and 2021 identified an increased interest and awareness in cyber security resilience. Stakeholders particularly asked for assurances that we would:

- Understand where your network may be vulnerable and work to put up barriers to prevent access.
- Ensure all systems, procedures, and processes are up to date.
- Keep up to date on emerging threats and hacking techniques.
- Increase your focus on network security to increase your resilience.
- Create, maintain, and test your incident recovery plans.
- Collaborate and work with third party experts, including those in government to identify threats.
- Share best practice with your partners and collaborate with other networks:

11.295. This has led to the inclusion of two core commitments within our RIIO-ED2 Business Plan.

- **Core Commitment 39** - Reduce the risk of data loss or network interruption from a cyber-attack by continually assessing emerging threats in order to enhance our cyber security systems.

- **Core Commitment 40** - Reduce the risk of disruption to our operations and enhance the resilience of our IT network security as we deliver greater digitalisation, by increasing levels of threat monitoring, prevention and alerting systems, and upgrading our disaster recovery capability to ensure continuity of operations. .

11.296. To meet the requirements of stakeholders and ensure that controls and processes are in place to mitigate the risk of any future possible cyber-attack, we have adopted the NIS directive as our benchmark standard along with cyber security principles.

11.297. To ensure continuous evolving NIS compliance and to manage the evolving IT cyber security risks, we plan to extend the size and scope of the existing cyber security team before the end of RIIO-ED1 and also include dedicated OT cyber security resource.

11.298. Figure SA-06. 231 reflect our cyber security principles.

Figure SA-06. 231: Our cyber security principles

11.299. Cyber initiatives planned for RIIO-ED2 across Operational Technology and Information Technology will focus on:

Identify

- Cyber risk management.
- Vulnerability management.
- Third party risk management.
- Performance management.

Protection

- Platform security.
- Network security.
- Identify and Access Management.
- Data protection.
- Training and awareness.

Detection

- Security monitoring.

Response & Recovery

- Respond and recover enhancements.

11.300. Forecast RIIO-ED2 expenditure associated to cyber resilience are factored across the three core IT&T cost categories as detailed in Figure SA-06. 232 to Figure SA-06. 234.

Cyber resilience - Operational IT & telecoms					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total

Figure SA-06. 232: Cyber resilience - operational IT & telecoms expenditure within RIIO ED2

Cyber resilience - Non operational IT & telecoms					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total

Figure SA-06. 233: Cyber resilience - non operational IT & telecoms expenditure within RIIO ED2

Cyber resilience - Business support IT & telecoms					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total

Figure SA-06. 234: Cyber resilience - business support IT & telecoms expenditure within RIIO ED2

11.301. However, as Ofgem requires DNOs to provide two separate cyber resilience plans, the following sections of this expenditure section has been aligned against:

- **A Cyber Resilience Operational Technology (OT) Plan** which is incremental expenditure focused primarily on OT, identifying the need for cyber OT improvements on a company's network when compared with the National Cyber Security Centre (NCSC) Cyber Assessment Framework outcomes, as well as compared with the company's own acceptable business risk tolerances.

- **A Cyber Resilience IT Plan** focused primarily on cyber resilience IT improvements on companies' networks.

11.302. Further detail on WPD's cyber resilience OT and IT plans can be found in Supplementary Annex SA-02 'Our commitments'.

Cyber resilience OT plan costs

11.303. Delivering cyber secure, reliable and resilient Operational Technology (OT) is a key requirement of the RIIO-ED2 Business Plan as networks become increasingly more digitised, interconnected and at risk of a cyber-security attack. This will be achieved through further investment in new OT systems and enhancement of our existing OT cyber security systems, controls and processes to specifically further align with the NCSC Cyber Assessment Framework (CAF) and to support our risk adverse approach to cyber security.

11.304. Operational technology communicates and interfaces with business systems and physical assets and includes systems such as our SCADA communications system which allows us to remotely interact with sensors and monitors on the physical distribution network.

11.305. WPD's approach to cyber security in RIIO-ED1 has been primarily focused on IT. Investment to date in OT cyber security controls has been proportionate to the OT cyber security attack risk and threat level has been perceived to be relatively low.

11.306. Publicised OT cyber-attacks, such as the 2016 Crashoverride attack against several Ukrainian power companies, raised the profile, understanding and the risk/threat level of OT cyber security attacks. This played a part in the implementation of the NIS directive, which has seen WPD place a greater emphasis on OT cyber security.

11.307. To ensure NIS compliance and to manage the evolving OT cyber security risks, WPD set up a dedicated cyber security team in 2019 and plans to extend this team further before the end of RIIO-ED1 to also include dedicated OT cyber security resource.

11.308. The work carried out to date by our cyber security team has initially focused on IT security but is now expanding to include more OT focused activities. A number of the initiatives planned or already in progress are set to be completed before the end of RIIO-ED1. The cyber security team is also working alongside Distribution System Operator function and the core IT team, as well as the telecoms team, to ensure a standardised common approach to cyber security is maintained within WPD.

11.309. In RIIO-ED2, WPD will migrate/upgrade existing OT systems, devices and services to new technologies where it is cost effective and beneficial to do so. Where this is not possible, we will use additional devices to interface to existing systems to perform the required cyber security functions.

11.310. As well as taking into account cost, resilience and reliability when implementing new technology delivery platforms, it is also critical to consider security and risk appetite. WPD uses a model which rates risk, based on a set of cyber security benchmarks and the criticality of the system. Cyber security controls such as logging and monitoring are then applied accordingly, based on the risk rating.

11.311. The detailed forecast for the RIIO-ED2 cyber resilience OT plan has been built on:

- Identifying NIS long-term goals/requirements.
- Working with KPMG who carried out a risk assessment and bench marking exercise to identify required work programmes for RIIO-ED2.
- Understanding IT cyber security best practice and how this is applied in the OT environment.
- Understanding what tools and technologies are required to further transition to a DSO.
- Identifying critical national infrastructure related telecoms components and ensuring they meet future requirements.
- Incorporating new initiatives to improve business functionality and effectiveness.
- Identifying opportunities for making efficiency savings.
- Working with the NCSC and other third party security specialists to establish best practice.
- Listening to stakeholders' requirements and expectations.

11.312. Since locking down our underlying RIIO-ED2 Totex expenditure forecast across Operational IT & telecoms, Non Operational IT and telecoms and Business Support IT and telecoms we have chosen to continue to strengthen our EJPs across Cyber Resilience OT (EJP010) & Cyber Security IT (EJP015).

11.313. This decision has been taken in consideration of the Ofgem/BEIS consultation to Operators of Essential Services (OES), published in October 2021, relating to proposed revised NIS operating compliance practices. This involved WPD undertaking further work as part of a

detailed risk assessment to baseline our current and future cyber security postures in order to ensure that the right projects and controls are delivered to the right timeframes during RIIO-ED2.

11.314. Whilst this has not altered our overall RIIO-ED2 cyber investment commitments (£102 million across cyber OT & IT) it has resulted in a late change to our proposed expenditure phasing and allocation of expenditure between capex and opex categories that will ensure WPD can successfully deliver its ambitious and risk focused RIIO-ED2 cyber security work programmes.

11.315. This explains any differences between our cyber EJPs and our underlying RIIO-ED2 Totex expenditure forecast phasing and categorisations across Operational IT & telecoms, Non Operational IT and telecoms and Business Support IT and telecoms.

11.316. Due to the sensitive nature of cyber security we have not disclosed specific project/activity details.

11.317. These are provided within EJP010 cyber resilience OT but may be further redacted.

11.318. Figure SA-06. 235 details our cyber resilience OT capex and opex over RIIO-ED2.

Cyber resilience (OT) - Capex					
	West Midlands	East Midlands	South Wales	South West	WPD Total
[redacted]					

Cyber resilience (OT) - Opex					
	West Midlands	East Midlands	South Wales	South West	WPD Total
[redacted]					

Figure SA-06. 235: Cyber resilience (OT) capex and opex expenditure by activity

Cyber resilience IT plan costs

11.319. Continuing to deliver cyber secure, reliable and resilient business IT systems is a key part of the RIIO-ED2 Business Plan. We'll achieve this through further investment in, and enhancement of, our existing cyber security systems, controls and processes.

11.320. Our business IT systems include our computers, telecommunications systems and applications that we use on a daily basis.

11.321. To protect against the ever increasing cyber risks, further investment in greater cyber security systems, controls and processes – and enhancement of our existing systems - will be required during RIIO-ED2.

11.322. Changes to the way electricity is generated and consumed means that many of the current IT systems and technologies need to similarly evolve. So-called 'legacy' IT systems have limited security built into their design, often making it difficult to carry out the basic fundamentals of cyber security, such as patch management, vulnerability management, access management, logging and monitoring and the verification of data.

11.323. The cyber security challenge during RIIO-ED2 will therefore be to carry out the following steps while still ensuring that WPD can continue to deliver highly resilient, reliable and available IT systems:

- Update old legacy IT systems, technologies and support processes to the NIS required standard.
- Ensure that all future IT systems and technologies are designed and implemented with cyber risk at the forefront and the use of greater cyber security controls.
- Identify and effectively manage emerging cyber security risks appropriately.

11.324. It should be noted that since locking down our underlying RIIO-ED2 Totex expenditure forecast across Operational IT & telecoms, Non Operational IT and telecoms and Business Support IT and telecoms we have chosen to continue to strengthen our EJPs across Cyber Resilience OT (EJP010) & Cyber Security IT (EJP015).

11.325. This decision has been taken in consideration of the Ofgem/BEIS consultation to Operators of Essential Services (OES), published in October 2021, relating to proposed revised NIS operating compliance practices. This involved WPD undertaking further work as part of a detailed risk assessment to baseline our current and future cyber security postures in order to ensure that the right projects and controls are delivered to the right timeframes during RIIO-ED2.

11.326. Whilst this has not altered our overall RIIO-ED2 cyber investment commitments (£102 million across cyber OT & IT) it has resulted in a late change to our proposed expenditure phasing and allocation of expenditure between capex and opex categories that will ensure WPD can successfully deliver its ambitious and risk focused RIIO-ED2 cyber security work programmes.

11.327. This explains any differences between our cyber EJPs and our underlying RIIO-ED2 Totex expenditure forecast phasing and categorisations across Operational IT & telecoms, Non Operational IT and telecoms and Business Support IT and telecoms.

11.328. Due to the sensitive nature of cyber security we have not disclosed specific project/activity details.

11.329. These are provided within EJP015 cyber security (IT) but may be further redacted.

11.330. Figure SA-06. 236 details our cyber resilience IT capex and opex over RIIO-ED2.

Cyber resilience (IT) - Capex					
	West Midlands	East Midlands	South Wales	South West	WPD Total

Cyber resilience (IT) - Opex					
	West Midlands	East Midlands	South Wales	South West	WPD Total

Figure SA-06. 236: Cyber resilience (IT) expenditure by project / activity

12. Vehicles, property and engineering equipment

Introduction

12.1. This section covers the capital purchase of non-network assets and associated running (Opex) costs to support these assets including:

- Purchase of vehicles and mobile plant and associated running costs (such as fuel, vehicle maintenance)
- Purchase and refurbishment of non-operational property (such as local depots and corporate offices) and running costs of existing property
- Purchase of small tools, equipment, plant and machinery

12.2. These costs represent 7% of Totex throughout RIIO-ED1 and 6% into RIIO-ED2.

Vehicles, property & engineering equipment					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	22	22	16	21	81
RIIO-ED2 Annual Average (forecast)	23	26	16	25	90
RIIO-ED2 Total (5 years)	115	128	78	127	448

Figure SA-06. 237: RIIO-ED2 forecast total expenditure - vehicles, property and engineering equipment

Vehicles and transport

12.3. The WPD vehicle fleet consists of vehicles and mobile plant to enable access to, and maintenance of, the electricity distribution network.

12.4. WPD has a dedicated transport operations team for the purposes of managing, specification, purchasing, maintenance and fleet compliance. The team is made up of a transport manager, area controllers and a technical specialist supported by a centralised administration team, as well as transport workshop teams supporting each of the company's distribution areas.

12.5. During RIIO-ED1, WPD continued to open transport workshops at key sites throughout the Midlands. The expansion of in-house services also included the centralisation of the transport administration team, realising efficiency benefits through resourcing, management activity and processes. Our in-house approach enables the majority of maintenance and repairs to be undertaken at our own offices and depots with added economy of scale and direct control over factors that impact the legal compliance of the fleet, while ensuring a swift response as required for the operational teams.

12.6. The primary function of our transport operation is to continuously and effectively manage an efficient, reliable, safe, and legally compliant fleet to support our distribution licence obligations. Our transport strategy is also increasingly aligned to meet WPD's commitment to net zero, by drastically reducing emissions from the fleet and reducing our reliance on fossil fuels while maintaining efficiency and reliability to meet business objectives.

12.7. In line with our core commitments, we will replace 89% of our existing commercial van vehicle fleet with electric vehicles by 2028. While the market prices for electric vehicles are currently

higher than those for diesel models, there are clear environmental benefits, as well as lower fuel and maintenance costs.

12.8. We will also replace at least 35 of our worst polluting mobile generators during RIIO-ED2, as part of our commitment to net zero. These will be replaced with modern, more efficient, improved emission versions.

Expenditure summary

12.9. Transport-related expenditure in Totex is structured into two key areas:

- Capital expenditure – this is our fleet replacement programme including a forecast of electric vehicle purchase and mobile generator replacement.
- Operational expenditure – this includes all the ongoing operating costs associated with operating our vehicle and mobile plant fleet, including fuel, servicing, accident repair and transport management and administration.

12.10. Figure SA-06. 238 and Figure SA-06. 239 summarise the costs for capital and operating expenditure.

Vehicles and transport (capital expenditure)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	4	4	3	4	14
RIIO-ED2 Annual Average (forecast)	6	8	5	6	26
RIIO-ED2 Total (5 years)	31	39	27	32	129

Figure SA-06. 238: RIIO-ED2 forecast total expenditure - vehicles and transport (capital expenditure)

Vehicles and transport (operating expenditure)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	6	6	4	6	22
RIIO-ED2 Annual Average (forecast)	6	6	3	5	20
RIIO-ED2 Total (5 years)	28	29	16	25	99

Figure SA-06. 239: RIIO-ED2 forecast total expenditure - vehicles and transport (operating expenditure)

Capital expenditure

Vehicles

12.11. The WPD vehicle fleet has:

- 2,849 commercial vehicles
- 238 heavy specialist vehicles
- 249 light commercial specialist vehicles
- 1,055 cars in the company car scheme
- 606 mobile generators

12.12. These are our permanent vehicle fleet numbers, on which our projections for RIIO-ED2 have been based. There have been some temporary increases in RIIO-ED1 to address Covid-19

restrictions and the need for social distancing amongst staff, but these have obtained through leasing and are not factored into RIIO-ED2 plans.

12.13. Cost benefit analysis (CBA) concludes that it is more cost effective for WPD to purchase its fleet outright rather than pursuing other financing or leasing options. Following the Midlands acquisition in 2011 and throughout RIIO-ED1, leased vehicles have been replaced with WPD-owned vehicles. There is no change to this strategy in RIIO-ED2.

12.14. Replacement of commercial vehicles has traditionally been driven by two criteria; an asset age profile and periodic condition assessment.

12.15. Vehicles replaced are firstly assessed for necessity by the network services team and, if approved, the replacement vehicle is chosen based on safety, reliability, fuel economy, vehicle emissions reductions, technical characteristics and cost.

12.16. Given WPD's aspiration to considerably reduce transport related emissions during RIIO-ED2 and achieve net zero by 2028, alternative technologies such as electric vehicles (EV) are central to our fleet plans, commencing in the latter years of RIIO-ED1 and continuing throughout RIIO-ED2. The only limitations are on available technology, particularly in the large van range. We expect increased commercial EV availability as we progress through RIIO-ED2.

12.17. WPD's strategy is to deliver a plan with low emission targets that are demanding in terms of timelines and early adoption of new technology to support our net zero commitments. That's why we are planning to adopt EV technology for 89% of our light commercial transport fleet by the end of 2028, resulting in 100% replacement of WPD's van fleet during RIIO-ED3, with the exception of larger specialist vehicles.

12.18. See EJP 001 for additional detail and justification of our commercial vehicle replacement programme. WPD are proposing that this is a Price Control Deliverable (PCD) for RIIO-ED2.

12.19. WPD's company car scheme is to be adapted to facilitate the replacement of internal combustion engine vehicles by 2025 with purely electric vehicles. The company car scheme during RIIO-ED2 will be 100% EV technology, allowing for lagging lease arrangements to transition to EV cars by 2025 in a combination of new employee car ownership schemes or car leasing arrangements. There is no capital outlay by Western Power Distribution for either arrangement, although car leases are accounted for on the company's balance sheet.

EV fleet charging installation

12.20. The operational accessibility of vehicle charging points is critical to the successful delivery of our electric vehicle (EV) programme. Therefore, WPD's current bunkered fuel arrangements (to service our diesel vehicle fleet) will need to be supplemented with an extensive EV charging infrastructure. With a large delivery area across the Midlands, the South West and Wales, we propose a network of charging points at strategic locations at substations and secondary sites to ensure our fleet can operate efficiently and that there will be no impact to service during the switch to EVs. Chargers will be more evenly distributed across our delivery areas to ensure fleet drivers are never too far from a WPD charge site. This will build on the installation of EV chargers at our 45 non-operational sites that is being delivered in RIIO-ED1. The ongoing maintenance costs of the chargers are also included in the expenditure forecasts.

12.21. The programme proposes the installation of a single 50kWh rapid dual charger at 134 sites. In addition to the EV chargers to be installed at our 45 non-operational sites by the end of RIIO-ED1, the total number of EV charger sites by the end of the RIIO-ED2 period will be 179.

12.22. See EJP 001 for additional detail and justification of our EV charger installation programme.

Mobile generators

12.23. To continue to deliver further emissions savings, a replacement programme for mobile generators is scheduled during RIIO-ED2. Historically, replacements are based on operating hours and condition; however, the RIIO-ED2 plan will replace 35 of our worst polluting mobile generators with a modern, more efficient, improved emission version. This supports WPD in meeting its commitment to achieve net zero by 2028.

12.24. See EJP 002 for additional detail and justification of our mobile generator replacement programme.

Operational expenditure

12.25. Our forecasts are based on RIIO-ED1 actuals, with changes, efficiencies and innovations to reflect initiatives and programmes at the end of RIIO-ED1 and into RIIO-ED2. These initiatives mean that we have been able to include £34 million of operating cost savings in our Business Plan

Fuel costs

12.26. Fuel costs associated with running an EV fleet are lower than the equivalent diesel vehicles. We have included savings in our operating costs in each year of RIIO-ED2, with savings growing throughout the period as more EVs are adopted into the fleet.

12.27. We anticipate a saving of £0.6m in 2023/24, rising to £2.7m in 2027/28 (net of additional electricity costs). These savings have been included in the EJP for the EV adoption (EJP 001).

