Cadent
Your Gas Network

Appendix 03

Cost Assessment and Benchmarking Approach

Cadent
Your Gas Network

Contents

Executive Summary

The contents of this appendix, and the supporting information, are critical evidence that Ofgem must assess fully in its RIIO-3 determination. In this Appendix, we set out:

- **Cost drivers** – The key drivers of our expenditure across RIIO-3;
- **Cost exclusions** - Our views on areas of our costs that are not suitable for comparative benchmarking using statistical regression models;
- **Regional and company-specific factor claims** – Our evidence on the pre-modelling adjustments that should be made before our networks are comparatively benchmarked;
- **Comparative efficiency modelling** – We propose improvements that Ofgem should consider for its cost assessment approach, and apply these when demonstrating the efficiency of our costs;
- **Ongoing efficiency** – We present evidence on the potential for us to deliver ongoing annual efficiency improvements within the RIIO-3 period; and
- **Real Price Effects** – We explain the indices, and the weightings that should apply to those indices, that Ofgem should use when adjusting costs to take account of future price movements.

Cost drivers

In the main business plan document[1], we set out the key drivers of our expenditure across RIIO-3, and explain the make-up of the material changes compared to our RIIO-2 spend. In this appendix, we provide detailed information on the changes in our expenditure.

Having extensively tested and challenged our plans, the resulting RIIO-3 totex forecast of £8.0bn reduces to £7.8bn inclusive of our ambitious ongoing efficiency savings of £0.2bn (0.5%), representing a 15.9% increase in controllable totex compared to RIIO-2. After including broadly flat non-controllable costs of £2.3bn our overall funded costs forecast grows by 11.5% to £10.1bn (vs. £9.1bn across RIIO-2). The four most significant contributors to this increase are:

- Our ambitious plans to roll-out advanced leakage detection technology across our networks and to invest in targeted interventions to **reduce methane leakage**;
- The additional costs associated with adherence to the HSE's emerging **fatigue management policy**;
- The need for us to adhere to new **cyber security (eCAF) and DESNZ-driven physical security** requirements; and
- The fact that we need to deliver more **larger diameter and more complex mandatory iron mains replacement work.**

Alongside these and other increases, we have mitigated cost pressures where possible, utilising our efficient cost position at the end of RIIO2 as a base, constraining our capex spend and employing our workforce and supply chain strategies to manage the risk of competition for scarce resources. In addition, we expect a **reduction in connections expenditure**, which is fully customer funded across RIIO3

Cost exclusions

For RIIO-2, Ofgem excluded historical/forecast costs from submitted totex, where:

- cost variations across GDNs were not well represented by comparative regression cost drivers;
- these related to large and atypical capex; and
- these related to bespoke outputs to be delivered by a GDN, or where the associated activities or costs were uncertain in size or scope.

Ofgem has confirmed it will continue to exclude costs that meet these criteria in RIIO-3, but has also stated that it intends to consider large and atypical repex projects for exclusion.

[1] Page 11

The table below summarises our proposed cost exclusions, all of which meet Ofgem's criteria.

Cost exclusion	Rationale
Local Transmission Systems (LTS) diversions and associated surveys	At RIIO-GD2, large (>£5m in project size), non-rechargeable diversions were excluded from regression benchmarking. Following our appeal to the CMA, large rechargeable diversions were also excluded. For RIIO-GD3, we believe all LTS Diversions (and any directly attributable opex to enable rechargeable diversions) should be excluded from regression benchmarking as the factors driving these costs are exogenous and are not well represented by Ofgem's current cost model drivers, with costs varying significantly across companies which could distort benchmarking. This would also bring the treatment of diversions into line with the approach Ofgem adopted for RIIO-ED2.
Digital Platform for Leakage Analytics (DPLA) and Advanced Leakage Detection (ALD)	Ofgem has confirmed it will fund the rollout of DPLA and consider Advanced Leakage Detection (ALD) rollout at RIIO-3. We understand a consistent basis for cost forecasts is being utilised across GDNs, but that GDNs may treat this activity differently in their business plans (e.g., with some suggesting using uncertainty mechanisms given their level of experience and maturity using the technology). As such, it is inappropriate to include these costs within comparative regression benchmarking. We propose that these costs are assessed separately.
Net zero and vulnerability activities	Costs associated with vulnerability and Net Zero may be treated by companies in different ways (some including them within base totex forecasts, others within 'use it or lose it' funding proposals). Furthermore, any costs included within totex regressions are likely to be assumed to be driven by MEAV (a variable to capture network scale). As there is likely to be inconsistent treatment of costs, and as these costs are not purely driven by network scale and vary significantly across networks, they should be excluded from regression assessment.
Large and atypical capex and repex projects	We list six projects which meet Ofgem's criteria of being large and atypical. [security-sensitive]
Robotic intervention	Robotic Intervention is now treated in the same way as other Repex within Business Plan Data Tables. A change in Ofgem's cost assessment approach is required to either: (a) derive a suitable cost driver; or (b) if this is not feasible, exclude costs and volumes from the comparative assessment[2].
RIIO-2 exclusions	We propose that Ofgem should continue to exclude costs/activities in RIIO-3 that were excluded in RIIO-2 (including Cyber and Physical Security), except: • Growth (reinforcement) governors - Growth governors support the reinforcement of the network. However, this reinforcement can also be achieved by laying pipes, the costs of which are included within benchmarked costs. The exclusion of growth governors from comparative benchmarking creates a bias. • Electric / zero-emission vehicles – For RIIO-3, Ofgem has said it will remove the separate treatment of the costs of purchasing and using electricity/zero-emission vehicles. Including these costs within regressed costs would make the comparison of fleet costs more consistent between GDNs.