12.28. There are also cost savings of £1.8m in RIIO-ED2 because EVs incur no excise duty. An additional benefit of EVs is that we avoid the Clean Air Zone charges that are now being introduced in some towns and cities. We are currently incurring some charges in the zones in operation in Bath and Birmingham, but will avoid these charges in future through the rollout of EVs.

12.29. In addition to EVs, we are also structuring a pilot of Hydrotreated Vegetable Oil (HVO) as a diesel substitute. If the trial is successful, this will support a reduction of circa 70-90% of the carbon emissions relating to combustion engines that remain on the fleet. HVO is a new product that could be released nationally by our suppliers over the next few months.

12.30. The 2021 Finance Bill provided for a reform of red diesel. The measure introduces legislative changes to restrict the entitlement of red diesel use from April 2022. Derogations apply to agriculture, forestry, horticulture and fish farming industries. However it is perceived that Western Power Distribution do not qualify for derogated use, and therefore will no longer be able to purchase or use red diesel from 1st April 2022. This change imposes a cost increase because red diesel currently attracts a fuel duty rate of 11.14 pence per litre compared to regular white diesel, which attracts a duty rate of 57.95 pence per litre (an increase of 46.81 pence per litre). Western Power Distribution uses on average 60,000 litres of red diesel per month. We have therefore included additional costs of over £0.3 million per year in our Business Plan.

Vehicle maintenance

12.31. WPD workshops will be delivered throughout RIIO-ED2 to support staff to accommodate our increasing electric vehicle fleet. Servicing of EVs is cheaper than the equivalent diesel vehicles. Based on initial information from manufacturers, we are assuming savings of 21% for small vans and 45% on large van/4x4 for servicing and wear and tear maintenance. All our mechanics are working towards their Institute of the Motor Industry Electric Vehicle accreditation (level 3). They are also working towards IRTEC which is an accreditation to work on ICE vehicles.

12.32. We have included savings of £0.1m in 2023/24, rising to £0.4m in 2027/28. These savings grow as more EVs are adopted into the fleet. These savings have been included in the EJP for the EV adoption (EJP 001).

Driver Behaviour System

12.33. WPD has recently installed a Driver Behaviour System in all its commercial fleet and company car fleet; the system went live in the first part of 2021/22. The system provides live audible and visual feedback on the driving behaviour. Drivers can review the data via a smart phone application, and managers are sent automated reports on their employees' driver behaviour.

12.34. There are clear safety and environmental benefits. We hope to reduce road traffic accidents, delivering clear safety benefits for both our vehicle users and wider road users. Environmentally, we hope to see lower fuel emissions through more efficient driving. So far we have seen an uplift of circa 10% in MPG, 43% reduction in fault accidents and 611,659 kg/co2e emission savings in year to date.

12.35. There are some additional annual running costs associated with the system, but these will be offset by savings in accident repair costs and fuel charges. We have included an annual net reduction of costs in the Business Plan of £900k.

Property

Overview

12.36. We distinguish between our operational and non-operational sites. Operational sites are directly associated with the distribution of electricity to customers via live network apparatus, such as transformers and switchgear. Non-operational sites comprise offices, depots, vehicle maintenance facilities and satellite reporting centres where our staff may be based. These are collectively referred to as our non-operational property portfolio and are the focus of this section of our Business Plan.

12.37. We operate from a non-operational property portfolio of 61 sites and 32 garages; ownership is mixed, with freehold and leaseholds and significant variations in the age of our buildings. We optimise available land by operating multi-use sites where possible, for example, our Tipton site comprises an office, training school, local depot and store.

12.38. An extensive programme of new depot construction and refurbishment has commenced in the last 10 years, driven by a desire to facilitate efficiency in our operations and minimise our energy consumption. Our RIIO-ED2 plan reflects consistency in this rigour, while introducing a quantitative property condition index to ensure maintenance of our sites at standards which are consistent with our brand. Critically however, our RIIO-ED2 plan reflects ambitions beyond the traditional approach of previous price reviews, with a determination to demonstrate leadership through our property strategy by delivering a series of important decarbonisation innovations.

12.39. Each non-operational site is managed by a Nominated Site Owner (NSO), who is a senior manager. As an example, in the case of a district office, the NSO is the distribution manager for that local district. NSOs are responsible for the day to day operation and maintenance of their designated sites.

12.40. From time to time, it is necessary for major capital works to be undertaken to non-operational properties. Major capital works comprise the purchase of replacement and new property assets, such as structural changes to stores, depots and offices, substantial office fittings and installation of carbon reduction assets such as photovoltaic panels (PV) and electric vehicle (EV) charging points.

12.41. The budgets for major capital works are held centrally by the Estates Team which implements and delivers large-scale investments. A centralised budgeting model ensures optimisation of spend in terms of value delivery, project prioritisation and consistency of output; and, through involving NSOs at every stage of the design process, also ensure local ownership in terms of the delivery of works which align with business needs.

Expenditure summary

12.42. Property related expenditure in Totex is structured into two key areas:

- Capital expenditure – this is our property investment programme including refurbishment of some depots and energy efficiency investment
- Operational expenditure – this includes all the ongoing operating costs associated with maintaining our non-operational property portfolio including energy costs, rents and facilities costs.

12.43. Figure SA-06. 240 and Figure SA-06. 241 summarise the costs for capital and operating expenditure.

Property (capital expenditure)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	4	2	4	2	12
RIIO-ED2 Annual Average (forecast)	2	2	2	7	13
RIIO-ED2 Total (5 years)	12	11	9	33	65

Figure SA-06. 240: RIIO-ED2 forecast total expenditure - property (capital expenditure)

Property (operating expenditure)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	6	7	4	5	21
RIIO-ED2 Annual Average (forecast)	6	6	3	5	20
RIIO-ED2 Total (5 years)	28	32	17	24	101

Figure SA-06. 241: RIIO-ED2 forecast total expenditure - property (operating expenditure)

Capital expenditure

12.44. Our proposals for expenditure on property throughout the RIIO-ED2 period are summarised below:

Exeter depot - refurbishment

12.45. Operations at Exeter are currently split across two sites located ¼ mile apart: Sowton and Moor Lane.

12.46. Sowton comprises a complicated, multi-occupancy site that accommodates the Central Distribution Stores for the South West & South Wales, four Network Service teams, a Projects Team and a number of Logistic functions such as Mapping and Inventory. An adjoining multi-occupancy office premises known as Osprey House is occupied by other companies.

12.47. Moor Lane is located on the northern boundary of Sowton Industrial Estate. The site comprises a Vehicle Maintenance Facility (VMF), store outbuildings, a pole store and 132kV substation.

12.48. The primary investment driver is over-intensification of activities at our Sowton site, resulting in too many people, vehicles and operations traversing on a site which is constrained in size and layout. This will only become exacerbated with the introduction of the additional cyber security staff required by the Information Resource (IR) department and the requirement for a new Data Centre as a result of being at full capacity and increased security requirements. Together with physical limitations arising from the layout of the site. These factors present an elevated safety risk to staff and visitors and an associated risk of non-compliance with the Health & Safety at Work Act (1974) and the Workplace (Health, Safety & Welfare) Regulations (1992).

12.49. We propose to rationalise our local operations at Exeter onto a single, multi-use, purpose-built facility at the Moor Lane site. Our rationalisation proposal will also provide a solution to our requirement to relocate one of our field teams to Exeter from its current base at Torquay to become operationally optimal. This will enable regional distribution stores to remain at Sowton, operating in a safe, efficient environment with a reconfigured storage layout.

12.50. In reaching our decision, we have considered a range of options, including extensively refurbishing and converting the existing Sowton site, and also purchasing land to develop elsewhere. The evaluation, including a full cost benefit analysis, supports a new purpose-built, multi-use development at our Moor Lane site as our most appropriate option. For the regional distribution stores benefit, we will also carry out critical refurbishment works on the fabric of the Sowton site.

12.51. The headlines of our proposed development at Exeter are as follows:

- Estimated development cost - £23.7 million
- Operating cost savings in energy, maintenance and rent (see EJP004 for additional detail).
- An increased generation of 86,608 kWh p.a. from rooftop PV (excluding EV charging) for own consumption compared to the baseline scenario.
- Ability to accommodate increased staff numbers, whilst the Torquay's teams relocation will facilitate a move to smaller, more energy-efficient premises at that location.
- A significant reduction in health & safety and traffic management risks. Through designing a site which optimises the separation of vehicles and pedestrians, we estimate that the new site will result in an overall 5% reduction in the risk of fatality or major injury.
- Optimal site security. The depot and data centre will be protected by high specification perimeter fencing, camera, and alarm systems. The IR department's cyber security staff will be retained in existing Sowton office space providing enhanced site security to that of shared office provision.
- Operational efficiency improvements and site future proofing at both sites.
- Maximised PV energy generation

12.52. See EJP 004 for additional detail and justification of this project.

Torquay – depot refurbishment

12.53. Our existing Torquay depot in Pavor Road is in urgent need of extensive refurbishment as a result of its extremely poor condition and energy performance characteristics.

12.54. With the intention of relocating one of our two network services teams to Exeter (18 miles north of Torquay), we propose to purchase and then refurbish a smaller garage property adjacent to our existing property to provide a new, energy efficient property into which we can relocate, optimising our operations in this location.

12.55. A number of factors are relevant to our decision to relocate to this smaller unit:

- The existing depot building is rented and requires extensive improvement and refurbishment. The office accommodation is out-dated, basic and requires significant modernisation. As an employer, we have an obligation to remain compliant with the relevant health and safety regulations and will risk falling into breach, if the building is allowed to deteriorate further.
- Externally, the building fabric is showing signs of significant deterioration including a leaky roof. It is not compatible with minimum energy performance standards and offers little scope for improvement, without significant investment.
- The low levels of security afforded by the existing windows and doors makes the building incompatible with the Network Information Systems (NIS) regulations for a higher level of physical security for sites hosting critical national infrastructure.
- Currently, two teams are located at Torquay. There is a clear operational need for one team to remain, but it is operationally more efficient to relocate the other team to Exeter. A relocation will result in part of the existing depot becoming unoccupied. The reason for relocating one team to Exeter is to meet our Target 60 initiative. Currently, the Exeter and Torquay teams are not meeting this standard, largely as a result of long travel times, particularly during peak commuter and holiday times. Moving one team to Exeter and leaving the other in Torquay will enable a move to smaller premises at Torquay which are financially, operationally and energy efficient.

12.56. In reaching our decision, we have modelled a range of options, including an extensive suite of modernisation works at the existing site, the purchase or lease of another building elsewhere and also a new development on a green field site. The evaluation, including a full cost benefit analysis, supports a purchase and reconfiguration of the garage adjacent to the existing facility to enable a relocation of the depot to that property as our most appropriate option.

12.57. The headlines of our proposed development at Torquay are as follows:

- Estimated refurbishment cost (incl. site purchase) - £3.5 million.
- Operating cost savings in energy, maintenance and rent (see EJP005 for additional detail).
- Estimated generation from rooftop PV (excluding EV charging) for own consumption – 10,340 kWh p.a.
- The site is ideally located and benefits from existing services and infrastructure.
- Delivery of the optimal solution for our operations in Torquay.
- Aligns closely with our four key principles in property; the safety and well-being of our staff, the needs of our core business operations, cost and energy efficiency.

12.58. See EJP 005 for additional detail and justification of this project.

Plymouth depot - refurbishment

12.59. Our Elliott Road Depot in Plymouth, that serves the largest city in the County of Devon, is a leased, multi-use site which, as well as being the base for our Network Services Teams, also provides accommodation for our Business Systems, Information Resources, Fleet, Telecoms, Management Accounting, Distribution, and Payroll & Pensions teams. It is congested as a result of operating in excess of its capacity and also due to a poor external layout; this causes operational inefficiencies which have the potential to cause health and safety risks.

12.60. A number of challenges need to be overcome at Elliott Road:

- The main office building was constructed in the 1960s. It is at the end of its design life and does not meet current energy efficiency, health & safety or welfare standards.
- The fabric of the office building needs modernising, in particular:
  - Replacement of old single glaze, metal casement windows to improve weather resistance and energy efficiency.
  - Re-roofing the flat roof which has deteriorated beyond economic repair.
  - Upgrading the building façade from the original 1960s finish, primarily to improve thermal performance but also to bring it up to an aesthetic standard which is appropriate for our brand.
- The site is not compliant with the legal requirements of the Disability Discrimination Act 1995 (DDA) because it does not have a staff lift to enable access to the upper floors.
- Meeting room facilities are severely limited and in particular there is a local need for accommodation for large staff group meetings. At present off-site facilities have to be used for that purpose. The movement of staff to and from off-site facilities presents logistical challenges and time loss inefficiencies.
- The limited yard space is unable to accommodate the installation and operation of sufficient EV chargers to align with the WPD's future requirements.
- The layout of the stores area is inefficient, and that part of the building is also in a dilapidated condition.

For these reasons, all of the options including the baseline, demand some level of intervention, meaning that an absolute 'do nothing' option is not viable.

12.61. Our future business requirements, as well as shortcomings in the building fabric and layout, make the site unsuitable in its existing form. Wakehams Quarry is currently used by the Network Services team as a secure cable storage yard. There is sufficient land at this site to accommodate a new vehicle maintenance facility (VMF) which will release space at our Elliott Road depot to enable it to be reconfigured to address future business needs. It is located a mile from Elliott Road.

12.62. We propose a two-phase project which will move the vehicle maintenance facility at the Elliot Road site to a new, energy-efficient, purpose-built base at Wakehams Quarry to enable reconfiguration and improvement works at Elliott Road.

12.63. In reaching our decision, we have modelled a range of options, including reconfiguring the existing Elliott Road site and also purchasing a green field site to develop a new facility elsewhere. The evaluation, including a full cost benefit analysis, supports acquiring the freehold of Elliott Road at the beginning of RIIO-ED2 before carrying out an extensive refurbishment and improvement programme, then relocating the VMF from Elliott Road to a new facility at Wakehams Quarry to facilitate an extensive suite of reconfiguration and improvement works at Elliott Road.

12.64. The headlines of our proposed reconfiguration at Plymouth are as follows:

- Estimated costs of purchase, refurbishment (Elliott Rd) and VMF construction (Wakehams) - £12.8 million.
- Operating cost savings in energy and rent (see EJP006 for additional detail).
- Estimated generation from rooftop PV (excluding EV charging) for own consumption – 171,000 kWh p.a.

12.65. See EJP 006 for additional detail and justification of this project.

General buildings refurbishment programme

12.66. Across a large portfolio of properties serving the needs of a dynamic business like WPD, a large and diverse range of reactive, small-scale, refurbishment, repair and improvement works are inevitable. We need to maintain our operational efficiency and as a responsible employer, ensure we manage our properties to comply with the Health & Safety at Work Act (1974) and the Workplace (Health, Safety & Welfare) Regulations (1992).

12.67. In addition to reactive works under this heading, throughout the RIIO-ED2 period, we also intend to conduct a series of planned works to improve the energy efficiency of our worst performing properties.

12.68. In the first five years of RIIO-ED1, we have spent a total of £23m on miscellaneous nominated site owner (NSO) projects. In RIIO-ED2, we can expect a similar number of projects to be necessary. However, we plan to reduce spend to ensure that, within an overall provision around 10% less than our total NSO projects spend in the first five years of RIIO-ED1, we can fund works that improve the energy efficiency of our buildings.

12.69. Our plans to invest in reactive NSO works and energy efficiency improvements are described below.

Reactive NSO works

12.70. To ensure our spending on reactive NSO projects is less than our RIIO-ED1 benchmark, we will implement a new governance process to provide an enhanced level of control. The new governance regime will end our RIIO-ED1 reliance on local (i.e. NSO) budget ownership and spend governance for smaller-scale works in favour of a centralised model with a property condition-based scoring system to inform spend prioritisation and ensure consistency of decision-making. We expect the new system to enable us to deliver more for less in RIIO-ED2.

Building energy performance

12.71. We intend to carry out a programme of works to improve the energy performance of our buildings. We expect spend under this heading to reduce our operational and capital expenditure elsewhere in our property portfolio.

12.72. We have analysed our property portfolio to assess each building's energy usage and performance. The analysis has informed a ranking of our properties by size, relative energy usage (in kWh/year), and property condition category.

12.73. Our 23 worst-performing properties from this analysis have been subject to further assessment. We have considered a range of potential works to improve each building's energy efficiency.

12.74. Looking past these quick-wins, we intend to conduct similar analysis of our other properties. The outcome of that analysis, together with conclusions from further studies on our worst-performing

23 properties (looking at more extensive building fabric upgrades), will enable us to deliver a further investment programme for building energy performance improvements in RIIO-ED3.

12.75. As well as our building energy performance works, we intend to replace the existing gas-fired boiler equipment in our properties when it becomes inefficient. For the last 10 years, gas-fired boilers have provided an effective contribution towards meeting Building Regulation targets for CO2 emissions and achieving the required BREEAM ratings for the new properties we have built. We will look to invest in alternative, decarbonised heating systems on a reactive basis as and when the efficiency and maintenance costs of the existing plant becomes unviable. At that time, we will assess the optimum solution for the site in question, considering air/ ground/water-source heat pumps and other solutions for our offices and electric radiant tubes or other technologies for our garages. Therefore, we will closely monitor the energy efficiency and economic viability of our gas-fired plant during RIIO-ED2. We will consider the impact of possible future changes in the operating costs differential between gas and electricity based on changes to their respective tariffs.

12.76. The headlines of our reactive NSO projects and energy efficiency works are as follows:

- Estimated total spend - £20m (reactive NSO projects £14m / energy efficiency £6m)
- Savings in energy costs across our 23 worst-performing properties
- Saving - 320tCO^2e p.a. thereby reducing our business carbon footprint.
- Compliance with the Health & Safety at Work Act (1974) and the Workplace (Health, Safety & Welfare) Regulations (1992).

12.77. See EJP 007 for additional detail and justification of this project.

Incorporating Solar PV in our non-operational sites

12.78. In RIIO-ED2, we intend to install photovoltaic (PV) solar panels at our non-operational property sites including depots, vehicle maintenance facilities, offices, stores and reporting centres.

12.79. Regulatory restrictions prevent network operators like WPD from generating revenue from energy which is exported to the grid. We are also unable to offset the energy requirements of one site with an excess of PV generation at another. Therefore, our analysis has targeted the economically optimal point of on-site consumption of PV-generated energy. The study strategy was firstly to identify sites which are suitable for PV arrays and secondly, at those sites, to calculate the optimal installation size which provides a maximal balance between generating capacity and economic return on investment.

12.80. Maximum output from an array is at midday, mid-summer. If we are unable to derive an income from power which is exported to the grid, the economic justification is weak for an array which generates more than our buildings' power needs, because the surplus will be exported with no financial return. This means that our return on the marginal investment of oversized arrays is nil. If peak generation is midday in mid-summer, then the optimal array size should be calculated against our buildings' peak power requirements at that time. In other words, it is uneconomic to buy an array which generates more power than our buildings can use at midday in mid-summer.

12.81. Optimised PV designs for each site have been deduced using the half-hourly meter readings, data from site-by-site surveys, and proprietary analysis software.

12.82. Electric vehicle charging has not been modelled into our analysis for the following reasons:

- Currently, there is inadequate data on the daily usage profile of our recently installed depot chargers and EV white fleet.

- Our EV white fleet charging model relies on the use of fast chargers so that our vehicles can be charged quickly during short visits to our depots. The high loads required by fast chargers would necessitate the incorporation of battery storage into PV-driven charging systems at our depots. Our assessment of suitable battery solutions for this purpose has concluded that the high cost of suitable batteries (typically £200-300k per unit) is prohibitive. Battery storage is discussed more below.

12.83. Working within the economic limitations of the nil-export to grid constraint described above, the economic sweet-spot at which both carbon offset and economic return are optimised has been deduced.

12.84. We are aware that PV is not the only source of renewable energy that could potentially be utilised to reduce the carbon output of the business. In reaching our decision the model considered installation of local wind turbines, biomass systems or hydroelectric systems. Although these are all valuable sources of renewable energy for the wider aim of reducing carbon output, they are not suitable for installation across our property portfolio, predominantly because of site-specific constraints which prevail and that solar PV provides significantly superior returns in terms of financial payback and also a reduction in carbon emissions; accordingly, they have been discounted.

12.85. The model also examined storage batteries to determine the economic viability of this emerging technology, particularly at the larger sites which operate on a 24/7 basis. The model was unsupportive of their viability because of the extremely high cost of the size and scale of batteries which are required to match the power needs of these sites. Additionally, the modelling showed that charging loads for battery storage were beyond the capacity of the arrays which could be accommodated within the limited site footprints. It is for these reasons that battery storage has not been included in our RIIO-ED2 proposals.

12.86. The headlines of our proposed deployment of PV on our sites are as follows:

- Estimated cost - £4 million.
- Savings in energy costs
- 18% electricity saving as a percentage of these sites total consumption.
- Estimated generation – up to 2,702 MWh p.a.

12.87. See EJP 008 for additional detail and justification of this project.

Replacement of Bunkered Fuel Tanks

12.88. This investment is for the replacement of bunkered on-site fuel tanks, pumps and AdBlue tanks at our operational sites which are at the end of their economic lives. The investment is necessary to ensure we remain compliant with the Health and Safety at Work Act (1974), the Workplace (Health, Safety & Welfare) Regulations (1992) and The Environmental Protection Act (1990).

12.89. The costs for this programme are £1.2m in RIIO-ED2.

12.90. See EJP 003 for additional detail and justification of this project.

Operational expenditure

12.91. Our forecast includes all the activities of providing, managing and maintaining all non-operational premises (with the exception of operational training centres). This includes rent (where WPD does not own the site), rates, utility charges, inspection and maintenance costs, facilities management

costs, security and the ongoing operating cost provision of all office equipment (with the exception of IT or Telecoms equipment).

12.92. Our RIIO-ED2 forecasts have been based on RIIO-ED1 actuals, with changes, efficiencies and innovations to reflect the impacts of the capital investment in RIIO-ED2. Impacts on operating costs have been detailed in the sections above (and also the accompanying EJPs and CBAs). As a summary, these include savings on maintenance and energy costs at sites where there is to be major refurbishment, as well as energy cost savings for the energy performance and PV projects.

Small tools, equipment, plant and machinery

12.93. Craft and engineering staff require tools to work on the network assets. These include hand tools for precision work such as electrical fitting and cable jointing, lifting and tensioning tackle for overhead line work, test equipment for commissioning assets and fault location, workshop machinery to enable fitters to refurbish components and plant such as drum trailers and winches used in the erection of overhead conductors.

12.94. Equipment is replaced as items become worn or broken. In addition, new staff are provided with the equipment that they require to carry out their duties. Since the rate of usage of equipment and number of new additional staff are related to the volume of work being carried out on the network, the costs have been rolled forward in proportion to the changes in the work programme.

12.95. RIIO-ED2 headcount associated with craft and engineering staff is anticipated to stay broadly in line with existing staff levels and therefore we expect small tools and equipment costs to also remain broadly in line with RIIO-ED1.

12.96. We will embrace the latest tool and equipment innovation and technology where cost effective and beneficial to do so. This demonstrated within our plan by the extension of our contract with Kelvatek who have a proven track record of delivering market-leading, innovative and transformative fault finding tools, devices and solutions.

12.97. Expenditure has been forecast based on a three year historical average in consideration of small tools, equipment, plant and machinery life cycles.

12.98. Figure SA-06. 242 summarises the forecast costs for small tools and equipment:

Small tools, equipment, plant and machinery					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	3	3	2	3	11
RIIO-ED2 Annual Average (forecast)	3	4	1	3	11
RIIO-ED2 Total (5 years)	16	18	7	13	54

Figure SA-06. 242: RIIO-ED2 forecast total expenditure - small tools, equipment, plant and machinery

13. Other costs within the price control

Innovation

13.1. Innovation is primarily funded through the Network Innovation Allowance (NIA) and Network Innovation Competition (NIC) with the NIC being replaced by the Strategic Innovation Fund in RIIO-ED2). DNOs fund approximately 10% of the costs, which are included in Totex as part of Other Costs.

13.2. For RIIO-ED2, Ofgem is proposing to continue its NIA funding, but restrict eligibility to projects which advance the UK's net zero goals and tackle consumer vulnerability. WPD plans to play an active part and will continue to invest in these innovation activities. RIIO-ED2 expenditure is likely to be fairly consistent with RIIO-ED1 levels.

13.3. Our plan includes a forecast for completion of NIC projects started in RIIO-ED1 and completed in RIIO-ED2.

13.4. No costs have been forecast for the Strategic Innovation Fund. This is a competitive process across the wider industry and has not been financially forecast at this stage. We expect to participate fully and work with a range of partners to develop projects for submission.

13.5. WPD funding of our involvement in the NIA scheme and completion of the NIC projects is shown in Figure SA-06. 243.

Innovation					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	0	1
RIIO-ED2 Annual Average (forecast)	0	0	0	0	1
RIIO-ED2 Total (5 years)	1	1	0	1	3

Figure SA-06. 243: RIIO-ED2 forecast total expenditure - innovation

13.6. Additional investment will also be specifically targeted at projects which promote technological advances to network assets, support community energy projects and explore non-carbon related environmental benefits. As these will not be eligible for NIA, these are forecast in engineering management (see paragraph 8.34).

13.7. Supplementary Annex SA-03 'Developing a smart and flexible electricity network' provides detail of our innovation strategy and the key themes that we propose to pursue in our innovation programme in RIIO-ED2

Atypicals

13.8. Atypical costs are those costs that are one-off and/or not foreseen for inclusion in a Business Plan. For this reason, we are not forecasting any in this Business Plan.

13.9. RIIO-ED1 atypical costs have included:

- Expenditure to address wooden pole claim activity which was not foreseen at the time of the RIIO-ED1 Business Plan. For RIIO-ED2, this has been included as part of our Diversions forecast (see paragraph 5.17).

- Exceptional expenditure associated with our response to the Covid-19 pandemic, especially to meet the unprecedented requirements of the first lockdown and the associated expenditure to ensure staff could work safely and effectively to continue to deliver excellent customer service under social distancing measures. We also discuss how we responded to the Covid-19 pandemic in Supplementary Annex SA-07 'Managing Uncertainty'.

13.10. Figure SA-06. 244 shows our RIIO-ED1 expenditure and our projected £nil expenditure in RIIO-ED2.

Atypicals					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	3	1	1	2	8
RIIO-ED2 Annual Average (forecast)	0	0	0	0	0
RIIO-ED2 Total (5 years)	0	0	0	0	0

Figure SA-06. 244: RIIO-ED2 forecast total expenditure - atypicals

Street works

13.11. Street works concern our operations where work is required in the highway. This can, for example, relate to the price control activities of asset replacement, responding to faults or diversions outside the price control, and also new connections. The costs we incur for activities inside the price control associated with working on the highway are embedded in the various activity level expenditure forecasts presented in this annex and the corresponding activity level BPDTs. We also report the totality of our street work cost forecasts in the BPDT memo tables; further details of our street work forecasts can be found in the BPDT commentary for tables M9a-b.

13.12. English Highway Authorities across our West Midlands, East Midlands and South West licence areas have been progressively replacing noticing schemes with permit schemes since 2011. Most schemes have gone live during RIIO-ED1 to date (2015/16 to 2020/21). As at 1st May 2021, there were still a few local authorities where permitting schemes have not yet gone live[11]. In accordance with the RIGs for forecasting costs in the BPDTs, we have not included forecasts for these in our baseline Totex forecast. Compared to noticing schemes, permits place increased legislative requirements on street work undertakers, including ourselves, when undertaking work in the highway. Over the course of RIIO-ED1, we have experienced increasing costs associated with the introduction of permit schemes related to Highway Authority fees, the cost of complying with conditions governing how and when we work and the administrative costs of managing our street works, where permits are required.

13.13. There are currently no Welsh permitting authorities in South Wales. We propose that any costs associated with the introduction of permit schemes in South Wales be included in the RIIO-ED2 Specified Street Works Uncertainty Mechanism.

13.14. During RIIO-ED2, we expect a number of English Highway Authorities to introduce lane rental schemes under NRSWA section 74A in our area. Lane rental schemes extend the arrangements of permitting schemes with daily fees chargeable for work undertaken in the road. Lane rental guidance is currently being developed nationally to drive consistency in the design of schemes developed by Highway Authorities. The timing, cost and associated volumes of street works that might be governed by lane rental schemes in our area are not yet known. For

[11] Birmingham City Council (WMID), Stoke on Trent City Council (WMID, Rutland County Council (EMID), Torbay Council (SWEST)

this reason, we are also proposing that English lane rental schemes be included in the RIIO-ED2 Specified Street Works Uncertainty Mechanism.

13.15. Ofgem outlined the inclusion of a streetworks reopener in their Sector Specific Methodology Decision (SSMD) (December 2021). We would expect to receive funding for permitting schemes that have not yet started in England, schemes where future fee levels significantly increase, future lane rental schemes that may come into operation in RIIO-ED2 and any change in arrangements in South Wales.

13.16. Street work schemes impose different working practices in different areas, for example, we see more stringent permit conditions applied in the Midlands than in the South West, which incurs additional cost. Because of these factors, there are some unavoidable differences in costs and unit costs between our four DNOs in our plans. We would expect Ofgem to recognise these differences in cost assessment, which is inherently conducted at a DNO level (not group), and make cost exclusions or adjustments as required to ensure high quality comparative assessment.

14. Activity costs outside the price control

14.1. Non price control costs are incurred by carrying out distribution network-related activities that operate outside the regulatory price control including the activities where the costs are recharged to third parties. The key activities undertaken are detailed in the following sections.

14.2. These costs are not included in Totex. An element of our indirect costs will be allocated to these activities to reflect the staff and processes that are needed to support this work. The indirect allocations process is detailed from paragraph 2.10.

14.3. We provide a number of connections services that are classified as 'outside the price control' and funded by third parties. Our assumptions and processes for developing the RIIO-ED2 connections forecast are detailed from paragraph 4.18.

Directly remunerated services (DRS)

14.4. Costs have been forecast under the following areas:

DRS2 Diversion works under an obligation

14.5. Each year, there are a number of enquiries for network assets to be moved as a consequence of third party activities. For example, the creation of a new access road onto an existing business estate will remove existing footpaths, lowering ground to road level and reducing depth of cables. This would require the existing cables to be installed deeper and ducted to provide mechanical protection from the weight of traffic traveling over them. In these circumstances, the costs of carrying out the work are recovered from the customers requiring the work and are excluded from price control assessments.

14.6. The majority of these enquiries will be small in scale and have been forecast to continue at similar levels to RIIO-ED1.

14.7. However, through RIIO-ED1, larger scale projects have been carried out relating to Hinkley power station (in the South West) and High Speed 2 (HS2) (in the Midlands).

14.8. Looking forward to RIIO-ED2, there will be minimal costs relating to Hinkley power station as the work will be completed by the first year of RIIO-ED2. We have included costs and associated income recovery in the plan for this year only.

14.9. For HS2, we forecast that Phase 1 will be complete by 2025/26; costs and associated income recovery have been included in the plan until then. Phases 2a and 2b will impact across RIIO-ED2. We have included initial forecasts on costs and associated income recovery for this in the plan through all of RIIO-ED2.

DRS3 Works required by alteration to premises

14.10. Every year, there are a number of enquiries for network assets to be moved to accommodate an alteration to existing premises. For example, an extension to a property may require the diversion of the existing overhead service. In these circumstances, the costs of carrying out the work are recovered from the customers and are excluded from price control assessments.

14.11. RIIO-ED2 forecasts are in line with the levels of current RIIO-ED1 expenditure and income.

DRS4 Top-up, standby and enhanced system security

14.12. Nil costs and revenues have been forecast in this activity, in line with RIIO-ED1 reporting.

DRS5 Revenue protection services

14.13. WPD will no longer provide any such services in RIIO-ED2 and so nil costs and revenues have been forecast.

DRS6 Metering services

14.14. WPD provides metering services through WPD South West to EDF where meters are purchased and provided primarily to EDF customers under rental agreements. It is anticipated that this service will continue into RIIO-ED2 until the rollout of the smart metering programme is completed. We have assumed the continued wind down of the service income associated with this agreement in line with the trend seen in the recent years in RIIO-ED1. There are also some similar services provided in WPD South Wales. There are no associated identifiable material costs.

DRS7 Smart meter rollout rechargeable services

14.15. Nil costs have been forecast.

DRS8 Value added services

14.16. Value added services are services that utilise DNO assets under commercial arrangements between the licensee and a third party for purposes such as (a) the installation of equipment for the purpose of electronic communications or data transfer; or (b) the display of any advertising or promotional material.

14.17. We have some minor commercial arrangements with third parties to utilise our assets in these ways. We have assumed that this income will continue at similar levels into RIIO-ED2. There are no associated identifiable material costs.

DRS9 Miscellaneous

14.18. The only service that has been provided under this heading in RIIO-ED1 is associated with the Accelerated Loss of Mains Change Programme (ALoMCP). We have forecast future activity on this programme until the end of RIIO-ED1.

14.19. No other service is foreseen at this time in RIIO-ED1 and so nil costs and income have been forecast in RIIO-ED2.

Expenditure summary

14.20. Figure SA-06. 245 summarises the expected level of activity in cost from RIIO-ED1 to RIIO-ED2.

Directly remunerated services (DRS)					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	16	11	3	10	40
RIIO-ED2 Annual Average (forecast)	10	17	2	6	35
RIIO-ED2 Total (5 years)	49	85	12	30	176

Figure SA-06. 245: RIIO-ED2 forecast total expenditure - directly remunerated services (DRS)

Legacy meters

14.21. Legacy metering activities relate to two elements.

14.22. The first is the provision of meters installed before 31 March 2007. Suppliers pay rental agreements for the provision of these meters, with only very small costs being incurred. This activity will be carried out until the end of the smart metering rollout programme. We have assumed the continued wind down of the service income associated with this agreement, in line with the trend seen in the recent years in RIIO-ED1.

14.23. The second element is the provision of data services (MPAS and data transfer).

14.24. MPAS costs are incurred through the overall MPAS/DUoS team in WPD who operate a 'single team' approach and undertake multiple tasks including MPAS, DUoS, Address Management, MAP, National Smart Meter tasks plus other minor activities ,all of which align to WPD's licence requirements. A proportion of these costs are reported and forecast in this activity in line with regulatory reporting requirements.

14.25. Costs relating to data transfer are incurred from a company called Electralink, which was set up as part of the 1998 project to procure and run the Data Transfer Service (DTS) on DNOs' behalf.

14.26. Costs and income in these activities are low and have been assumed to carry on at current levels into RIIO-ED2. Costs are shown in Figure SA-06. 246.

Legacy meters					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	0	0	0	0	0
RIIO-ED2 Annual Average (forecast)	0	0	0	0	0
RIIO-ED2 Total (5 years)	1	1	0	0	2

Figure SA-06. 246: RIIO-ED2 forecast total expenditure - legacy matters

De Minimis

14.27. The services included under this heading which will be continued going forward are:

- property rentals to third parties;
- training provision to third parties;
- fleet maintenance to third parties; and
- private networks.

14.28. Some services have been discontinued in RIIO-ED1. This includes the multi-utility offering (gas/water).

14.29. Costs are shown in Figure SA-06. 247. For the services continuing, it is expected that volumes of activity will remain constant during the RIIO-ED2 period.

De Minimis					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	2	2	2	2	7
RIIO-ED2 Annual Average (forecast)	1	1	2	2	5
RIIO-ED2 Total (5 years)	5	3	10	8	27

Figure SA-06. 247: RIIO-ED2 forecast total expenditure - de minimis

Other consented activities and out of area networks

14.30. WPD does not provide any service under these headings and so no costs have been included in this Business Plan.

15. Non activity based costs

15.1. These are costs where companies can vary their annual revenue in line with the actual cost, either because they are outside the DNO's control or because they are subject to separate price control measures. These costs are therefore outside Totex.

Pass through

15.2. Pass through cost in RIIO-ED1 includes network rates, transmission exit point charges and Ofgem licence fees. We have assumed in determining allowed revenues that these items will continue to be treated as pass through costs in RIIO-ED2.

15.3. Network rates are reviewed periodically by government. The next revaluation will take place in April 2023 with a valuation date of 1 April 2021. While the outcome of this is uncertain, we have held our forecast constant at the current level for RIIO-ED1.

15.4. The WPD network is connected to the National Grid at transmission exit points. National Grid provides infrastructure at these exit points to allow power to flow from the transmission system to the distribution network. National Grid recovers the cost of providing the exit points through annual charges. We have kept our forecasts consistent with the end of RIIO-ED1.

15.5. Ofgem licence fees are calculated for the year ahead based upon an estimate of Ofgem's net costs plus an amount for Consumer Focus and Consumer Direct/The Office of Fair Trading. These are allocated across licence holders in proportion to the number of customers. Fees are assumed to remain at the same level as in RIIO-ED1.

15.6. RIIO-ED1 also allowed some costs associated with smart metering to be treated as pass through, until the rollout programme is complete. As this programme is continuing into RIIO-ED2, the pass through will continue until the end of this price control period. The costs relate to smart meter communication licensee costs (those costs payable to the Data and Communications Company (DCC) which manages the systems for communications between the meters and users of smart meter services) and smart meter Information Technology costs (expenditure on additional IT assets and services which are specifically associated with the systems required to access, store, process and use smart meter derived data).

15.7. A small forecast has been included for incremental costs associated with complying with the additional regulatory requirements of ring fence requirements.

15.8. Pass through is also applicable for costs associated with Supplier of Last Resort and bad debt associated with supplier default. Since bad debt is difficult to forecast, we have assumed nil cost for this.