In addition to these areas, we note that since the finalisation of our totex forecasts, the costs we incur associated with pension administration are projected to increase significantly over the RIIO-2 period and into RIIO-3. Cadent is disproportionately impacted in comparison to the other GDNs, because we bear the costs of administering a number of legacy pension arrangements for employees from the period prior to the gas distribution networks being sold by National Grid. Therefore, it is important these costs are also considered for alternative cost treatment relative to RIIO-2, where they are funded ex-ante and included within Ofgem's totex regression.

Regional and company-specific factor claims

Even with appropriate cost exclusions, comparative benchmarking models are highly unlikely to capture all of the exogenous factors that drive variations in GDNs' costs sufficiently for efficiency scores from regression analysis to be robust. There are two ways that robust efficiency scores can be derived. One way is to make sufficient pre-modelling adjustments for regional and company-specific factors. The table below summarises our proposals for what these pre-modelling adjustments should be, based on a wealth of evidence and regulatory precedent established at RIIO-ED2.

[2] We exclude these costs for our comparative efficiency analysis as there as there was no synthetic unit cost for robotic intervention available when developing our work

Regional and company-specific factor	Approach adopted by Ofgem at RIIO-2	Proposed approach for RIIO-3	Proposed RIIO-3 adjustment (£m, 23/24)			
			EoE	Lo	NW	WM
Impact of higher labour costs in and around the London region	Regional Labour Adjustment applied to the London, Eastern and Southern GDNs (only accounting for wages).	'Labour Costs' factor, applying the Regional Labour Adjustment to London, Eastern and Southern GDNs – reflecting updated data, a more accurate reflection of the geography impacted by the London labour market and accounting for Employer National Insurance Contributions	30.4	207.9		
Impact of operating in London on GDNs' productivity	Ofgem applied two adjustments: • Urbanity productivity • Urbanity reinstatement (extended to include Repex reinstatement and Repex plant hire based on company proposals at the time)	A singular adjustment to reflect the impact of the 'Nature of Streets' in London, aligned with the approach adopted at RIIO-ED2.	13.0	180.3		
Impacts of population and property density not accounted for by the 'Nature of Streets'	Ofgem accepted that the density of London impacted London's emergency job times and extended its urbanity productivity adjustment to emergency activities.	A 'Network-Specific Factors' claim to take account of the pervasive impact of population and property density across our cost base.		30.3		
Impact of serving sparse populations	Sparsity adjustment applied to all GDNs except London.	Sparsity adjustment applied to all GDNs except London (reflecting updated data and analysis on the size of cost impacts)	10.2		4.9	3.4
Total			**53.8**	**418.5**	**4.9**	**3.4**

Comparative efficiency modelling

Improvements to Ofgem's RIIO-2 approach

In Ofgem's RIIO-2 model, each cost driver within its 'Composite Scale Driver' (CSV) was weighted by the industry average share of expenditure and was assumed to have the same impact on costs. However, this does not capture the fact that: (a) the composition of costs is different across GDNs; (b) this composition will change over time; and (c) different cost drivers have different proportional impacts on different activities. Not capturing these aspects distorts Ofgem's efficiency assessment.

To address these problems, we propose weighting components of the CSV by annual, network-specific expenditure shares (to account for (a) and (b)), each multiplied by an estimate of the cost area's 'elasticity' to changes in the cost driver (to account for (c)). We find this demonstrably improves on the statistical performance of Ofgem's RIIO-2 model applied to new data.

Using a density driver

Differences in costs caused by GDNs' different operating environments can be controlled for by using pre-modelling adjustments (i.e. our proposed regional and company-specific factor claims - above), and/or by the inclusion of drivers within the regression. Therefore, in addition to considering regional and network-specific adjustments, we have also explored the robustness of a regression model which includes density as an explanatory variable.

We have tested the use of different density variables against Ofgem's criteria for informing the choice of explanatory variables. We have also assessed the extent to which a density variable is/is not likely to capture effects covered in our proposed regional and company-specific factors. We find that network density best meets all of Ofgem's criteria and is likely to capture all our proposed factors except Labour Costs.

A model which applies our Labour Costs factor and includes a network density cost driver also performs better under standard statistical tests than Ofgem's RIIO-2 model and other model variants which solely utilise pre-modelling adjustments.

Finally, we have tested potential concerns that the use of a density driver could result in 'overfitting' of the model. We provide evidence that this is not a concern.

Based on our analysis, therefore, it is clear that using a model that takes account of our Labour Costs factor and uses a density driver should be included within a multi-totex model framework for assessing costs at RIIO-3.

Cadent's comparative efficiency

To establish the efficiency of our cost base, we have benchmarked ourselves against other gas distribution ownership groups. Whilst we have utilised comparative regression analysis at the network-level to inform this, as Cadent owns multiple networks, we consider the most appropriate comparison is relative to other ownership groups. We have therefore compared our group-level efficiency position relative to SGN and CKI (who are the common owners of both NGN and Wales and the West Utilities).