15.9. Figure SA-06. 248 summarises our forecast pass through expenditure compared to RIIO-ED1.

Pass through					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	48	52	28	31	159
RIIO-ED2 Annual Average (forecast)	44	43	23	29	139
RIIO-ED2 Total (5 years)	221	213	115	147	695

Figure SA-06. 248: RIIO-ED2 forecast total expenditure - pass through

Other non-activity based costs

15.10. The main element of these costs relates to Established Pension Deficit Repair costs.

15.11. Ofgem has given companies an allowance to pay the regulated 'distribution' portion of the WPD ESPS and the CN ESPS deficits as at 31 March 2010. This is known as the Established Deficit. These allowances for companies' Established Deficits are updated through a triennial review. The last review was completed in November 2020 and the next triennial review will be in November 2023 (based on the 2022 actuarial valuation). We have included a forecast in this plan based on the latest projection from our actuarial service provider, but we do not currently anticipate the requirement for any further allowances in RIIO-ED2 to cover these. This will be reviewed again as part of the 2023 Reasonableness Review. Supplementary Annex SA-09 'Financing our Plan' also includes further detail on our pension forecasts.

15.12. The only other cost forecast in this section relates to profit/loss on disposal of assets. Assets are disposed of when they are removed from the network or at the end of their useful life (e.g. vehicles) and will be sold as scrap as far as possible, both for environmental reasons and to recoup some of the original cost. Although difficult to forecast, an amount has been included in the forecast based on the 2019/20 value of this activity, with an adjustment relating to the sale of old ICE vehicles and future EVs in the fleet, aligned with modelling in the CBA accompanying EJP001 for EV adoption in our commercial fleet.

15.13. No other costs have been forecast in this activity. Nil has been assumed for both the value of non supplier bad debts and the value of guaranteed standard and ex-gratia compensation payments.

15.14. Figure SA-06. 249 summarises our non-activity based costs for RIIO-ED2 compared to RIIO-ED1.

Other non-activity based costs					
£m, 20/21 prices	West Midlands	East Midlands	South Wales	South West	WPD Total
RIIO-ED1 Annual Average	26	26	22	35	108
RIIO-ED2 Annual Average (forecast)	-1	-1	2	5	5
RIIO-ED2 Total (5 years)	-4	-6	12	23	24

Figure SA-06. 249: RIIO-ED2 forecast total expenditure - other non-activity based costs

16. The efficiency of our RIIO-ED2 business plan

Summary

16.1. WPD has a track record of delivering high quality of service to our customers at efficient costs. At RIIO-ED1 we were the only DNO to be fast tracked, demonstrating we proposed an efficient plan, clearly linked to outputs with our customer's requirements at the centre of our plan, which required little intervention by the regulator.

16.2. Our commitment in RIIO-ED1 has been to deliver excellent service performance in the most efficient way possible. We have delivered performance levels beyond our commitments while realising efficiency savings for customer's equivalent to 0.3% Totex underspend (for the full RIIO-ED1 period). We are also delivering significant additional outputs, including connecting over 10GW of distributed generation and more recently a green recovery programme in response to customer and Government requirements, which are beyond those set out in our RIIO-ED1 plan.

16.3. In RIIO-ED2, we are committing to further improve the standards of service provided for our customers and stakeholders, and we are looking to lead the industry with our environmental action plan. Alongside these, we are also committing to deliver new and increased volumes of activity, including delivery of additional network capacity to facilitate central government net zero policy targets.

16.4. Affordability and delivering value for our customers are very important to us. We always strive to be efficient while continuing to deliver our outputs and commitments and to provide industry leading performance and innovation. This is documented in our Destination Net Zero: Business Innovation and Efficiency Strategy (see **www.westernpower.co.uk/RIIO-ED2/innovation-efficiency-strategy**).

16.5. In preparing our business plan we have challenged ourselves to deliver our programme of work building in ambitious efficiencies, helping to keep customer bills broadly similar to RIIO-ED1, despite the significant increase in activity. Whilst our RIIO-ED2 plan costs are higher than RIIO-ED1, due to the need to facilitate over 1.5million EVs connecting to our network, and increasing environmental and performance standards, our proposed costs present better value for money for customers and the environment than in previous periods.

Evidencing the efficiency of our RIIO-ED2 costs

16.6. In preparing our RIIO-ED2 forecasts, we have considered our historical efficiency performance in RIIO-ED1 to date, both in relation to the performance between our four licence areas, and between the 14 DNOs in the GB electricity distribution sector.

16.7. We have not been able to make comparisons beyond the GB electricity distribution sector due to non-comparability of the regulatory jurisdiction, policy context, costs and activities and different reporting approaches / definitions. It would not be possible to determine whether performance to a benchmark that included observations beyond our sector was due to differences in underlying efficiency or differences in how costs have been captured.

16.8. However, we have sought external assurance to ensure our proposed unit costs are efficient. We appointed GHD, one of the world's leading professional services firms, who provide

advisory services in the global market sectors of water, energy and resources, environmental and project management services, to review the unit costs that we have prepared for our Asset Replacement forecast (the largest activity area in our Business Plan). GHD's conclusion is that the "resulting unit costs for each asset are typical, accurate and efficient"[12].

16.9. The asset replacement unit costs have also informed the primary reinforcement costs in our Business Plan. This means that over 20% (£1.4 billion) of the costs in our Business Plan have been externally assured as efficient.

Embedded efficiency savings in our RIIO-ED2 plan

16.10. Figure SA-06. 250 summarises efficiency savings we have embedded in activities throughout our plan. In addition, we have included ongoing efficiency savings in our plan. These are discussed in chapter 17 of this annex.

Totex efficiencies	RIIO-ED2 Benefit £m	Description	These efficiencies are embedded through our Plan[13]
Digitalisation initiatives in Connections	189	Connections self-design, Connections application tracker	Digitalisation strategy and plan, Connections strategy, Core Commitments, Chapter 8 Engineering management expenditure
Flexibility and smartgrid developments	181	DSR and flexibility, use of smart meter data, LV Monitoring to deliver targeted investment	DSO strategy, Sensors and Monitoring strategy, Core commitments, Chapters 4 (reinforcement) and 11 (IT expenditure)
Updated managed wayleaves policies	150	Clear termed wayleave-based settlement strategy	Chapter 6 Non Load expenditure
Unit cost efficiencies	110	Efficiencies embedded in our unit costs, especially in Faults activities.	Chapter 6 Faults expenditure
Working smarter	47	Investing in our business applications and improving our processes to allow staff to work more effectively	Digitalisation strategy and plan, Chapter 8 Engineering management expenditure
Owning and operating a cleaner, safer and more efficient vehicle fleet	34	Delivering savings from an electric vehicle fleet, investing in our vehicle monitoring and operating more efficiently	Environmental Action Plan, Chapter 6 Vehicles
IT and system initiatives	13	Reviewing our IT hardware, software and servers	Chapter 6 IT expenditure
Total embedded efficiencies	**723**	**Equivalent to 11% of our forecast Totex**	

Figure SA-06. 250: Embedded efficiency benefits

16.11. Figure SA-06. 251 shows that our proposed costs for RIIO-ED2 are £818 million lower than they otherwise would be if we had not embedded the efficiency savings set out in the figure above and the ongoing efficiencies.

[12] GHD (November 2021, Unit Cost Process Review: Assurance of process for RIIO-ED2 Business Plan Submission, pg ii

[13] All references to chapters are chapters in this annex

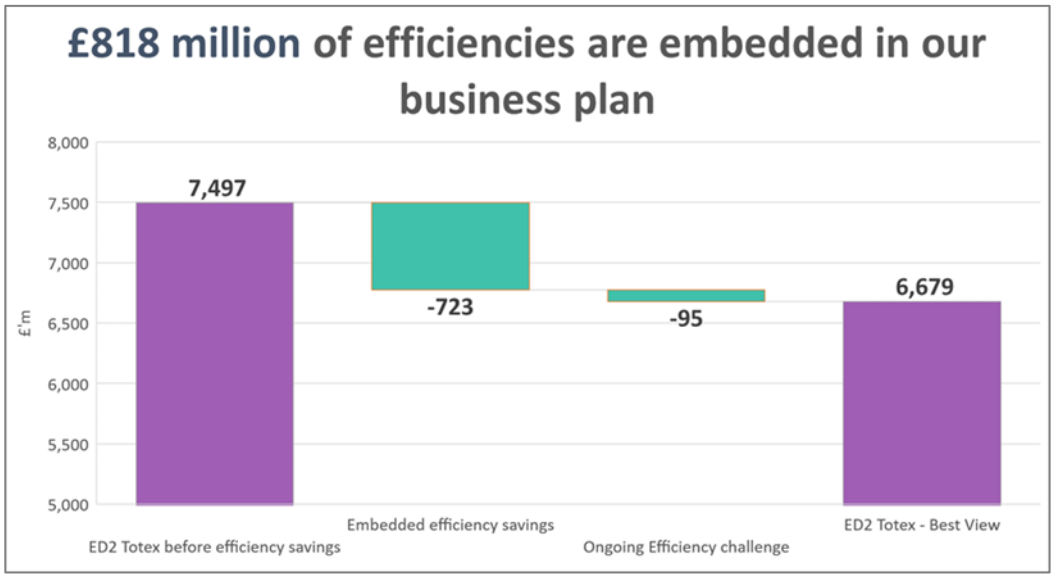


Figure SA-06. 251: Overall efficiencies

Developing our plan

16.12. Figure SA-06. 252 summarises our approach to developing our forecast unit costs. Where available, we have built our forecasts bottom-up using input costs on labour and materials and the expected scope of works. We have also benchmarked our unit costs against other DNOs in RIIO-ED1 to date, to identify activities where further efficiencies could be delivered.

Our approach to developing our RIIO-ED2 forecast unit costs			
Data	**Approach**	**Application**	**Activity**
Quantity of relevant unit cost information available (high at the top)	Bottom up detailed analysis based on representative typical projects (informed by labour, materials and contractor costs)	High expenditure areas New areas of work that have no historical reference	- Asset Replacement - Legal & Safety - school risks - Rising & Lateral Mains - Environmental reporting - new progs (e.g. POPs) - Tree Cutting - adoption of LiDAR
	Historical 3 year average (last three years)	High volume activities Representative of more recent business practice and cost base	- I,R&M - Faults & ONIs - Smart meter defects
	Historical ED1 average	Lower volume activities Longer time period used to get a more representative unit cost of typical work.	- Legal & Safety - substation security - Civils - OHL Clearances - Worst Served Customers - Diversions - Refurbishment
	Historical all WPD ED1 average	Very low volumes of activities Recognition that some activities may not have taken place in a DNO area so alternative references are required	- Flood defences
		Recognition that some activities may not have taken place in a DNO area so alternative references are required	- Environmental actions such as PFT
	Historical all WPD ED1 and DPCR5 average	Rarely carried out activities Token volumes to cover off infrequent work	- Used infrequently

Figure SA-06. 252: Our approach to developing our RIIO-ED2 forecast unit costs

16.13. There are other activities for which expenditure forecasts are not built up on a unit cost basis because volumes for these activities are not measured. We have used a similar approach to the above, referring to historical performance and benchmarking against other DNOs, as well as referring to outputs and commitments that our customers and stakeholders want us to deliver, known changes in RIIO-ED2 and increasing workloads in RIIO-ED2.

16.14. Focusing on our previous total cost performance is not always appropriate to test the efficiency of future costs. This is particularly relevant where the proposed solutions are different (e.g. greater need for cyber security) or where the volumes of activity are likely to rise and are outside the control of the DNO (e.g. connections activity and investment to support decarbonisation impacts such as increased electric vehicle charging).

16.15. For this reason, we consider that our bottom-up approach to costing our programmes of work, built on externally tested unit costs where appropriate, is appropriate and reliable. Our programme of work is consistent with the outputs we have committed to deliver, and we sought to further optimise the combination of resources based on our experience.

16.16. The following sections present case study examples of our disaggregated approach to our RIIO-ED2 forecasts aligned to the above hierarchy and illustrate how we have tested the efficiency of our RIIO-ED2 costs. These case studies relate to:

- Asset replacement (16% of RIIO-ED2 forecast expenditure inside the price control)
- Faults (6% of RIIO-ED2 forecast expenditure inside the price control)
- Core engineering management costs (16% of RIIO-ED2 forecast expenditure inside the price control)

Case Study: Asset Replacement

16% of RIIO-ED2 forecast Totex

16.17. Asset replacement activity is driven by a number of underlying network factors, including asset condition, historical trends / learned characteristics of assets of a certain type as well as the overarching strategy of asset management. Overall, our RIIO-ED2 asset replacement forecast is driven by a strategy to remove poor condition assets. We view the resultant network risk as being a consequence of our actions rather than the driver of need. For example, we do not seek to undertake a level of activity to maintain the overall health of assets as such a strategy assumes that the underlying level of network risk is correct. By focusing on the assets that need intervention, network performance is maintained.

16.18. WPD's outturn unit costs for asset replacement are efficient compared to Ofgem's RIIO-ED1 expert view unit costs[14] and compared to the outturn unit costs of other DNOs. While we are not driving the benchmark on each and every sub-activity (there are 103 individual asset replacement activities), our total asset replacement costs are efficient overall.

16.19. We have developed our RIIO-ED2 asset replacement unit costs bottom-up using detailed analysis based on representative typical projects (informed by labour, materials and contractor costs) for each activity of asset replacement. Our unit costs are forecasted to increase slightly in RIIO-ED2 even after considering ongoing efficiency gains. The increase reflects higher contractor costs (which are likely to affect all DNOs) and the use of lower loss assets (which are of higher capacity) at RIIO-ED2.

[14] These were established to support RIIO-ED1 cost assessment for asset replacement and have since been the reference unit costs used to inform other assessments in RIIO-ED1, such as the calculation of Monetised Equivalent Asset Value (MEAV).

16.20. Larger capacity assets may be used either to reduce network losses or to take account of anticipated load growth. The anticipated load growth from the increased uptake of low carbon technologies (electric vehicles and heat pumps) means that consideration will be given to installing greater capacity assets where there is a strong indication that load growth will take place. This incremental reinforcement should negate the need for subsequent reinforcement as load increases, meaning that assets are only 'touched once' before 2050. The small incremental increase in material costs will reduce long term costs particularly for cable assets, where the majority of the costs arise from excavation and reinstatement. No additional costs have been included in the forecast for 'touch once', but the unit costs used represent the lower loss assets that will be used in RIIO-ED2.

16.21. The combination of deriving our RIIO-ED2 unit costs bottom-up and then testing them against RIIO-ED1 benchmarks has provided assurance that our proposed RIIO-ED2 expenditure is both deliverable and efficient. This is important given the scale of asset replacement activities we carry out (representing 16% of our proposed RIIO-ED2 costs) and our usage of asset replacement unit costs to inform our RIIO-ED2 forecast expenditure in other areas, including reinforcement. As described above, our asset replacement unit costs have also been subject to an external review by consultants GHD.

16.22. There are a number of reasons that explain why our efficient unit costs vary between our four DNOs. This is also discussed with reference to specific asset categories in para 5.139.

16.23. Firstly, there is regional variance in our input costs. Regional variations are accounted for by incorporating local contract rates. For example, there are different contracts in place for excavation activities across WPD's licence areas. These are all subject to competitive tendering processes but, due to availability of contractors within an area or timing of contractual negotiations, can lead to variations in different WPD areas. The unit cost derivation has incorporated these regional variations which is why there is a range of typical costs for asset replacement activities across WPD.

16.24. Pension costs also cause minor variations between our four DNO areas. Unit costs need to include an element for pension costs which may differ because of the different schemes in operation across WPD and the staff who belong to the various schemes (see para 3.33). Further detail on our pension costs are included in this annex and in Supplementary Annex SA-09 'Financing our Plan'.

16.25. Secondly, there are differences due to the equipment used in different licence areas as a consequence of historic network topography. For example, in the West Midlands, there is limited 33kV network and therefore transformation is directly from 132kV/HV. This means that the mix of transformer sizes will be different between our DNOs.

16.26. Third and finally, our RIIO-ED2 unit costs may vary across our DNOs (and will also be different to our RIIO-ED1 unit costs) where larger capacity assets are used either to reduce network losses (i.e. an uplift for our losses initiatives) or to take account of anticipated load growth. Generally, however, assets will be replaced on a like-for-like basis using modern equivalents.

CASE STUDY: FAULTS

6% of RIIO-ED2 forecast expenditure

16.27. Total fault costs are driven by the cost of repair and volume of faults requiring work. The cost of repair varies by the type of fault and voltage. Even then, fault costs of the same type and voltage can vary substantially, reflecting a wide range of different situations and required work content. Faults typically occur due to deterioration of assets and external damage (e.g. by trees or third parties). As such, poor network health, greater tree coverage and poor vegetation management can lead to a higher fault rate. Year-on-year volume fluctuations can be attributed to weather-related damage, such as wind, rain and lightning.

16.28. WPD's drive for excellent customer service means that we respond to faults quickly and restore supplies quickly. As a consequence, we have recorded a very small number of guaranteed standard failures, making us an industry leader. This enhanced performance, delivering what our customers expect, comes with a higher cost.

16.29. We recognise that our fault costs have been generally higher than our peers and therefore have set ourselves significant challenges to reduce costs in the remainder of RIIO-ED1, as well as proposing unit costs for RIIO-ED2 that build in efficiency savings. We have embedded over £100 million of savings in our Business Plan.

16.30. The

16.31. Faults section of this supplementary annex details our approach to setting our fault unit costs in RIIO-ED2.

CASE STUDY: CORE ENGINEERING MANAGEMENT COSTS

16% of RIIO-ED2 forecast expenditure

16.32. Our core engineering management costs comprise costs associated with network design and engineering, project management, system mapping, engineering management and clerical support, stores, network policy, the control centre and the call centre. Expenditure in this area provides the planning, project management, and coordination activities that enable works on our network to take place.

16.33. Based on RIIO-ED1 to date cost performance, we recognise that there are opportunities to improve the efficiency with which we deliver these business-critical support activities. However, it is important that we do not cut corners in the back-office functions in order to focus our operations in the field on efficient delivery and driving service performance improvements.

16.34. WPD has undertaken a number of internal reviews of specific cost areas in RIIO-ED2 to identify and share best practice across our four licence areas, leading to lower costs in our forecasts than would otherwise have been the case. One focus area has been on overtime, where we have analysed the variations and reasons for overtime across our networks in RIIO-ED1, to reduce this as much as practicable in RIIO-ED2.

16.35. As we approach RIIO-ED2, we are committed to delivering new and increased volumes of activity, including the delivery of additional network capacity to facilitate central government's net zero targets. While this means a 108% increase in our load-related expenditure for RIIO-ED2 compared to RIIO-ED1, we are looking to deliver even more value through our engineering management activities as we continue to identify new and more efficient ways of working. This includes making better use of new data streams and developing new planning and mapping tools, to enable our existing design teams to deal with the expected increase in connection quotations for EVs and heat pumps in RIIO-ED2.