Having shown that there is clear scope for improvement on Ofgem's model, we have assessed our efficiency using a combination of models: one which continues to utilise pre-modelling adjustments exclusively and one which incorporates a density driver. This analysis shows that Cadent is the most efficient GDN ownership group in RIIO-2.

Ongoing efficiency

At RIIO-2, following the CMA appeals process, Ofgem assumed that all GDNs could deliver an average 1% per annum ongoing efficiency improvement across totex. This assumption was largely derived from data from before the financial crisis.

Ofgem and its advisors justified reliance on pre-crisis data by suggesting the potential for productivity growth to return its higher, pre-crisis levels. However, new data published since the RIIO-2 decision shows this has not been the case.

Together with other gas networks, we commissioned Economic Insight to undertake an independent, principles-based benchmarking analysis of the potential for Ongoing Efficiency improvement for RIIO-3. Economic Insight estimates a potential range of Ongoing Efficiency from 0.2%-0.8% per annum. Alongside this, Economic Insight has also 're-run' Ofgem/CEPA's analysis from RIIO-2 with a more up-to-date dataset – they find an upper bound estimate of 0.5% per annum when using the latest data.

We present evidence that it is wrong to argue that regulated utilities should be able to deliver higher Ongoing Efficiency than the level that is achievable in the economy as a whole. Based on the analysis undertaken by Economic Insight, the re-run of Ofgem/CEPA's analysis with the latest data and consideration of other factors (detailed in the appendix) we believe the mid to lower bound of Economic Insight's range is a realistic representation of what we can deliver. As a result, to build on the impressive gains we have made in the RIIO-2 period, we make an ambitious assumption of 0.5% per annum in our plan[3].

Real price effects

For RIIO-2, Ofgem used three equally-weighted indices to adjust for real price effects – in other words, each index had a weight of 33.3%.

One of the indices used by Ofgem represented price movements in steel. However, steel makes up less than 1% of our materials spend and whilst we are increasing work on steel assets marginally in RIIO-3, the weighting that Ofgem applied in RIIO-2 is not rational.

We have proposed indices to capture real price effects which are better aligned with our costs, to improve on the approach of RIIO-2 given real price effects relate to the changes in the price of inputs used by network companies above inflation.

[3] Following Business Plan Data Table (BPDT) guidance all costs set out in our data tables exclude ongoing efficiency, except table S1.02, where our ongoing efficiency assumption is set out

Other information

This appendix should be viewed alongside:

- our main business plan[4].
- our Appendix 10 (Network Asset Management Strategy), which includes an explanation of the way we have developed costs for our investment expenditure.
- our Investment Decision Packs[5], which explain the options we have assessed for our planned investments and provide further information on how we have derived our cost projections.
- our Appendix 8 (Innovation Strategy) which, amongst other things, includes a discussion of the way we plan to transform our business during RIIO-3, an initiative that we describe as Operations 4.0; and
- our Business Plan Data Table Commentary, which provides further information on the assumptions we used to derive our cost and other projections.

1. Cost drivers and Totex forecasts to deliver customer outcomes

1.1. Introduction and Totex overview

We have assessed and analysed historic data, internal and external benchmarks, future trends and macroeconomic factors to determine the workload and costs to deliver the outcomes set out in the main business plan[6], and as detailed in the system efficiency and long-term value for money section[7] of our plan. In line with Ofgem guidance, we have ensured our proposals meet the relevant legislative and safety requirements and tested our plans against the Future Energy Scenario (FES) Holistic Pathway and the FES Counterfactual scenarios (results can be seen in FES table M8.22).

In the main business plan document, we set out the key drivers of our expenditure across RIIO-3 and explain the make-up of the material changes in comparison to our RIIO-2 spend. The content that follows in this appendix section breaks out these variances into further detail, explaining their impact across Opex, Repex, and Capex, the justification for our spend profile, and the make-up of our non-controllable costs.

Further context is provided here to aid understanding of elements of our plan not discussed in detail in the system efficiency and long-term value for money chapter but please note that we have sought not to repeat content here so this appendix should be viewed alongside the main business plan document rather than in isolation, to gain a full understanding of our costs.

Total funded costs

£m	RIIO-2	RIIO-3	Var	
Direct Opex	1,823	1,989	167	
Indirect Opex	835	1,079	245	
Repex	2,907	3,707	801	
Load Capex	347	131	(215)	
Non-Load Capex	862	1,112	250	
Controllable Totex	**6,773**	**8,020**	**1,247**	
Ongoing Efficiency	(21)	(197)	(176)	
Net Totex	**6,752**	**7,823**	**1,070**	*15.9%*
Non-Controllable	2,329	2,307	(22)	
Total Funded Costs	**9,081**	**10,129**	**1,048**	*11.5%*

Figure 1: Total funded costs

4 System Efficiency and Long-term Value for Money, page 66 onwards of the main business plan
5 Investment Decision Packs include both Engineering Justification Papers and Major Justification Papers
6 Pages 31-40, 44-52, 55-65
7 System Efficiency and Long-term Value for Money, page 66 onwards of the main business plan

Our plan sets out net controllable Totex expenditure of £8,020m, reducing to £7,823m for RIIO-3 including ongoing efficiency, which is a 15.9% increase on expected spend over RIIO-2. Non controllable costs are broadly consistent across the two periods resulting in total funded costs of £10,129m across RIIO-3, an 11.5% increase compared to RIIO-2.

We are putting forward ambitious ongoing efficiency savings of 0.5% per annum, equating £197m over the RIIO-3 period, in addition to the efficiencies already embedded throughout RIIO-2. Our evidence and rationale behind this commitment is explained in section 6.1.

Figure 1 shows the key Totex movements from RIIO-2 and we explain each of the material changes, including the drivers behind them, in the system efficiency and long-term value for money chapter.

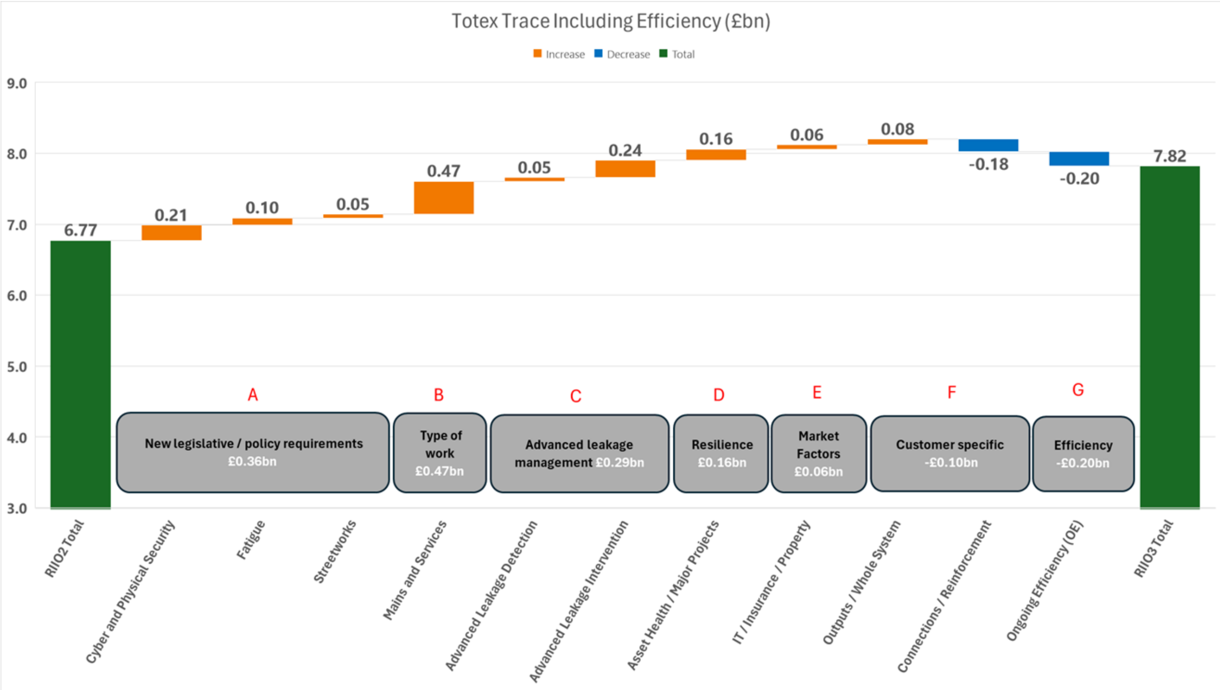

Figure 2: Totex movements

Table 1 below provides an overview of the key changes discussed alongside the above trace in the main plan, in terms of the three cost drivers that underpin our Totex spend (volume of work, type of work and unit costs), and their alignment across Totex.

Ref	Description	Driver	Opex	Capex	Repex
A	Cyber and Physical Security – enhanced cyber assessment framework (eCAF) cyber and targeted DESNZ driven physical security requirements	Volume & Type	+£98m	+£114m	
A	Fatigue – the latest HSE policy requirements regarding effective management of fatigue across our workforce	Type of work	+£102m		
A	Streetworks – increased local authority (LA) permit and traffic management requirements	Volume & Type	+£2m		+£48m
B	Mains and Services - Larger diameter and more complex work mix, supply chain and externally driven price pressures in Tier 1 iron mains replacement drives higher unit rates across all networks.	Type of work & Unit rate			+£467m
C	Advanced Leakage Detection (ALD) – roll out of this technology across all networks, including DPLA and running costs	Volume	+£21m	+£32m	
C	Advanced Leakage Intervention - Targeted leakage intervention to meet our environmental commitments, impacting higher tier iron and steel mains.	Volume			+£241m
D	Asset Health / Major Projects - Asset Health and other project spend including Tinsley and West Winch diversions in Capex and London and Grays medium pressure projects in Repex	Volume & Unit rate		+£111m	+£44m
E	Market Factors – impacting insurance, IT, property and vehicles	Unit Rate	+£59m		