16.36. Despite the 108% increase in load-related expenditure for RIIO-ED2, we are only proposing 8% increase in our core engineering management costs to deliver this significant increase in work. We are also committed to the rollout of proven innovation in the RIIO-ED2 period. Our plan includes additional investment in extra staff and systems to replicate projects, scale up solutions to a production standard and cover the cost of training/deployment. We anticipate that some projects will bring improvements in systems and processes that will directly benefit engineering management activities.

We have high confidence in our plan

16.37. We have developed our plan by building it bottom-up. Building a plan bottom-up has several advantages over a top-down approach (a top-down approach is, for example, where the cost envelope that we would be allowed is estimated and a programme of work is matched to this estimated 'budget'). These advantages include:

- Developing a programme of work that is appropriate in scope and cost for our network and our customers.
- It requires us to consider and justify each individual programme of work.
- It allows us to explicitly take into account the interactions between planned activities – an interaction which might be overlooked in a top-down approach.
- It is consistent with our internal assessment of efficiency and monitoring of spend relative to delivery, providing understanding not only of what efficiencies (and inefficiencies) might exist but where they originate from and how they can be targeted. This cannot be appreciated in a top-down approach to plan development.

16.38. We are confident that our business plan is efficient. Our bottom-up approach, supported by detailed EJPs, an external review on key elements of the plan and benchmarking across our four DNOs, provides us with high confidence in our business plan.

16.39. We have considered the confidence in our forecasts, activity by activity, in a way that satisfies Ofgem's economic and engineering definitions of confidence:

- From an economic perspective, we have only included forecast costs in our baseline plan where it is possible to set independent benchmarks. Namely, where there is enough data to allow for the development of a robust cost benchmark. This follows Ofgem's Cost Assessment Working Group (CAWG) discussions on how stage 3 and stage 4 of the BPI will be assessed with respect to the confidence of costs.
- From an engineering perspective, we have only included projects for which we have high confidence in the expected costs. These forecasts were based on historical outturn costs consistent with our in-source operational model.

16.40. Reinforcement is a key uncertainty area at RIIO-ED2. Our baseline Totex view includes only reinforcement costs and volumes of investment we expect to be required on the network to fully deliver on government and local authority objectives. There is a risk in RIIO-ED2 that as more and more local authorities look to decarbonise their areas as quickly as possible, this will put pressure on us to reinforce the networks quicker and quicker. To mitigate the risk associated with future levels of load growth and reinforcement activity, we have proposed a symmetrical load-related volume driver[15]. This uncertainty mechanism ensures that risk is allocated efficiently between customers and shareholders in the face of uncertain and uncontrollable growth. It reduces the risk that customers pay for assets that are not required (e.g., under a low

[15] See Supplementary Annex SA-07 'Managing Uncertainty'.

growth scenario). It also reduces the risk that investors are unable to recover costs on assets that are required beyond what was forecasted at the beginning of the period (e.g., under a high growth scenario).

16.41. The unit cost for the uncertainty mechanism that we propose is based on the cost of reinforcement projects across our DNOs. We used projects for which we have high confidence in their design and have challenged their cost to be efficient.

16.42. We have also included two Price Control Deliverables (PCDs) in our plan: for the purchase of EVs to decarbonise our fleet and for switching from remotely controlled communication devices on the network to an LTE communications protocol. PCDs ensure that customers are protected if we do not deliver these activities.

The cost assessment framework at RIIO-ED2

16.43. The sector is undergoing significant changes in RIIO-ED2. These changes affect the nature of services, and consequently the cost base, delivered by DNOs. These changes include:

- Developing DSO capabilities and flexible solutions.
- Transitioning to net zero through adoption of low carbon technologies (e.g. electric vehicles).
- Ramping up reinforcements to support LCT connections (e.g. EVs and heat pumps) and facilitate the transition to net zero.
- Enhancing our IT&T, cyber resilience and security infrastructure to support these new demands.

16.44. It is important that the cost assessment framework at RIIO-ED2 recognises these changes and adapts as required to accommodate them. The tools that were used at RIIO-ED1 should be reviewed in detail and adjusted where appropriate to ensure that they are fit for purpose for RIIO-ED2.

16.45. DNOs are rising to the challenge of supporting and delivering the new roles expected of them in RIIO-ED2. The additional expenditure being driven by central government policy changes needs to be reflected in cost assessment. Under-provision of allowances brings with it the risk of delay and under-delivery, with far reaching consequences, including to third parties and on the UK's delivery of net zero.

16.46. Below we set out key issues and considerations that need to be reflected in the cost assessment framework at RIIO-ED2.

The importance of disaggregated assessment in RIIO-ED2

16.47. Both Totex and disaggregated models (e.g. activity based models) have their respective advantages. Disaggregated models allow consideration of more bespoke cost drivers and will help reveal information on the specific cost of different activities. Totex models take into account trade-offs between activities and are less susceptible to potential inconsistent allocations of costs across activities by DNOs.

16.48. For these reasons, regulators have tended to use both approaches in combination in recent price determinations. Both approaches were an important part of the cost assessment toolbox at RIIO-ED1.

16.49. A key question for RIIO-ED2 is whether Totex and disaggregated models can adequately capture the significant changes set out above? How best can such policy drivers be captured in any RIIO-ED2 modelling? For example it is not clear how Totex models' cost drivers would reflect the work required on the network to facilitate net zero by 2050, resulting in a ramp up of work for EVs, when a number of the drivers are network length and customer numbers, which will not be changing to anywhere near the same extent over the period.

16.50. Given these changes, we consider that the disaggregated approach offers important advantages over the Totex modelling approach. Disaggregated models allow more flexibility in the choice of model specification and the implementation of bespoke adjustments to capture the change in the nature of costs. Compared with Totex models, disaggregated models can better deal with the fact that the future may be very different to the past.

16.51. Moreover, in the face of uncertainty regarding future electricity demand scenarios and the role of DSOs, different DNOs may use different planning scenarios and assumptions in their business plan. This can create a bias to Totex models which use high level cost drivers. This bias is because while the Totex forecast would change with the underlying scenario, high level cost drivers would largely be unaffected. Disaggregated models can mitigate this challenge by using a cost driver that reflects the planning scenario, such as a workload driver. This ensures that the benchmarking is not distorted, and Ofgem can apply a separate scrutiny and adjustment to the cost driver should that be required for the setting of allowed cost.

16.52. Totex models, on the other hand, tend to use high level cost drivers (e.g. MEAV, population) and are therefore less flexible to adapt and reflect efficiency under circumstances of change and diverging assumptions across DNOs. There is a significant risk that Totex models would confound efficiency with a DNO's planning scenario and programme of work at RIIO-ED2.

16.53. The importance of disaggregated benchmarking was highlighted by the CMA in its final determination to the Bristol Water referral in 2015.[16] The CMA critiqued Ofwat for not using disaggregated benchmarking in its cost assessment at the 2014 price review (PR14). It highlighted advantages of disaggregated modelling ("Disaggregated models or more granular forms of benchmarking analysis may allow a more accurate estimation of the relationship between expenditure and specific cost drivers and allow a greater number of cost drivers to be taken into consideration"[17]) and disadvantages of Totex modelling. The CMA states: "Totex approach also comes with drawbacks and risks; these need to be considered alongside their benefits and, in our view, raise questions about an approach that places emphasis on high-level Totex models without complementing these with other forms of analysis".[18]

16.54. The CMA specifically used the RIIO-ED1 disaggregated approach as an example of disaggregated benchmarking that provides "significant benefits…despite the existence of trade-offs between opex and capex and cost allocation issues".[19]

16.55. We summarise key advantages of the disaggregated approach:

- Disaggregated modelling allow the cost drivers to be tailored to the activity, reducing risks of inaccuracy in estimated coefficients, in particular when the nature of costs changes over time and when different DNOs may make different underlying assumptions about the future.
- Disaggregated modelling provides greater depth of efficiency understanding, not only what efficiencies or inefficiencies might exist but where they originate from. This knowledge is

16 Competition and Markets Authority (6 October 2015), Bristol Water Plc: a reference under section 12(3)(a) of the Water Industry Act 1991, final report pp 69-71 and appendix 4.1
17 Ibid, final report, paragraph 4.46, page 70.
18 Ibid, final report, paragraph 4.47, page 71.
19 Ibid, appendix 4.1, paragraph 150, page A4(1)-34.

useful to both the regulator and DNOs to support the targeting of efficiency improvements and subsequent monitoring, e.g. through the RRP annual reporting.

Cost drivers for Totex modelling at RIIO-ED2

16.56. A challenge with Totex modelling is finding cost drivers that would accurately isolate efficiency rather than reflecting a company's programme of work (so that if it is in a period of intensive investment it would look inefficient even if the investment is efficient).

16.57. The ENA commissioned Oxera, on behalf of the DNOs, to consider cost drivers for Totex modelling at RIIO-ED2.[20] The Oxera study is insightful. While the report finds that that MEAV is the single best cost driver for modelling historical data, it clearly caveats that this is based only on partial RIIO-ED1 data (i.e., up to 2019-20) and that the anticipated changes we have set out above (e.g., transitioning to net zero and DSO functionalities) mean that a simple extrapolation of historical cost models is not appropriate. Oxera was also unable to identify drivers for the DSO functionality in the context of a Totex model.

An academics' critique of the RIIO-ED1 Totex modelling

16.58. We consider that the commentary of Gibbens and Zachary (2013)21 with respect to the candidate RIIO-ED1 Totex models remains valid and should be reflected upon again ahead of RIIO-ED2 model development, namely:

- The statistical relationship of the variables identified in the model are commonly not reflective of operational insight[22,23]
- The challenge of disentangling inefficiency from the unidentified or unmeasurable company-specific factors embedded in the residual is not possible without strong assumptions on the distribution of efficiency and a significantly large data set; neither of which are remotely satisfied[24].
- The inclusion of variables that are relatively constant introduces collinearities into the fit of the model which means that the regression coefficients cannot be determined with confidence. These variables are typically those which might be used to capture heterogeneity between companies, such as density. It is also not appropriate to leave out of the model variables representing heterogeneity as this simply redefines all heterogeneity as efficiency[25].
- The use of a random effects model is not a sufficient solution[26].
- There are also associated issues with density as a variable, because it is so heavily influenced by just two licensees[27].

[20] Oxera (May 2021) Assessment of cost drivers for RIIO-ED2 benchmarking, prepared for the ENA.

[21] Gibbens, R.J. and Zachary,S. (May 2013) Commentary on the report by Frontier Economics to Ofgem on the feasibility of econometric benchmarking in DNO cost regulation

[22] Gibbens, R.J. and Zachary,S. (May 2013) Commentary on the report by Frontier Economics to Ofgem on the feasibility of econometric benchmarking in DNO cost regulation, p.3-4

[23] We consider this finding equally applicable to use of CSVs in Totex models, which add the further challenge of non-interpretability of the cost driver-cost relationship

[24] Gibbens, R.J. and Zachary,S. (May 2013) Commentary on the report by Frontier Economics to Ofgem on the feasibility of econometric benchmarking in DNO cost regulation, p.4

[25] Gibbens, R.J. and Zachary,S. (May 2013) Commentary on the report by Frontier Economics to Ofgem on the feasibility of econometric benchmarking in DNO cost regulation, p. 4-5

[26] Gibbens, R.J. and Zachary,S. (May 2013) Commentary on the report by Frontier Economics to Ofgem on the feasibility of econometric benchmarking in DNO cost regulation, p.5

[27] Gibbens, R.J. and Zachary,S. (May 2013) Commentary on the report by Frontier Economics to Ofgem on the feasibility of econometric benchmarking in DNO cost regulation, p. 10

16.59. Gibbens and Zachary conclude that, “for all the reasons outlined above, an econometric approach to DNO benchmarking in the present GB context is so unreliable as to produce efficiency scores which might almost as well have been randomly generated. We therefore believe that the nature of the problem, and of the available data, is such that the proposed approach is simply not feasible for this purpose”[28].

Our conclusion

16.60. In light of the above, and the points raised earlier which are significantly changing the role of electricity distribution networks in line with the UK government’s recent net zero carbon legislation, we consider that a Totex modelling approach has a lower relevance for RIIO-ED2.

16.61. This challenge may support greater use of cost exclusions and a greater weight being placed on a disaggregated approach, where each RIIO-ED2 challenge can be considered in more manageable parts, examining the specific drivers of the investment proposals.

Exclusions from Totex models

16.62. At RIIO-ED1 Ofgem excluded certain costs from its Totex models. It noted: “These are costs that are inappropriate for comparative benchmarking because they are not adequately explained by cost drivers that are being used in the Totex models or because there is a substantial change in the nature of the activity between DPCR5 and RIIO-ED1. These exclusions only apply to the Totex models. This does not apply to the disaggregated analysis. At the disaggregated level each cost activity is assessed by a bespoke model which uses the most intuitive cost driver and accounts for any changes in historical and/or forecast costs.”[29]

16.63. We consider that due to the change in nature of costs between RIIO-ED1 and RIIO-ED2, and increased focus on stakeholder endorsed costs, exclusions from Totex modelling may be proportionately more material at RIIO-ED2 than at RIIO-ED1.

16.64. For example, policy driven expenditure as discussed at the beginning of this section (e.g., in relation to transitioning to net zero and the enhanced DSO functionalities) are unlikely to be adequately captured by cost drivers in Totex models and may therefore have to be excluded and assessed using a bespoke approach.

16.65. Totex models, with their high-level cost drivers, struggle to explain costs that change in nature, or lumpy capital costs. The underlying assumption behind the Totex models is that all DNOs have a synchronous investment cycle. The CMA highlighted this point in its Bristol Water redetermination and excluded a large share of Totex which is particularly lumpy (known as ‘enhancement’ capital expenditure)[30].

16.66. We proposed a framework for the consideration of cost exclusions and presented it in Ofgem’s cost assessment working group. The framework is summarised in Figure SA-06. 253.

[28] Gibbens, R.J. and Zachary,S. (May 2013) Commentary on the report by Frontier Economics to Ofgem on the feasibility of econometric benchmarking in DNO cost regulation, p. 10

[29] Ofgem (2014). RIIO-ED1: Final determinations for the slow-track electricity distribution companies, Business plan expenditure assessment, paragraph 4.1(3), p 41.

[30] Competition and Markets Authority (6 October 2015), Bristol Water Plc: a reference under section 12(3)(a) of the Water Industry Act 1991. Final report, paragraph 4.46, pp. 69-70.

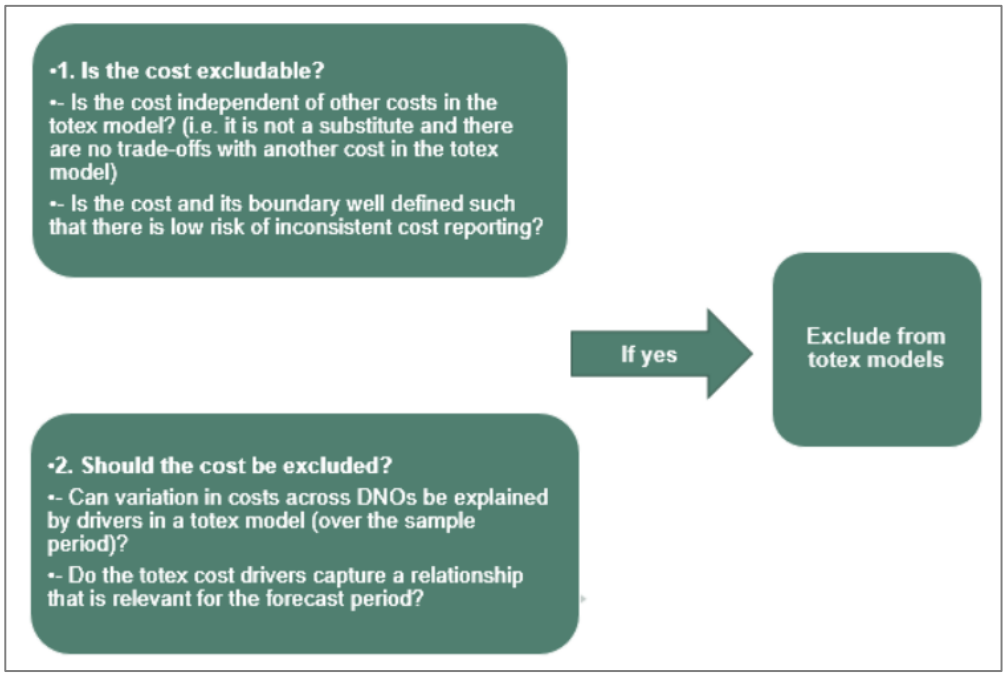


Figure SA-06. 253: A framework for the consideration of Totex models cost exclusions

16.67. The framework suggests two criteria to consider. The first is whether the cost is excludable. That is, whether it is largely independent of other costs and well-defined for cost reporting purposes. If it is largely independent then trade-offs with other costs are not material, and if it is well-defined then inconsistency in cost allocation across DNOs is not a material risk. A cost that satisfies this criterion can be excluded with relatively little risk of distortion to Totex benchmarking and should be excluded if it fails the second criterion.

16.68. The second criterion is whether the cost should be excluded. A cost should be excluded if it is not explained by the cost drivers in the model, or if it is explained by the cost drivers in the model but the nature of the cost has changed such that the estimated parameters are not relevant for the purpose of forecasting costs for the future.

16.69. We consider that this framework may be particularly relevant for costs of the following nature:

- Costs that are new or have substantially changed in nature.
- Costs that are incurred by a small number of DNOs, which may include cost driven by stakeholder support and region-specific cost – see below.
- Costs that are very atypical or lumpy.
- Costs that are related to mandated programmes and therefore the volume of work is beyond company control.

16.70. Applying the criteria above may not always be clear-cut and would require analysis, assessment and judgement. However, having an analytical framework against which to make decisions can help make this process work better. Excluding costs appropriately can improve the overall quality and accuracy of cost assessment with benefits for companies and customers.

Stakeholder endorsed costs

16.71. We have undertaken extensive engagement with our stakeholders and customers, consulting on our Business Plan and holding a number of workshops to co-create our RIIO-ED2 plan in line with our core business commitments (as set out in Supplementary Annex SA-02 ‘Our Commitments’) as well as Ofgem’s requirements.

16.72. We have received a strong stakeholder endorsement and willingness to pay for increased expenditure compared to RIIO-ED1.

16.73. We urge that due consideration is given to the voices of our customers and stakeholders when assessing the expenditure we have proposed. Stakeholder endorsed costs may be best assessed separately, as a cost exclusion, to support benchmarking on a comparable basis across DNOs.

16.74. For example, to enhance the safety of our network our stakeholders approved our commitment for RIIO-ED2 to divert overhead lines, where these cross school-playing fields. This illustrates our ongoing efforts in this area to deliver safety standards over and above those required of us. The cost of this programme would not be reflected in the historical data and should be assessed separately as a cost exclusion.