Ref	Description	Driver	Opex	Capex	Repex
F	Other Outputs / Whole System - Climate resilience, Environmental Action Plan (EAP), strategic network planning and data and digitalisation costs	Volume & Type	+£78m		
F	Connections and Reinforcement - Net connections costs reduce to zero as customer contributions expected to cover in full	Volume		-£178m	
G	Ongoing Efficiency – further ongoing efficiency throughout RIIO-3 of 0.5% per annum	Unit Rate	-£76m	-£29m	-£92m

Table 1: Totex movements across Opex, Capex and Repex

1.2. Opex, Repex and Capex Analysis

[Due to commercial sensitivity, this section has been redacted. For more information, please see our Redaction Statement]

[redacted]

Figure 3: [cost-sensitive data]

[redacted]

Figure 4: [cost-sensitive data]

[redacted]

Table 2: [cost-sensitive data]

[redacted]

Table 3: [cost-sensitive data]

[redacted]

Figure 5: [cost-sensitive data]

[redacted]

Table 4: [cost-sensitive data]

[redacted]

Figure 6: [cost-sensitive data]

[redacted]

Table 5: [cost-sensitive data]

1.3. Project and Cost Impacts Spanning Totex

[Due to commercial sensitivity, this section has been redacted. For more information, please see our Redaction Statement]

[redacted]

Figure 7: [cost-sensitive data]

[redacted]

Table 6: [cost-sensitive data]

[redacted]

Table 7: [cost-sensitive data]

1.4. Key movements in our non-controllable Totex

Non-controllable costs reduce by £22m (1%) from £2,329m to £2,307m

£m	RIIO-2	RIIO-3	Var
Shrinkage	228	125	(104)
Ofgem Licence	65	76	10
Network Rates	999	902	(97)
Pension Deficit Recovery Plan	70	0	(70)
NTS Exit Costs	840	1,098	258
Innovation	45	27	(18)
Xoserve	74	79	6
Supplier of Last Resort	7	0	(7)
Total Non Controllable	**2,329**	**2,307**	**(22)**

Figure 8: Non-controllable costs

In addition to the above costs of £2,307m for RIIO3, we propose that Joint Office costs should also be treated as a non-controllable cost due to the upcoming change to establish a new Code Manager function. This would apply a consistent treatment with other industry wide Central Data Service Provider Xoserve. Please see data table commentary[8] for further details.

Movements in non-controllable	Main driver	Change	Highlights	Document Ref
Shrinkage	Volume and unit rates	-£104m	Gas prices increased considerably during RIIO-2 due to global uncertainty regarding security of supply. Both volume and unit rates are projected to be lower in RIIO-3	CV4.12 Shrinkage
Ofgem Licence	Unit Rates	+£10m	Above inflation increases in the Licence Fee seen in RIIO-2 expected to continue into RIIO-3	CV4.00 Opex Cost Matrix
Network Rates	Unit Rates	-£97m	A revaluation of rateable values in 2023 led to a reduction in network rates which continues into RIIO-3	CV4.00 Opex Cost Matrix
Pension Deficit Recovery Plan	N/A	-£70m	One-off cost in RIIO-2, not expected to repeat in RIIO-3	CV4.00 Opex Cost Matrix
NTS Exit Costs	Unit Rates	+£258m	Driven by National Gas Transmission published indicative charges. In GD2, we saw significant volatility in these unit rates particularly in 2023/24 when rates were c50% lower than they are today	CV4.00 Opex Cost Matrix
Innovation	Type of work	-£18m	RIIO-2 included significant costs in support of the HSE's assessment of the technical and safety evidence for hydrogen repurposing. Our plans for RIIO-3 are detailed in the innovation strategy appendix	M9.00 Innovation Appendix 8
Xoserve	Unit Rates	+£6m	Xoserve are planning to undergo extensive system upgrades which is driving the increase in fees in RIIO-3	CV4.00 Opex Cost Matrix
Supplier of Last Resort	N/A	-£7m	One-off cost in RIIO-2, not expected to repeat in RIIO-3	CV4.00 Opex Cost Matrix

Table 8: Key movements in our non-controllable costs

[8] Table M8.14, section 2.4.2

1.5. Phasing of costs over RIIO-3

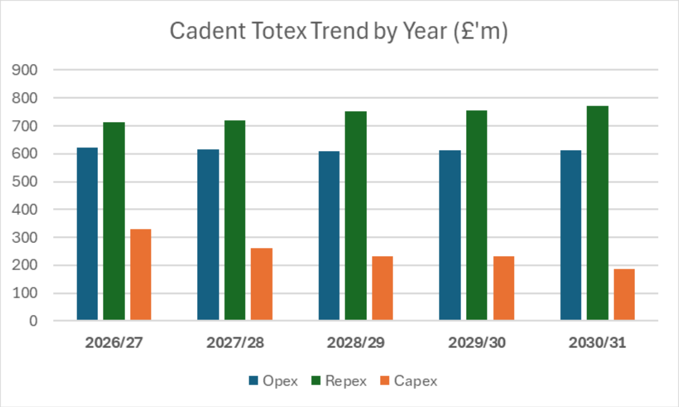

Figure 9: Cadent Totex trend by year

The majority of Totex costs through RIIO-3 follow a flat and stable profile, with the following exceptions:

- Physical Security spend is concentrated in the first two years of RIIO-3 because it is imperative that we act as soon as possible protect our assets in line with DESNZ specifications.
- IT & Telecoms cyber security related spend peaks in years one and two of RIIO-3 due to the need to respond to the new cyber assessment framework requirements by 2027.
- The initial investment of advanced leakage detection technology is forecast in 2026/27 alongside the work to complete the roll out of the DPLA across our networks.
- Vehicle related Capex costs for converting and fitting out new vans are incurred in line with our vehicle replacement cycle, which is determined by the expiry date of vehicle leases and therefore fluctuates over the RIIO-3 period.
- The timing of Repex and underlying Capex spend (excluding the above noted items) is aligned to projected workload delivery, which has been scheduled after taking into account deliverability and supply chain considerations.