16.75. We consider that expenditure associated with Consumer Value Propositions (CVPs) should also be excluded from Totex models due to the high likelihood of non-comparability of CVP expenditure across DNOs, both in number and type of CVPs. We have highlighted these and other areas of stakeholder endorsed costs as 'bespoke activities' in BPDT table M21.

Green recovery

16.76. RIIO-ED1 'green recovery' expenditure should be excluded from cost assessment, if and where Ofgem chooses to rely on historical cost information to assess future costs. This is because green recovery expenditure has been separately assessed and approved and, for some companies, will affect the view of efficiencies gained in RIIO-ED1. Ofgem should also give due consideration to the treatment of green recovery expenditure that will be incurred in the early part of RIIO-ED2 as the schemes are completed.

Accounting for service quality in cost assessment

16.77. Incentivising high standards of service to customers is rightly at the heart of Ofgem's approach to regulation. WPD has a track record of delivering sector leading standards of service. In RIIO-ED2 we plan to improve our standards of service further, in line with what customers and stakeholders expect from us.

16.78. Ofgem's cost assessment approach relies on comparative assessment (benchmarking). Ofgem compares costs across DNOs to identify which DNOs are efficient (in the sector) and which ones are inefficient. To make DNOs' costs comparable, Ofgem standardises them for various factors that drive, or are correlated with, costs. For example, Ofgem standardises DNOs' costs for differences in total asset value, units distributed, volume of work done and other factors.

16.79. Importantly, DNOs' costs have not historically been standardised for the varying standards of performance across DNOs. As a result, companies that deliver a high quality of service, and incur additional costs in the process, will appear less efficient in a comparative assessment than if differences in service levels were taken into account. This, in turn, may have three consequences on the accuracy of allowed cost:

- The models may be biased. The omission of a relevant cost driver may cause the models' parameters to be biased, which in turn leads to inaccurate cost predictions by the models.
- The efficiency benchmark may be biased (i.e., overly stretching). This is because the omission of service quality standardisation from the comparative assessment may lead to identifying false efficiencies: companies that appear efficient may not in fact be efficient but incurring low cost due to provision of a lower-than-average quality of service.

- There is a disconnect between a DNO's cost allowance and its quality of service (even if the models and efficiency benchmark were not biased). The omission of a service quality cost driver from benchmarking models means that cost allowances are not based on a DNO's service quality.

16.80. The first and second issues can be mitigated by careful consideration of the efficiency benchmark. The efficiency benchmark must be chosen to reduce the risk that it is unduly influenced by low-cost companies rather than by truly efficient companies. Ofgem must also recognise that other than the normal statistical noise that leads regulators to shy away from setting the efficiency benchmark at the 'frontier' (usually opting to use the 'upper-quartile' instead), the issue of bias discussed above also adds to statistical inaccuracy and should play a role when determining the efficiency benchmark.

16.81. The third issue can be addressed through post-modelling adjustment. Without a service quality cost driver in the models, the models provide funding to deliver average performance in the sector. If a DNO's performance targets are different from average performance, a cost adjustment would be appropriate to ensure that DNOs are accurately funded to deliver their targets (and the outputs/ODI framework would incentivise companies to go beyond the target).

16.82. Outcomes Delivery Incentives (ODIs) on their own do not address the issue. ODIs are paid for improving incentive beyond a target. The issue at hand is that varying levels of performance are not considered when deciding the level of funding for companies to maintain their different performance levels, or to improve them up to the target level.

16.83. Service quality performance needs to be integrated into cost assessment. Above average performance that results in above average costs should not be automatically considered as inefficient. We have presented on this issue at Ofgem's CAWG and are keen to continue providing supporting to further develop an approach to this issue at RIIO-ED2.

16.84. In the water sector Ofwat identified the area of quality of service and cost assessment integration as a key area to resolve for its next price control, PR24[31]. This follows its experience in its recent price review, PR19, and the subsequent CMA appeal, where it transpired that Ofwat has not given the issue enough attention.

16.85. The lack of integration between cost assessment and service quality has been also highlighted by Oxera in their report to the ENA on cost drivers for RIIO-ED2. Oxera notes that it has previously argued that "the relationship between costs and service quality must be analytically modelled when setting cost allowances" and that "cost assessment has historically not taken sufficient account of differences in quality/performance as a differentiating factor between DNOs".[32]

Considering the long term and environmental benefits in cost assessment

16.86. Delivering an environmentally sustainable network is extremely important to both our customers and us, and is at the centre of government policy. DNOs play a key role in facilitating the transition to net zero.

16.87. To demonstrate our duty to the environment, and in response to stakeholder feedback, we are committing to achieving net zero in our internal business carbon footprint by 2028.

[31] Ofwat (May 2021), PR24 and beyond: Creating tomorrow, together, Chapter 10.
[32] Oxera (May 2021) Assessment of cost drivers for RIIO-ED2 benchmarking, prepared for the ENA, pages 118-119.

16.88. As part of this, we are working towards establishing a non-carbon vehicle fleet during RIIO-ED2. In strict value for money terms, delaying this investment until RIIO-ED3 could be considered more cost-efficient; however, this does not account for the environmental cost of carbon-emissions released to the atmosphere in the interim and the domino-effect of environmental impact triggered as a result.

16.89. Investing in environmentally sustainable solutions is the right thing to do. However, DNOs that invest in sustainable solutions may appear inefficient because such investments are often may not represent the least cost option in the short term.

16.90. Ofgem must ensure that its cost assessment framework is not short sighted and does not disincentivise DNOs from undertaking the appropriate sustainable investments. Ofgem must consider sustainable investments on a whole life cost basis and the wider benefits to communities and the environment must be recognised (even if these benefits do not directly offset DNOs' costs in the short or long run).

Regional factors and company-specific factors

Regional factors

16.91. There may be factors that are specific to a DNO's region, which affect the efficient costs of operating in the region. To ensure benchmarking is done on a comparable basis and allowances are efficient and accurate, these factors must be taken into account in cost assessment.

16.92. The cost assessment framework allows DNOs to make a well-evidenced claim for cost adjustments in respect of regional factors in their area. These factors must be beyond management control and have a unique or disproportionate impact on a geographic region.

16.93. Historically, Ofgem made adjustments in respect of regional wages (acknowledging that some DNOs operate in areas where prevailing wages are higher, such as London), and density/sparsity (recognising that some DNOs incur greater costs due to a higher proportion of their operations taking place in densely populated or very rural areas).

16.94. It is difficult to say with certainty if a regional factor for any of our DNOs is required, without visibility of Ofgem's cost assessment approach, the regional adjustments that it intends to make and its approach to quantifying these adjustments.

16.95. Having said that, we do not consider that any of our regions have exceptionally high or low wage rates, density or sparsity levels, compared with most other DNOs. For this reason, we do not raise a regional factor claim at this point.

Unit cost variation

16.96. Whilst WPD is not claiming for any regional factors, required work content and costs for some of our activities do vary by DNO within our group and are related to factors which do have a geographical distribution. For example:

- **Contract services** – Our contractual arrangements reflect the nature of the supplier market for each activity across the WPD area. We use third party contracts for a number of activities including dig and lay excavation, tree management and substation civils works. There are also project specific contractual arrangements for overhead tower lines. Our tendering process allows us to select the best rates for different regions.

- **De-centralised design and implementation of policy** – Work content and unit costs can vary due to differences in localised policy requirements. Many local authorities in our licence areas have their own net zero plans, which will drive different paces of change and levels of investment on the network.
- **Differences in network configuration –** Historical network developments have led to different network configurations e.g. the West Midlands has limited 33kV network, whereas the South West has an extensive 33kV network. These differences lead to the installation of a different mix of transformer sizes, creating a different combination of material costs within unit costs.
- **Street works schemes -** There are clear regional differences in the operation of permit schemes. No such schemes are in place in South Wales, but in most local authority areas in England (but not all), these schemes are in operation. This can impose different working practices in different areas, for example, we see more stringent permit conditions applied in the Midlands than in the South West, which incurs additional cost.
- **Pension schemes -** We operate several legacy pension schemes for our employees across our business, and for these older schemes, these may have scheme specific characteristics, which impact our unit costs.

16.97. We expect Ofgem to recognise these differences in cost assessment, which is inherently conducted at a DNO level (not group) and make cost exclusions or adjustments as required to ensure high quality comparative assessment.

16.98. We expand on these forecast differences in unit costs between our four DNOs at an activity-by-activity level in other sections of this annex.

Company-specific factors

16.99. Company-specific factors are similar in nature to regional factors. These are factors that uniquely (or disproportionately) affect the costs of one or a sub-set of DNOs. Company-specific factors may not follow a geographical distribution that warrants adjustments at an industry level.

16.100. Similar to regional factors, such adjustments are made to ensure that benchmarking of costs is done on a more comparable basis and allowances are more reflective of the true efficient cost of delivery at each network.

16.101. WPD is not claiming for any company-specific factor in our RIIO-ED2 plan. This position may change depending on the information that comes to light during the price review process, including in relation to Ofgem's cost assessment approach.

16.102. Despite not claiming for a company specific factor, we have highlighted the areas associated with unit cost variation (discussed in paragraph 16.96) in BPDT table M25. Ofgem should consider a bespoke treatment of these types of costs in their cost assessment.

17. Ongoing efficiency

Summary

17.1. "*Ongoing efficiencies are incremental gains in productivity that are achievable for a notional DNO that is already operating at the efficient frontier, due to technological progress. It is separate from catch-up efficiency improvements*"[33] which is discussed above.

17.2. In addition to the efficiencies embedded in our business plan, we have challenged ourselves to deliver a further £95m in Ongoing Efficiencies (OE) during RIIO-ED2. This is equivalent to a 0.5% per annum OE assumption, as set out in Figure SA-06. 254.

RIIO-ED2: Ongoing Efficiency assumptions							
	2023/24	2024/25	2025/26	2026/27	2027/28	Total RIIO-ED2	Average per year in RIIO-ED2
OE assumption	0.5%	0.5%	0.5%	0.5%	0.5%		
WMID Impact, £m	2	4	6	7	9	27	5
EMID Impact, £m	2	4	6	8	9	28	6
SWALES Impact, £m	1	2	3	4	5	16	3
SWEST Impact, £m	2	3	5	7	8	25	5
WPD Impact, £m	**6**	**13**	**20**	**25**	**31**	**95**	**19**

Figure SA-06. 254: RIIO-ED2 Ongoing efficiency assumption

17.3. Our assumption has been informed by a wide range of evidence identified and evaluated by the economic consultants, NERA as part of an all-DNO ENA study[34] (April 2021). In particular, this evidence base has drawn upon: growth accounting analysis, including that of the EU KLEMS data set and those of independent institutions, both before and after the Great Financial Crisis (2008); historical outturn productivity of the ED sector; and short term productivity forecasts from independent institutions.

17.4. Consideration of this wide body of evidence has informed a recommended OE assumption of 0.3% by NERA for the period of RIIO-ED2 and they have found that "the 0.1 to 0.5% range of mean estimates defines the widest range of assumptions that could reasonably be derived from the evidence"[35].

17.5. In consideration of this evidence and the conclusions by NERA, we have challenged ourselves, in line with our ambition to produce the most efficient plan, to deliver the highest point of this reasonable range and therefore included an ongoing efficiency assumption of 0.5% in this Business Plan.

17.6. "*For a given volume of outputs, ongoing efficiency improvements, can take two forms: 1) Reducing the cost of providing the given volume of outputs; or 2) Improving the quality of outputs*"[36]. As an industry-leading service performer in RIIO-ED1, we will continue to strive to improve the high quality of outputs and service our customers and stakeholders expect during RIIO-ED2. While continually seeking to improve on our outputs, we are also planning to deliver £95 million in ongoing efficiencies by releasing cost efficiencies in how we run our network, for

[33] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p. i
[34] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA
[35] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p. 11
[36] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p. 67

example through harnessing new technologies available to us in the next price control and continuing to embrace innovation and digitalisation.

17.7. We are fully committed to delivering this. Our core commitment 16 states we will: “keep bills for customers low by delivering an additional stretch efficiency saving of £95m through RIIO-ED2 (on top of £723m of efficiencies already included in the plan) by utilising innovation to improve our processes and show a positive carbon impact”.

17.8. Our OE assumption has been included in the Totex baseline view presented in this annex, but is excluded from the individual activity areas (in line with regulatory reporting requirements).

Informing our ongoing efficiency challenge

17.9. Our assumption has been informed by a wide range of evidence identified and evaluated by the economic consultants, NERA, as part of an all-DNO ENA study[37]. Figure SA-06. 255 summarises the evidence base that has been drawn upon and OE range estimates supported by each source of evidence.

Ongoing Efficiency Evidence Base and Assumption		
Evidence	Range of Estimates	Mean of estimates
Growth accounting analysis (GAA) of the EU KLEMS data set (NERA analysis)	0.3 - 0.8%	0.5%
Historical outturn productivity of the ED sector (NERA analysis)	-0.1 - 0.4%	0.2%
GAA undertaken by independent institutions	0.3 - 0.5%	0.4%
GAA undertaken by independent institutions, as above with a time period restricted to post the Great Financial Crisis (2008)	0.1 - 0.3%	0.2%
Short term productivity forecasts available from independent institutions	0.0 - 0.3%	0.1%
Mid-point of the range of mean estimates		**0.3%**

Source: NERA (April 2021), Table 1

Figure SA-06. 255: Ongoing efficiency evidence base and assumptions

17.10. The table demonstrates the range of mean estimates as between 0.1% and 0.5%, with 0.3% as the mid-point of the range of mean estimates.

17.11. Each source of evidence is briefly considered in turn.

Growth Accounting Analysis: EU KLEMS

17.12. Section 3.2 of NERA’s report sets out their Growth Accounting Analysis (GAA) using the EU KLEMS dataset. The following methodological choices have been made:

17.13. **Choice of comparator sectors[38] –** The UK has been referenced as the country comparator of greatest relevance to the UK ED sector. No one single set of comparator UK sectors has been relied on in NERA’s EU KLEMS analysis as this could invite subjectivity into the selection process. Considering productivity in the whole economy has informed two of the comparator sets[39]. Three other sets of comparator sectors reflect those used in the relevant regulatory determinations of DPCR5, RIIO-GD/T2 and the Authority for Consumers and Markets (ACM)[40]

[37] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA
[38] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, section 3.2.5
[39] one as an unweighted average and the other as an average, weighted by the share of total market sector output
[40] The economic regulator of the Netherlands for the Dutch energy networks

and therefore have regulatory precedent. Collectively the five sets of comparator sectors has informed the range of estimates of 0.3-0.8%.

17.14. **Choice of time period[41] –** NERA has used the NACE 1.1 (1970-2007) data set to inform their analysis as it provides the longest available time period. Using a longer time period reduces volatility and minimises the possibility that the productivity estimate might also include an element of catch-up.

17.15. **Choice of productivity measure[42] –** Reflecting that OE will be applied to total expenditure[43], a Gross Output (GO) measure of productivity, not a Value Added (VA) measure of productivity is appropriate in this regulatory application as it is consistent with the applicable cost base. This is because GO is "*productivity measured as the ratio of all outputs to all inputs*", i.e. total expenditure, whilst VA is "*productivity measured as the ratio of outputs after subtracting the value of intermediate inputs, to the sum of capital and labour inputs only*.[44]" Regulatory precedent on this methodological choice is set out in Table 3.1 of NERA's report (April 2021).

Historical productivity of the ED sector

17.16. Section 4 of NERA's Report sets out its methodology, analysis and estimates for historical productivity achieved by the ED sector in the 10 year period covering DPCR5 and RIIO-ED1 to date (2010/11 to 2019/20). This analysis is based on DNO supplied data on inputs and outputs, from which NERA has calculated outturn productivity as the ratio of inputs to outputs using a Törnqvist framework.

17.17. NERA identified five models each with a different specification which have collectively informed the range of -0.1-0.4% in average total factor productivity growth, across the time period.

17.18. This exercise has added new evidence to inform the OE assumption in comparison to previous energy sector price reviews[45]. The Törnqvist estimates are highly relevant as they use the most recent sample period and are based on productivity growth achieved by the sector, rather than comparators. The Törnqvist analysis provides evidence of how DNOs have performed against the RIIO-ED1 OE assumption. As with all backward looking evidence of OE, historical evidence is no guarantee of what might be achieved in the future.

Growth Accounting Analysis: Independent institutions

17.19. This section brings together productivity estimates from independent institutions that have undertaken growth accounting analysis (GAA) separate to that of NERA's analysis of the EU KLEMS data set (see paragraphs 17.12 to 17.15). NERA distinguishes between GAA using long-run data series and GAA using a time period restricted to post the Great Financial Crisis (2008)[46].

17.20. Figure SA-06. 256 and Figure SA-06. 257 set out the historical productivity informed by the GAA of independent institutions using the two time periods set out above. Productivity is expressed

[41] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, section 3.2.4

[42] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, section 3.2.3

[43] Ofgem have set out via the workings of the RIIO-ED2 Business Plan Data Tables, that OE will be applied to total expenditure (Totex) as part of base Totex.

[44] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p.29

[45] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p. iii

[46] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, section 3.3 and section 5.1.1 respectively

in Gross Output (GO) terms, providing comparability to the other categories of evidence discussed.

Growth Accounting Analysis: Long Time Period			
Institution	Comparator Sectors	Time Period	GO Productivity per annum
ONS	UK, all market sectors	1994-2019	0.3%
BoE	UK, all market sectors	1998-2007 and 2010-2019*	0.5%
OBR	UK, all market sectors	1998-2017	0.5%
OECD	UK, all market sectors	1985-2019	0.4%

Source: NERA (April 2021), section 3.3

*The BoE estimate excludes the Great Financial Crisis therefore a higher productivity estimate is expected

Figure SA-06. 256: Growth accounting analysis - long time period

Growth Accounting Analysis: Post Great Financial Crisis (2008)			
Institution	Comparator Sectors	Time Period	GO Productivity per annum
ONS	UK, all market sectors	2010-2019	0.2%
BoE	UK, all market sectors	2010-2019	0.2%
OBR	UK, all market sectors	2010-2017	0.3%
OECD	UK, all market sectors	2010-2019	0.1%

Source: NERA (April 2021), Table 5.1

Both tables have been informed by the Office for National Statistics, ONS (January 21); the Monetary Policy Report of the Bank of England, BoE (January 20); the Office for Budget Responsibility, OBR (March 18); and the Organisation of Economic Co-operation and Development, OECD (2021).

Figure SA-06. 257: Growth accounting analysis - post Great Financial Crisis (2008)

17.21. These two sets of evidence of GAA from independent institutions have informed the range of estimates of 0.3-0.5% and 0.1-0.3%, for the respective time periods.

Forecasts: Independent institutions

17.22. Section 5.2 of NERA's report sets out forecasts of productivity growth from independent institutions. These are presented in Figure SA-06. 258.