2. Assessing the efficiency of our plan

To assess the efficiency of our business plan, we have aligned our approach to the principles of the framework adopted by Ofgem at RIIO-GD2 to assess network costs, which we expect will be used as the starting point for RIIO-GD3. In assessing costs for the RIIO-GD2 price control, Ofgem assessed the vast majority of forecast, controllable expenditure through comparative benchmarking between GDNs using a single Totex regression model. The model used had the following specification, where the 'Totex Composite Scale Variable (CSV)' is a weighted average of seven cost drivers, each weighted by the industry average expenditure share of the cost area which each cost driver was intended to explain[9]:

$$\log(totex_{it}) = \alpha + \beta_1 * \log(totex\ CSV)_{it} + time\ trends_t + \xi_{it}$$

Equation 1: Ofgem RIIO-GD2 Totex regression model

Table 9 below lists the seven cost areas within regressed Totex at RIIO-GD2, and their respective cost drivers which Ofgem used to calculate the Totex CSV. Ofgem estimated this Totex regression model using 13 years of data (ultimately outturn data for the first seven years of RIIO-GD1, and forecast data for the last year of RIIO-GD1 and the five years of RIIO-GD2) for all eight GDNs. In this model specification, α is a constant term, β_1 is a coefficient that captures the elasticity of Totex with respect to the Totex CSV, and ξ_{it} is a residual term that captures the difference between Totex predicted by the model and Totex observed in the data. The model also includes two-time trend variables (one for the entire sample including historical and forecast data, and one for forecast data only) which capture industry-wide changes in Totex over time. The subscript *i* refers to each of the eight GDNs, and the subscript *t* refers to each year in the sample.

[9] Ofgem (February 2021), RIIO-2 Final Determinations – GD Annex (Revised), Para. 3.83 - 3.109

Cost Area	Cost Driver	Cost Driver Description	GD1-GD2 Industry Average Expenditure Share
Emergency	Emergency CSV	Weighted average of customer numbers and Repairs Reports	5%
Repair	Repair (External Condition) Reports	External condition reports	6%
Maintenance	Maintenance Modern Equivalent Asset Value (MEAV)	Subset of MEAV, only including above-ground assets	7%
Connections	Connections Synthetic Cost	Product of workload and industry-average unit costs	5%
Reinforcement	Reinforcement Synthetic Cost	Product of workload and industry-average unit costs	2%
Repex	Repex Synthetic Cost	Product of workload and industry-average unit costs	39%
Other[10]	MEAV	Modern Equivalent Asset Value (Replacement value of network assets)	36%

Table 9: Cost drivers used by Ofgem in its RIIO-GD2 Totex regression model (source: Cadent analysis)

Prior to running this model, Ofgem applied ‘normalisations’ to exclude costs not suitable to be assessed via comparative benchmarking (cost exclusions) and to reflect regional and company-specific factors. Costs excluded from the regression were then assessed using other approaches, such as technical assessment.

Our RIIO-3 business plan has been built bottom-up, with cost forecasts using RIIO-GD2 values as a starting point, supplemented with additional analysis of changes in unit costs and workload needing to be delivered within RIIO-3, undertaken at a detailed activity-by-activity basis. Given this starting point, we have assessed the efficiency of our plan by undertaking comparative benchmarking of actual and forecast RIIO-GD2 costs. This then establishes the efficiency of our underlying cost base which has been rolled forward for our RIIO-3 plan[11]. This approach is appropriate and necessary as (i) Ofgem will comparatively assess the majority of Totex against other GDNs and (ii) other GDN forecasts are only available until the end of RIIO-GD2 (via the 2023/24 Regulatory Reporting Process (RRP) datashare). We also detail how we have driven this efficiency over the RIIO-2 period.

The next three Sections set out the methodological choices made in undertaking our benchmarking and the underpinning evidence we are submitting to Ofgem which should be taken into careful consideration for its’ RIIO-GD3 assessment approach on:

- **Cost exclusions** (section 3) – which **identifies specific costs that should not be comparatively benchmarked and should be separately assessed** (we also signpost where further information and justification of these costs can be found across our wider plan);
- **Regional and company-specific factors** (section 4) – **required adjustments to our costs needed so that comparative efficiency analysis of our costs is robust**. These reflect impacts on our activities that are outside of our control and increase cost, but which are not captured through Ofgem’s regression modelling approach; and
- **Comparative efficiency modelling** (section 5) – **objective modelling improvements that Ofgem should consider in its RIIO-GD3 cost assessment approach, which demonstrably improve on the RIIO-2 model**, and which we have applied to RIIO-GD2 actual and forecast costs across networks to establish the comparative efficiency of our costs.

In undertaking our analysis we have worked collaboratively with NERA Economic Consulting and have had the quantitative outputs of our work independently assured by Economic Insight (EI)[12]. Owing to the page limit on

[10] The “other” cost area includes cost associated with Work Management, Business Support, Other Direct Activities, Other Capex, and LTS Pipelines, Storage & Entry.
[11] The RRP forecasts have been supplemented with additional information and assumptions where required to create the full dataset required to estimate benchmarking models.
[12] Specifically cost exclusions and regional factor proposals – set out in BPDTs M8.13 and M8.14 – and regression analysis results

this appendix, which is particularly challenging for Cadent as we have double the number of networks compared to other ownership groups, in some areas we have insufficient space to set out all the details we would like which underpin our work. However, where helpful for Ofgem to see this, it can be provided.

3. Areas of our plan which require exclusion from comparative benchmarking

In general, comparative regression benchmarking models should aim to explain as much of the GDNs' cost base as possible through selecting the appropriate cost drivers and functional form and applying sufficient cost normalisations. However, it is important to recognise that it is unlikely that a regression model (or models) will ever capture all exogenous variation in GDNs' costs sufficiently for efficiency scores to be completely robust. For example, one network may undertake work to deliver a specific output that no other GDN does. If there is no driver in the model to capture this activity, this would understate the efficiency of that network. Therefore, it is important such costs are excluded and assessed via other assessment methods. For RIIO-GD2, Ofgem excluded historical/forecast costs from submitted Totex, where:

- cost variations across GDNs were not well represented by regression cost drivers (i.e. it was not possible to develop a robust cost driver).
- they related to large and atypical Capex – using a £5mn materiality threshold; and
- they related to bespoke outputs to be delivered by a GDN or were uncertain in size or scope[13,14]

In the RIIO-GD3 Sector Specific Methodology Decision (SSMD), Ofgem confirmed it would continue to exclude costs using these criteria. However, Ofgem also stated that it "intend[s] to consider both large and atypical Repex projects for exclusion as well as Capex projects"[15]. Ofgem will apply these criteria to determine which areas they will exclude for RIIO-3 when all GDN business plans are submitted.

To inform Ofgem's assessment, **we have proposed specific costs for exclusion from comparative regression benchmarking**, with values for all years set out in Business Plan Data Table (BPDT) M8.14. Below we set out (i) why each area meets Ofgem's exclusion criteria, (ii) the level of costs we forecast for the RIIO-GD3 period and (iii) explain where further information can be found. We first detail new exclusions we propose before summarising where exclusions and adjustments made in setting the RIIO-GD2 price control should be maintained (including costs and adjustments only applicable to GD1 and GD2 periods) or where inclusion of previously excluded costs is warranted.

3.1. Proposals for new cost exclusion, relative to RIIO-GD2

3.1.1. LTS Diversion activities and associated surveys

GDNs incur Capex associated with LTS pipelines. The LTS connects National Gas' National Transmission System to GDN lower capacity distribution mains. LTS diversions relate to the re-routing of LTS pipelines, for example, to accommodate building works near to existing LTS pipelines. Of these, some are rechargeable, meaning costs associated with projects are recovered from the third parties requesting the diversion, to permit land development of some type. For example, in RIIO-GD2 in our West Midlands network we have undertaken significant works to accommodate the development of the HS2 rail network. In some instances, GDNs have the choice as to whether to deliver the diversion (or compensate the third-party for loss of land development potential and not undertake the diversion). However, in many cases the latter is not possible. In delivering these diversions, additional Opex is also incurred to undertake required surveys specific to each of the rechargeable diversions. Other LTS diversions are non-rechargeable, meaning GDNs incur the associated costs. Despite not being recoverable from third parties, these diversions are typically required due to a change in, or the impact of,

[13] Ofgem (2023) "*RIIO-3 Sector Specific Methodology Consultation – GD Annex*", P. 83, see here: RIIO-3 Sector Specific Methodology Consultation – GD Annex (ofgem.gov.uk) Accessed: 13/02/2024

[14] CMA (2021) "*Cadent Gas Limited, National Grid Electricity Transmission plc, National Grid Gas plc, Northern Gas Networks Limited, Scottish Hydro Electric Transmission plc, Southern Gas Networks plc and Scotland Gas Networks plc, SP Transmission plc, Wales & West Utilities Limited vs the Gas and Electricity Markets Authority: Final determination Volume 3: Individual Grounds*", P. 17, Para. 9.52, P. 7, Para. 9.10, see here: Final determination Volume 3: Individual Grounds (publishing.service.gov.uk) Accessed: 13/02/2024

[15] Ofgem (2024) "*RIIO-3 Sector Specific Methodology Decision – GD Annex*", P. 115, see here: RIIO-3 Sector Specific Methodology Decision – GD Annex (ofgem.gov.uk) Accessed 11/09/2024

the external environment on asset health or safety. For example, in RIIO-GD2 SGN's Scotland GDN is diverting a pipeline near Dunkeld due to the asset's proximity to the River Tay affecting pipeline integrity.[16]

[commercial-sensitive data]