Forecasts of UK Total Factor Productivity Growth: Independent Institutions			
Institution	Date of Forecast	Forecast Period	GO Productivity per annum
BoE	2020	2020 - 2023Q1	0.0%
OBR	2018	2018 - 2022	0.2 - 0.3%

Source: NERA (April 2021), Table 5.2

Figure SA-06. 258: Forecasts of UK total factor productivity growth - independent institutions

Bringing the evidence together

17.23. NERA's consideration of this body of evidence has informed a recommended OE assumption of 0.3% for the period of RIIO-ED2, based on the mid-point of their range of mean estimates between 0.1%-0.5%. However, we have challenged ourselves to the highest point of this reasonable range and therefore included an assumption of 0.5% in this Business Plan.

17.24. In relying on a range of evidence, each informed by different sources, reference sectors and time periods, this both reduces the scope for selectivity in the choice of evidence presented in our plan and mitigates the potential for error in using any one single piece of evidence[47].

17.25. NERA's analysis captures the full scope of potential OE that the ED sector may be able to realise in RIIO-ED2. No adjustment is therefore required, for example, to capture the benefits of innovation funding or interaction with output quality, as the evidence surveyed already captures these. Each consideration is further discussed below.

OE interactions with innovation stimulus funding (past and future)

17.26. Innovation funding may not result in efficiency savings. Innovation funding can be used for a multitude of purposes, e.g. investigatory work in a new area (research and development) such as decarbonisation or driving improvements in safety and the environment. Not all innovation is successful and results in benefits; where innovations do realise benefits, they are not all realised as efficiency savings.

17.27. Innovation spend is already reflected in the OE evidence presented by NERA. For example, the comparator sectors used in the EU KLEMS and in the other growth accounting analyses include the innovation spend of the reference firms and sectors used as comparators. The Törnqvist analysis uses DNO total costs as an input which includes innovation spend in the calculation of historical ED productivity. Any adjustment to the OE assumption to account for innovation stimulus funding would therefore introduce double counting.

17.28. In the RIIO-GD/T2 control[48], Ofgem proposed an upward adjustment to the OE assumption derived from GAA of the EU KLEMS data set to account for the benefits of innovation funding. NERA notes that the approach taken by Ofgem was equivalent to claw-back of innovation funding provided in previous controls and that, "*retroactively rescinding any type of funding that was granted during previous regulatory period's increases uncertainty and unpredictability for companies*"[49]. The CMA subsequently determined that "GEMA should be directed to amend the OE challenge to remove the innovation uplift of 0.2% and set the innovation uplift at zero."[50]

17.29. We conclude that any interaction that does exist between OE and innovation stimulus funding is already included in the evidence base surveyed by NERA informing their recommendations.

Interactions between OE forecasts and output quality

17.30. "*For a given volume of outputs, ongoing efficiency improvements, can take two forms:*

- *Reducing the cost of providing the given volume of outputs; or*
- *Improving the quality of outputs*"[51].

17.31. The achievable rate of OE, measured as the ratio of inputs to outputs, will be lower if the outputs produced are of a higher quality, all else being equal, i.e. some of the efficiency gains are realised as quality improvements[52].

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[47] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p. i-ii
[48] CEPA (May 2020), RIIO-GD2 and T2: Cost Assessment – Frontier shift methodology paper, p. 35
[49] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p.65
[50] CMA (October 2021), RIIO-2 Energy Licence Modification Appeals, Summary of final determinations, p.8
[51] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p. 67
[52] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p. 67

17.32. Output quality is already reflected in the OE evidence presented by NERA. For example, EU KLEMS uses quality adjusted data and the Törnqvist analysis accounts for quality improvements. This means the OE estimates produced would otherwise be higher if quality wasn't controlled for[53].

17.33. NERA sets out in its report[54] that the treatment of output quality in the assessment of OE and the assessment of catch-up efficiency in the regulatory framework should be consistent, as the two concepts, while separate, are related[55]. As output quality is included in the OE assumption (see paragraph 17.32) we recommend that due consideration of output quality be accounted for in catch-up cost assessment. This is consistent with our views in chapter 16.

17.34. We believe that a link exists between OE and output quality. We consider adjusting for quality is important as it reflects our own and Ofgem's expectations for improving service quality. To be consistent across the regulatory framework, output quality should also be accounted for in cost assessment to incentivise both service quality improvements *and* efficient costs in RIIO-ED2.

Applicability of OE recommendation to RIIO-ED2

17.35. The prior section concerns treatment of improved quality of *existing outputs* in the OE assumption. Delivery of *new outputs* also needs to be considered in the OE framework. Paragraph 17.30 sets out the trade-off that OE can be achieved as improvements in output quality or as cost savings. As DNOs, including WPD, transition to RIIO-ED2, new regulatory requirements including net zero legislation and the development of DSO functionality "*represent important new sets of outputs*"[56] which must be considered within the OE framework. "*Where DNOs are required to deliver new outputs, performance against efficiency targets based on existing outputs will deteriorate*"[57]. Therefore a lower OE assumption could be justified on the basis of the new outputs we are planning to deliver in RIIO-ED2[58].

17.36. In addition, a lower OE assumption could be supported[59] due to the likely adverse impact of Brexit and the Covid-19 pandemic on long term productivity, factors not quantified in the evidence base surveyed by NERA. Both factors are outside the control of management.

17.37. Therefore, the achievable rate of OE may actually be lower per annum in RIIO-ED2, as the body of evidence surveyed by NERA does not account for new regulatory requirements in RIIO-ED2, Brexit and the long-term impact of Covid-19. It is however difficult to quantify the expected magnitude of these factors which is why we consider our 0.5% assumption provides a sensible balance of challenge, given the future unknowns.

17.38. While our 0.5% per annum OE assumption may appear to differ from recent regulatory precedent, we consider a 0.5% OE challenge as reasonable and ambitious overall, in the context of stretching commitments for RIIO-ED2 (see Supplementary Annex SA-02 'Our Core Commitments') and the embedded catch-up efficiencies we are planning to deliver as set out in chapter 16.

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[53] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p.67

[54] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p. 67

[55] OE concerns the movement of the efficient frontier and catch-up efficiency concerns movement towards a benchmark, which could be less than or equal to the efficient frontier.

[56] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p. 76

[57] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p. 76

[58] Experience of the Australian regulator, AER, on pages 18-20 of NERA's report provide a recent example of this in practice.

[59] NERA respectively set out in sections 5.1.2 and sections 5.1.3 of their report the likely channels of impact that Brexit and Covid-19 could have on long term productivity of the ED sector within the next price control period.

17.39. We highlight NERA's report recommendation[60]:

"*The…OE assumption…is lower than some assumptions used in previous price control reviews, although in line with recent international precedent. The difference is driven by three factors:*

- *We have presented new evidence not considered before in the form of the Törnqvist analysis, which indicates that the rate of achievable ongoing efficiencies for DNOs is lower than previously assumed;*
- *Some earlier price control reviews have erroneously placed weight on Value Added measures of productivity growth. These are inconsistent with a requirement on Totex, and result in OE assumptions that are biased upwards. As such they are not suitable for use in the context of the RIIO-ED2 regulatory framework. Correctly using Gross Output measures results in a lower assumption; and*
- *We have reviewed recent evidence that economy-wide productivity growth has been slower in the decade since the Global Financial Crisis of 2008-2009 than in the historical period used in estimates of long-term productivity growth.*"

17.40. We have also reflected on the starting point for setting and delivering our RIIO-ED2 OE challenge. While recent GB regulatory precedent may be centred on a 1% OE assumption, we cannot indefinitely continue to deliver 1% efficiencies cumulatively year-on-year. As we rise to the challenge of meeting central government policy targets for net zero and delivering DSO over the course of RIIO-ED2, the introduction of these new and infant activities will make application of the OE challenge at a Totex level more stretching[61]. We do not envisage a technological revolution to bring about deliverability of our OE challenge in RIIO-ED2, but rather a series of incremental changes, much of it driven by the rollout of successful innovation projects. In core commitment 16, we set out to deliver our ongoing efficiency assumption (see Supplementary Annex SA-02 'Our Core Commitments').

[60] NERA (April 2021), Ongoing Efficiency Improvement at RIIO-ED2, prepared for the ENA, p. ii

[61] This reflects our understanding that OE will be applied to total expenditure (Totex) as part of base Totex as set out by Ofgem via the workings of the RIIO-ED2 Business Plan Data Tables

18. Real price effects

Summary

18.1. We refer to Real Price Effects (RPEs) as the delta between the rate of change of the price of inputs required to operate an electricity network and the rate of change of prices in the general economy, which is measured by general inflation (CPIH).

18.2. Given the existence of RPEs, the indexation of price control allowances to general inflation might under or over provide allowances to network companies. The RIIO-ED2 price control framework therefore provides for an assessment of RPEs that adjusts allowances, subject to DNO provision of a supporting evidence base.

18.3. Given that future input prices are uncertain, RPEs have been prepared as an uncertainty mechanism in our plan. In the same way that Ofgem indexes baseline allowances to CPIH, Ofgem have signalled that they will adjust RPE allowances annually through indices that proxy for the price of our inputs.

18.4. We worked with economic consultants, NERA, as part of an all-DNO ENA study in spring 2021[62] and with an update in autumn 2021[63] to propose indices to Ofgem that proxy for the price movement of these inputs used in the operation of an electricity distribution network, in line with Business Plan requirements.

18.5. We have included evidence in our plan to support RPEs with respect to the input categories of general labour, specialist labour, materials capex, materials opex, plant and equipment, and transport.

18.6. Figure SA-06. 259 sets out the combined impact on our cost base of the above RPEs by input, taking into account the cost structure of WPD.

Impact on Baseline Totex by RPE Input							
	2023/24	2024/25	2025/26	2026/27	2027/28	Total RIIO-ED2	Average per year in RIIO-ED2
WMID Total, £m	11	14	18	20	25	87	17
EMID Total, £m	11	15	19	22	24	91	18
SWALES Total, £m	6	8	11	12	14	52	10
SWEST Total, £m	10	13	17	19	22	81	16
WPD Total, £m	38	49	65	73	84	309	62

Figure SA-06. 259: RPE impact on our RIIO-ED2 baseline Totex

18.7. Overall, we forecast that RPEs will have a £309 million impact on our business during RIIO-ED2. Although RPEs will be subject to indexation (a form of Uncertainty Mechanism), we have included our projections in our base view of Totex (as explained in paragraph 1.11).

The regulatory framework

18.8. At the start of a price control Ofgem sets revenue allowances in constant prices (for RIIO-ED2, this will be 2020/21 prices). For each year of the price control, Ofgem indexes revenue allowances with a forecast of inflation for the coming year. Ofgem then trues-up the forecast

[62] NERA (June 2021), Price Effects for RIIO-ED2, prepared for the ENA
[63] NERA (November 2021), Price Effects for the RIIO-ED2 Price Control Review - Addendum, prepared for the ENA

inflation embedded in customers' bills with actual outturn inflation through the Annual Iteration Process (AIP).

18.9. However, this process however does not account for the additional input price cost pressures DNOs are likely to experience due to RPEs. During RIIO-ED1 and in other price controls, RPE allowances were set on an ex-ante basis, based on forecasts equal to a long run average growth rate of indices that proxy for input costs. In contrast to the treatment of general inflation, there was no true-up process.

18.10. Ofgem has set out two main changes to the regulatory framework which concerns the assessment and allowance setting process for RPEs in RIIO-ED2, compared to RIIO-ED1:

18.11. Firstly, for RIIO-ED2, DNOs' revenue allowances will be indexed to CPIH, in contrast to RIIO-ED1 where RPI was the inflation measure used. This means the absolute value of RPEs will be different, all else being equal.

18.12. Secondly, Ofgem intends to index RPE allowances instead of setting them on an ex-ante basis. In the same way that Ofgem indexes DNO revenues to CPIH, Ofgem has proposed to index the sector-specific increases in input prices DNOs are likely to experience due to RPEs in RIIO-ED2. It is not yet clear if Ofgem will true-up differences between the forecast and outturn position of the proxy input price indices on an annual basis (as is done for CPIH), when the end of the price control is reached (e.g. as has been done in PR19), or along different intervals altogether.

How the change in regulatory framework impacts the choice of indices

18.13. Index selection for ED sector-specific inputs is not a new pre-requisite to the setting of RPE allowances. However, the proposed use of input price indices to support indexation of allowances through the price control, as opposed to on an ex-ante basis only, places greater demands on the selection process, if the resultant indices are to be fit for purpose to the new regulatory application.

18.14. For RIIO-ED1, the main criteria informing index selection was that the "*long-run average growth of an index reflected average growth in the relevant DNO unit costs*"[64], to enable allowances and costs to align, over the medium to long term of a price control.

18.15. For RIIO-ED2, the regulatory proposal to index RPE allowances therefore means that short term movements in indices need to also reflect short term movements in the cost pressures DNOs face. This allows the same allowance-cost equality to be maintained year-on-year, not just in the round over the course of the control. "*For instance, an index which has similar long-run average growth but is only weakly correlated with changes in DNOs' costs and is volatile may no longer be a suitable index for setting RPE allowances. A weakly-correlated and volatile index would expose DNOs to additional and unnecessary risk and reduce the likelihood that they would recover their efficient costs over the RIIO-2 price control period*"[65].

18.16. This change in regulatory approach has therefore informed the index selection process set out in the below section Proposed Input Price Indices, in particular the use of the Mean Squared Deviation (MSD) statistical test to distinguish between the suitability of candidate indices with

[64] NERA (June 2021), Price Effects for RIIO-ED2, p. ix
[65] NERA (June 2021), Price Effects for RIIO-ED2, p. ix

regard to aligning as far as possible short-term correlation, volatility and the long run average of candidate indices and the growth in ED inputs prices they proxy for.

Informing our Real Price Effects

18.17. We have worked with NERA as part of an all-DNO ENA study[66] to identify DNO inputs for which CPIH is a poor proxy of their price growth and to propose indices that are superior alternatives to be used as a proxy for input growth. This all-DNO study has used industry unit cost data to help select and assess the choice of indices.

Inputs for which RPEs are applicable

18.18. RPEs are applicable where CPIH is a poor proxy of price growth in inputs.

18.19. CPIH measures the growth in prices of a representative basket of consumer goods and services. "*Changes in CPIH reflect, amongst other things, changes in factor input prices*"[67] such as materials and labour.

18.20. In general terms, CPIH is therefore a poor proxy of the growth in prices of the inputs DNOs purchase because:

- The types and mix of inputs required to operate an electricity distribution network differ to those required to make the goods and services included in the average consumer basket monitored for the purposes of CPIH measurement.
- Changes in inflation can be due to factors other than changes in factor input prices[68], for example increases in consumer demand, all else being equal.

18.21. The existence of RPEs, due to measures of general inflation being poor proxies for the growth in price of inputs DNOs purchase, has been long recognised and acknowledged in GB regulatory price controls.

18.22. The following paragraphs set out specifically why CPIH is a poor proxy of growth in the price of each input we, WPD, purchase to run our network.

General and specialist labour

18.23. We manage our network using a mixture of direct and contract labour, making use of different skills and skill level according to the role and tasks required. Direct and contract labour costs are capitalised according to the type of work for which the labour is employed. The growth rate in unit labour costs (direct or contracted) is the same whether the labour is employed for operating or capital works[69].

18.24. We operate a single pay structure which concerns 98.5% of our direct employees. The pay structure does not differentiate between employees, which in regulatory terms, may be labelled as providing 'general' or 'specialist' skills. As such, the growth rate in the price of direct labour is the same for all staff.

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[66] NERA (June 2021), Price Effects for RIIO-ED2, prepared for the ENA; NERA (November 2021), Price Effects for the RIIO-ED2 Price Control Review - Addendum, prepared for the ENA

[67] NERA (June 2021), Price Effects for RIIO-ED2, p.16

[68] Even if the factor inputs used to make the goods and services in the general consumer basket were good proxies of the factor inputs required to run an electricity distribution network

[69] As such we have completed the BPDT such that our general labour (capex) RPE index is the same as our general labour (opex) RPE index; and specialist labour (capex) RPE index is the same as our specialist labour (opex) RPE index

18.25. Likewise, our employment of contract labour does not differentiate between the provision of 'general' or 'specialist' skills within or across contracts. For example, we tender service contracts at an activity level with third-party suppliers to provide services such as tree management, dig and lay works and overhead clearances; delivery of these services will inherently require a mixture of differing skillsets and skill levels.

18.26. The growth rate in wages paid to direct staff are determined by trade union negotiations, taking into account historical inflation and a productivity-based uplift.

18.27. The growth rate in wages paid to contract labour is determined by contracts. The growth rate of labour cost in these contracts is therefore determined both by clauses within contracts agreed at contract negotiation and between contract changes as a result of competitive re-tendering exercises. The growth rate in these labour costs is therefore based on competitive market prices.

18.28. As a company, we are entering into an extended period of significant growth in electricity distribution with a limited skillset which will ultimately drive up the relative costs compared to other sectors. This is because the differing skillsets and skill levels needs to operate our network are different to those used to make the average consumer basket of goods and services for the purposes of CPIH measurement.

Materials

18.29. We routinely purchase cables, wooden poles, conductors, transformers, overhead line steelwork and other materials to support the replacement, maintenance and development of our network across our low, high, EHV and 132kV voltages. WPD procures materials centrally and currently has tendered contracts with over 200 suppliers.

18.30. Contracts are awarded via framework agreements for the supply of a particular material based on estimate volumes of materials required. Base unit prices are determined when contracts are first negotiated. Base unit prices are then adjusted at the point of order in line with the agreed-upon contract clause. 'Within contract' price movements therefore have the potential to be frequent and variable.

18.31. The determination of base prices and 'within contract' price movements varies by contract and material. When purchasing cables, base contract prices and 'within contract' price adjustments are often informed by prevailing metal rates. At the point of order, the base cable price is adjusted to reflect the prevailing metal rates to inform the purchase price, as per the agreed-upon contract clause price adjustment formula. As such, CPIH is a poor proxy given the indexation of cable prices to underlying metal prices.

18.32. Other examples include the price of primary transformers which is adjusted based on a formula linked to copper, iron and oil prices; while the price of RMUs is adjusted based on a formula linked to BEAMA indices. Grid transformers are procured via mini competitions in which suppliers provide a quote to meet our tendered for specification. Specifications and suppliers can vary by purchase. The movement of grid transformer prices over time therefore embeds not only RPE effects, linked to metal prices, other input prices and exchange rates, but also some degree of site-specific requirements for each grid transformer purchased.

Plant and equipment

18.33. Our plant and equipment purchases include fault location equipment, minor tools, and testing and monitoring equipment consistent with what we report in the Small Tools, Equipment, Plant and Machinery (STEPM) category in regulatory reporting.

18.34. We procure these items centrally on the same basis as for materials (see above) and therefore anticipate price movements on the same basis.

Transport

18.35. We purchase and run an extensive fleet of vehicles to undertake work on the network across our four licence areas. We incur transport-related costs associated with both the capital purchase of operational vehicles, from vans to vehicular cranes; and also operational costs associated with vehicle maintenance, repairs, insurance and fuel.

18.36. While vehicles are an input in the running of our business, in contrast to labour, materials, plant and equipment, the purchase of vehicles could be considered an intermediary input, as vehicles themselves are made up of labour and materials. When we purchase vehicles, we do not have the same level of information on what drives the price growth of a vehicle, compared to when we buy another kilometre of cable for example. However, we would expect this to be linked in particular to metal and commodity, e.g. oil, prices. With regard to the operating costs, fuel prices are linked to oil prices, and as we electrify more of our fleet, linked to electricity prices as well. Therefore, there are drivers that will differ from the general basket of CPIH.

18.37. Figure SA-06. 260 further illustrates why CPIH is a poor proxy of growth in the price of inputs that DNOs purchase. Comparison of CPIH is made to ED-specific industry average unit cost growth data where this is available.

Source: Graphs prepared by WPD using industry average unit cost data calculated by NERA using data supplied by DNOs

Figure SA-06. 260: Historical Annual Growth Rate of DNO inputs

Proposed input price indices

18.38. Figure SA-06. 261 sets out the proposed indices by RPE input category as recommended by NERA[70], along with justification for their selection.

Forecast Input Price Indices		
RPE Input	**Proposed Indices**	**Reason for Selection**
General Labour (capex and opex)	ONS Private Sector AWE (K54V)	These indices have a lower Mean Squared Deviation (MSD) than CPIH. With reference to industry average unit cost data, it can be used as a proxy for wage (price) growth of the "*average employee*" (NERA, June 2021, p. 42)
	ASHE Median Hourly Earnings for All Employees	
Specialist Labour (capex and opex)	BEAMA Electrical Engineering Labour (BEL)	These indices have a lower MSD than CPIH. With reference to industry average unit cost data, it can be used as a proxy for wage (price) growth of skilled operatives, such as "*craftspersons, technicians, overhead linespersons, cable joiners, HGV drivers, field staff, supervisors, etc.*" (NERA, June 2021, p. 42)
	BCIS PAFI civil engineering (4/CE/01)	
	BCIS Electrical Installations – cost of labour (2/E1)	
	BCIS Electrical Engineering Labour (4/CE/EL/01)	
Materials (capex)	ONS Wood, Sawn and Planed for Domestic Market (EVUD)	This index has a lower MSD than CPIH. With reference to industry average unit cost data, it can be used as a proxy for price growth of wood poles
	BCIS PAFI Pipes and Accessories: Aluminium (3/59)	These indices have a lower MSD than CPIH. With reference to industry average unit cost data, they can be used as proxies for price growth of cables. Of the shortlisted candidate indices, NERA selected the two with the lowest MSD
	BCIS PAFI Pipes and Accessories: Copper (3/58)*	
	BCIS PAFI Pipes and Accessories: Copper (3/58)*	These indices have a lower MSD than CPIH. With reference to industry average unit cost data, they can be used as proxies for price growth of transformers. Of the shortlisted candidate indices, NERA selected the two with the lowest MSD
	BCIS Electrical – materials (3/E2)	
	BCIS RCI Infrastructure Materials (FOCOS)	These indices have been selected as suitable proxies based on regulatory precendent and which have a long-run mean growth that is statistically significantly different from that of CPIH
Materials (opex)	BCIS RCI Infrastructure Materials (FOCOS)	
Plant & Equipment	BCIS PAFI plant and road vehicles (90/2)**	
Transport	BCIS PAFI plant and road vehicles (90/2)**	

Source: WPD summary of NERA (June 2021), Table 4.1 and Table 4.2, NERA (October 2021), Table 2.1

**NERA recommend this index twice within the materials (capex) RPE input category, once in proxy for cables and once in proxy for transformers. As each index receives an average weight, this index is weighted double that of the other indices*

***Based on regulatory precendent, NERA recommend this index for both the Plant & Equipment and Transport RPE Input Category*

Figure SA-06. 261: RIIO-ED2 proposed input price indices

18.39. NERA[71] sets out for each input, index by index, why the above are recommended over alternative candidates identified. While we do not differentiate between general and specialist skills in our employment of labour and determination of salary growth (see paragraphs 18.24 to 18.25), we have taken on board NERA's proposed indices as the output of an all-DNO study and in reflection that the proposed indices align best to industry average unit cost growth data.

18.40. In summary, NERA[72] first identifies a long list of candidate indices, based on regulatory precedent, current availability of the index, NERA's own expertise and relevance. NERA then evaluates each candidate input price index to create a shortlist based on each indices' relevance to electricity distribution costs, data quality, volatility of the time-series, regulatory precedent and feasibility. NERA then assesses the shortlist for each input using the statistical tests below. They also reviewed the index selection again in November 2021, taking into account any changes in index availability and data since available for the final two months of financial year 2020/21[73].

[70] NERA (June 2021), Table 1 and Table 3.5, NERA (November 2021), Table 2.1

[71] NERA (June 2021), Price Effects for RIIO-ED2, sections 3.4.2 to 3.4.5 and Appendix A

[72] NERA (June 2021), Price Effects for RIIO-ED2, sections 3.3

[73] NERA (November 2021), Price Effects for the RIIO-ED2 Price Control Review - Addendum, section 2

18.41. **For inputs where industry average unit cost data was available:** If the Mean Squared Deviation (MSD) is lower for the candidate input price index than CPIH, then the candidate index is a better proxy of price growth of the input than CPIH[74].

18.42. **For inputs where industry average unit cost data was not available:** If the long run average growth of the candidate input price index is statistically significantly different to the long run average growth of CPIH[75].

18.43. Application of the above two statistical tests confirms "*that an RPE is needed for each input cost category*"[76].

Mean adjustments

18.44. Paragraphs 18.13 to 18.16 set out the greater task expected of input price indices in the setting of RPE allowances for RIIO-ED2, compared to RIIO-ED1. The above selection criteria has, through placing greater weight on short-term correlation between the candidate input price indices and industry average unit cost growth rates, by definition, placed relatively less weight on aligning long-run growth rates. As such, 'off-the-shelf' use of these indices might systematically under or over provide for allowances, due to the differences in the long-run average of the growth rate of the index and the growth rate of DNO input costs, even if they trace short term movements in DNO input cost growth reasonably well. Section 3.6 and Figure 3.12 of NERA's report (June 2021) expands on and illustrates this respectively.

18.45. This issue arises because there is no perfect third-party proxy index of DNO unit cost growth. NERA proposes to correct this by applying a mean adjustment to indices selected using the MSD test (see paragraph 18.40). NERA sets out the mean adjustments in Table 3.6 of its report (June 2021) which are applied when calculating the forecast RPEs in section 5.1 of NERA's report. The need and use of mean adjustments has also been continued in the addendum prepared by NERA in November 2021[77].

18.46. We strongly recommend Ofgem considers the robust arguments for the need for mean adjustments in their determinations for the RIIO-ED2 price control, as set out by NERA in their two reports prepared for the ENA.

Forecast RPEs

18.47. In their addendum of November 2021, NERA now forecast the RPE for each benchmark index directly, based on the average historical RPE of the index.

18.48. NERA previously forecast the RPE for each benchmark index based on the difference between the average historical growth of the index and Ofgem's forecast of CPIH.

18.49. This change in approach is due to the revised forecast of CPIH provided in the Ofgem BPDTs. The July 2021 draft BPDTs (for which the June 2021 report was prepared) used CPIH from the

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[74] "The MSD measures the average squared difference between the growth rate" (NERA, June 2021, p. x) of the candidate index (or CPIH) and the growth rate of the industry average unit cost. A low MSD means the "index more closely tracks DNO unit cost growth" (NERA, June 2021, p. x) and is attributable to the candidate index having a long-run growth similar to the long-run growth of DNO unit costs and / or being of similar volatility and / or having strong correlation, i.e. the year on year movements of index growth are similar to that of the year-on-year movements of DNO unit cost growth. Therefore, if the MSD of the candidate input price index is lower than for CPIH, the tested index is a more appropriate proxy of price growth of the input than CPIH and therefore an RPE is applicable.

[75] This test determines whether there is a sustained deviation between growth in the candidate input price index and general inflation based on regulatory precedent of the index being a suitable proxy of the respective input and therefore that an RPE is applicable (NERA, June 2021, p. x)

[76] NERA (June 2021), Price Effects for RIIO-ED2, p. ix

[77] NERA (November 2021), Price Effects for the RIIO-ED2 Price Control Review – Addendum, p. ii

Office of Budget responsibility (OBR) from November 2020. The December 2021 final BPDTs (for which the November 2021 addendum was prepared) use Her Majesty's Treasury's (HMT) Consensus forecast from August 2021. Ofgem's revised forecast is now for CPIH growth above its historical average across the forecast period. If the economy enters a period of high price growth, it is expected that growth rates of benchmark indices will also exceed their historical averages. Therefore a forecast, as previously prepared, on historical averages may underestimate the RPE.[78]

Forecast input price indices

18.50. NERA present their updated forecasts for each input price index in their November 2021 addendum[79]. The change of forecasting approach means that the forecast RPE is now constant over the forecast period (whereas it varied by year in the June 2021 report).

Forecast RPEs

18.51. Each index is associated with one of six input categories required in the BPDT. To forecast the RPEs for the input category, NERA take an unweighted average of the forecast RPEs for the benchmark indices within that category[80].

18.52. The resulting RPEs by input category are set out in Figure SA-06. 262. These are the rates which we have used to inform our BPDT tables. Because the RPEs ultimately to be incurred in RIIO-ED2 are subject to an uncertainty mechanism, to calculate the most prudent view at this time for baseline Totex, these exclude the mean adjustments proposed by NERA and discussed in paragraphs 18.44 to 18.46 – the forecast RPEs presented in the table would be higher if the mean adjustments were applied.

Forecast RPEs, % delta to CPIH	
RPE Input	Constant RPE
General Labour, %	1.10%
Specialist Labour, %	0.87%
Materials (capex), %	1.25%
Materials (opex), %	2.18%
Equipment / Plant, %	0.66%
Transport, %	0.66%
Totex, %	0.97%

Source: NERA (October 2021), Table 3.5 ; except for the totex level RPE (WPD calculation)
These RPEs represent forecasts at the time of business plan preparation. They are for information only as it is expected these will be part of the uncertainty mechanism.

Figure SA-06. 262: Forecast RPEs for RIIO-ED2

18.53. The Totex RPE is for information and transparency only. It is not required for inclusion in the BPDTs. We have calculated this using our own cost structure and NERA's input RPEs by cost category[81].

[78] See section 2.3 of NERA (November 2021), Price Effects for the RIIO-ED2 Price Control Review - Addendum

[79] Mean-adjusted RPEs are presented in Tables 3.1-3.3; Non-mean adjusted RPEs are presented in tables B.1-B.3

[80] This is further explained in section 3.2 of NERA (November 2021), Price Effects for the RIIO-ED2 Price Control Review - Addendum

[81] For this reason, this differs from the Totex of 1.00% shown in NERA's November 2021 addendum (table 3.6). NERA's percentage uses an average DNO cost structure.

Impact on our cost base

18.54. The forecast materiality of these RPEs on our cost base is £309 million over RIIO-ED2 at a WPD level. This value is included in the baseline Totex presented in this annex.

18.55. Figure SA-06. 263 summarises the impact by RPE input category on WPD, when considered in relation to our cost structure[82].

Impact on Baseline Totex by RPE Input							
	2023/24	2024/25	2025/26	2026/27	2027/28	Total RIIO-ED2	Average per year in RIIO-ED2
General Labour, £m	6	9	11	13	15	53	11
Specialist Labour, £m	17	22	29	33	39	140	28
Materials (capex), £m	12	16	23	24	28	103	21
Materials (opex), £m	1	1	2	2	2	8	2
Equipment / Plant, £m	0	0	0	0	0	1	0
Transport, £m	1	1	1	1	1	4	1
Other, £m	0	0	0	0	0	0	0
WPD Total, £m	**38**	**49**	**65**	**73**	**84**	**309**	**62**

Figure SA-06. 263: RPE impact on our RIIO-ED2 baseline Totex, by RPE input

18.56. The expenditure categories to which these RPEs relate and to what extent are set out in the BPDTs at a licence level. Figure SA-06. 264 summarises the impact these RPEs have on our cost base by expenditure category at a WPD level, and also at Totex level for each of our 4 DNOs.

Impact on Baseline Totex by Expenditure Category							
	2023/24	2024/25	2025/26	2026/27	2027/28	Total RIIO-ED2	Average per year in RIIO-ED2
Load related capex, £m	6	7	11	12	14	50	10
Non-load related capex - asset replacement, £m	10	14	19	20	25	88	18
Non-load related capex - other, £m	4	6	8	7	8	34	7
Faults, £m	3	4	5	6	7	27	5
Tree cutting, £m	1	2	2	3	3	11	2
100% 'revenue pool' expenditure, £m	2	3	3	4	4	15	3
Controllable opex, £m	11	14	17	20	23	85	17
WMID Total, £m	**11**	**14**	**18**	**20**	**25**	**87**	**17**
EMID Total, £m	**11**	**15**	**19**	**22**	**24**	**91**	**18**
SWALES Total, £m	**6**	**8**	**11**	**12**	**14**	**52**	**10**
SWEST Total, £m	**10**	**13**	**17**	**19**	**22**	**81**	**16**
WPD Total, £m	**38**	**49**	**65**	**73**	**84**	**309**	**62**

Figure SA-06. 264: RPE impact on our RIIO-ED2 baseline Totex, by expenditure category

18.57. We will work with Ofgem to develop the approach for RPEs and the uncertainty mechanism through the determinations process. We are keen to explore further the concept of mean adjustments ahead of RIIO-ED2 final determinations.

[82] Details of our cost structure are presented in the BPDTs at a DNO level. The BPDT commentary describes how we have calculated this.

19. Bill impact

19.1. WPD is proposing to spend an average of £1.3 billion per year in our baseline view of expenditure for RIIO-ED2. This is £286 million per year higher than our average annual spend in RIIO-ED1, and will fund the delivery of the commitments in our Business Plan, including the delivery of key government policies and the transition to a net zero carbon future.

19.2. The additional cost in our base plan excluding Real Price Effects and Ongoing Efficiency is £243 million per year higher than RIIO-ED1. This increase would add £3.37 each year to WPD's average domestic customer bill for RIIO-ED2 if all other elements of the price control were unchanged.

19.3. However, as set out in Chapter 9, this potential increase as a result of higher investment will be broadly offset by changes to the financing parameters and other aspects of the RIIO-ED2 price control process.

19.4. Overall, WPD's average domestic customer bill, after adjusting for macro-economic changes outside of our control as shown in chapter 9, is expected to fall slightly under our baseline view from £91.62 to £89.51.

19.5. Supplementary Annex SA-09 'Financing our Plan' presents the customer bill impact of our Totex proposals in more detail, including the specific position for each of our DNOs, which does vary around the WPD average.

20. Appendices

Appendix A01 - GHD (November 2021), *Unit Cost Process Review: Assurance of process for RIIO-ED2 Business Plan Submission*

20.1. A report prepared by GHD (Gutteridge, Haskins and Davey Ltd), who were appointed by WPD to perform an independent review of WPD's approach to deriving asset replacement unit costs for inclusion within the Business Plan and to provide an independent assurance of the approach.

20.2. The report can be found on our website at:
https://yourpowerfuture.westernpower.co.uk/downloads-view/41598

Appendix A02 - Gallagher (September 2021), *WPD Business Plan 2023-2028 Insurance Premium Projections*

20.3. A report prepared by Gallagher (Arthur J Gallagher), WPD's insurance broker, to provide commentary and analysis with regards to projected insurance premiums for the Business Plan period.

20.4. The report has been redacted from our website due to commercial sensitivity.

Appendix A03 - Oxera (May 2021), *Assessment of cost drivers for RIIO-ED2 benchmarking*, prepared for the ENA

20.5. An all-DNO ENA study prepared by Oxera, to identify, assess and evaluate Totex cost drivers that could be used in the assessment of costs as part the RIIO-ED2 price control framework. The study builds on the RIIO-ED1 evidence base and identifies new and existing cost drivers fit for purpose for RIIO-ED2 cost assessment. The study was supported by DNO supplied data for the DPCR5 and RIIO-ED1 to date (2015/16-2019/20). The primary purpose of the study was to provide an evidence base for DNOs to present to Ofgem via the Cost Assessment Work Group (CAWG), which took place on 25th May 2021.

20.6. The report can be found on our website at:
https://yourpowerfuture.westernpower.co.uk/downloads-view/41601

Appendix A04 - Gibbens, R.J. and Zachary, S. (May 2013), *Commentary on the report by Frontier Economics to Ofgem on the feasibility of econometric benchmarking in DNO cost regulation*

20.7. A commentary prepared for WPD by Gibbens, R.J. and Zachary, S. of the Frontier Economics report (Volume 1 and Volume 2 (both April 2013)) submitted "*to Ofgem on the feasibility of using an econometric approach to estimate the relative efficiency, and hence assist in the cost regulation.*"

20.8. The report can be found on our website at:
https://yourpowerfuture.westernpower.co.uk/downloads-view/41610

Appendix A05 - NERA (April 2021), *Ongoing Efficiency Improvement at RIIO-ED2*, prepared for the ENA

20.9. An all-DNO, ENA study prepared by NERA to inform the likely level of OE achievable by companies in the Electricity Distribution sector in the period 2021/22 – 2027/28 (i.e. covering the remainder of RIIO-ED1 and RIIO-ED2). The study reviews the work undertaken by Ofgem in RIIO-ED1 and builds upon interim regulatory precedence since RIIO-ED1, NERA's own expertise and understanding of productivity movements in related sectors and the wider economy, to present an up-to-date view for RIIO-ED2 business planning purposes.

20.10. The report can be found on our website at:
https://yourpowerfuture.westernpower.co.uk/downloads-view/41604

Appendix A06 - NERA (June 2021), *Price Effects for RIIO-ED2*, prepared for the ENA

20.11. An all-DNO, ENA study prepared by NERA to recommend input price indices which track closely the input price movements experienced by DNOs and thus which are suitable for use in indexation of RPE allowances by Ofgem in RIIO-ED2. The study, for the purposes of RIIO-ED2 business planning, gives consideration and recommendation of input price indices, how component input price indices are weighted and how the individual input RPEs are combined to given an overall RPE index per input, building on RIIO-ED1, interim regulatory precedence and NERA's own expertise.

20.12. The redacted report can be found on our website at:
https://yourpowerfuture.westernpower.co.uk/downloads-view/41607

Appendix A07 - NERA (November 2021), Price Effects for the RIIO-ED2 Price Control Review - Addendum, prepared for the ENA

20.13. An all-DNO, ENA study prepared by NERA to update their previously prepared analysis in June 2021 in light of the most recently available data. NERA have made two revisions (in their recommended selection of benchmark indices; and in their forecast of RPEs) and therefore this report presents updated forecasts of RPEs for each input cost category. This report should be read alongside the June 2021 report.

20.14. The report can be found on our website at:
https://yourpowerfuture.westernpower.co.uk/downloads-view/41595

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