At RIIO-GD2, large (>£5m in project size), non-rechargeable diversions were excluded from regression benchmarking for other networks (notably the SGN project set out above), and following our appeal to the Competition and Markets Authority (CMA), large rechargeable diversions were also excluded (for all GDNs). However, for RIIO-GD3 we believe all LTS Diversions, no matter the size or who pays for the diversion, should be excluded from regression benchmarking. This would bring the treatment of LTS diversions in line with loss of land development claims (the alternative to a diversion) and Repex diversions (diversions of a different size and pressure of pipe) which were excluded at RIIO-GD2, and we propose should continue for RIIO-GD3. It would also bring the treatment of diversions in cost assessment into line with RIIO-ED2, where Ofgem stated: "We (Ofgem) do not see a strong rationale for MEAV or network scale generally being the key driver for diversions activity and so do not consider a change to a MEAV-based benchmarking method to be appropriate[17]." We agree with Ofgem's RIIO-ED2 assessment and think it would equally apply to gas distribution diversions which we further explain in the next section.

Why these costs should be excluded (how they meet Ofgem's criteria):

In the Totex regression model at RIIO-GD2, MEAV was the cost driver intended to explain LTS diversions costs, but MEAV is in fact unrelated to the factors driving the need for and costs of LTS diversion projects. Indeed, Ofgem did not select the MEAV cost driver at GD2 specifically to explain LTS diversions, but rather it grouped LTS Diversions into a category of 'other' costs that it assumed were related to GDNs' scale in aggregate. While MEAV measures the scale of GDNs' assets, it is unrelated to the levels of work required to divert LTS pipelines (as they are driven by external factors as set out above). Furthermore, even if all GDNs incur some level of LTS diversions costs, over the duration of a price control, there may be wide differences in the costs expected across the GDNs for reasons beyond their control[18]. As such, LTS diversions costs were not well represented by the assigned cost driver in Ofgem's RIIO-GD2 regression model and vary significantly between networks.

This logic underpinned our RIIO-GD2 appeal, in which we showed that MEAV was unrelated to the level of LTS rechargeable diversions by assessing the correlation between the two[19]. Following the CMA decision, both large LTS rechargeable diversions and non-rechargeable diversions were excluded from the Totex regression. However, based on evidence of the time, the CMA did not instruct Gas and Electricity Markets Authority to exclude smaller diversions. For our RIIO-GD3 plan we have re-examined whether smaller LTS diversions should be related to MEAV in theory and practice. The same logic above applies to small and large LTS diversions (i.e., there is no appropriate driver in the model and there are wide differences in costs incurred between networks). Therefore, assuming that the RIIO-GD3 model also relies on MEAV to explain LTS costs, projects that do not meet the £5 million materiality threshold should also be excluded. The £5 million threshold is ultimately an arbitrary choice, and costs of any magnitude that do not have an appropriate driver and vary significantly across networks for exogenous reasons will distort regression benchmarking outcomes.

[commercial-sensitive data]

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[16] For more information see: SGN (2019) "RIIO-GD2 Business Plan Appendix: Transmission integrity" December 2019, see here: [Appendix-021-SGN-Transmission-Integrity-Compliance.pdf] Accessed: 31/10/2024

[17] Ofgem (2022) "*RIIO-ED2 Final Determinations Core Methodology Document*", P. 282, Para 7.281, see here: [RIIO-ED2 Final Determinations Core Methodology Document (ofgem.gov.uk)] Accessed: 11/01/2024

[18] For example, dependent on the amount of public infrastructure investment currently being undertaken in each region of Great Britain.

[19] NERA (2021), Expert Report on Ofgem's Approach to Cost Assessment at RIIO-GD2; NERA (10 May 2021) Second Expert Report on Ofgem's Approach to Cost Assessment at RIIO-GD2, P. 30

[redacted]

Figure 10: [commercial-sensitive data]

Directly linked to the costs incurred for specific rechargeable LTS diversion projects, GDNs must also incur additional costs for new surveys of assets in close proximity to the location of the diverted pipeline to ensure they are unaffected (we incur these as part of Work Management and Maintenance Opex). Today, we have dedicated Plant Protection & Assurance resources responsible for performing these surveys for external projects which impinge on Cadent's networks and could lead to LTS diversions. In RIIO-GD1 and RIIO-GD2 Cadent's London and West Midlands networks incurred significant cost to undertake these surveys to support execution of the specific HS2 and Lower Thames Crossing projects. The assigned cost drivers in the RIIO-GD2 model for these costs are MEAV and Maintenance MEAV (the latter being intended to capture GDNs' scale of applicable assets for maintenance activity). However, as is the same for the actual diversions themselves, neither driver reflects the need for these activities, which is outside of GDN control and likely to disproportionately incurred by some GDNs. Therefore, these costs should also be excluded from comparative regression benchmarking.

[commercial-sensitive data]

3.1.2. The Digital Platform for Leakage Analytics (DPLA) and Advanced Leakage Detection (ALD)

In its SSMD, Ofgem confirmed it would fund the rollout of DPLA and consider ALD rollout at RIIO-GD3 and asked GDNs to include costs within their business plans. The HSE's Proposed Revisions to the Iron Mains Enforcement Policy 2026 -2032 also set out that GDNs should "Extend the use of condition monitoring using ALD Technologies for all iron pipes of any distance[20]". Within our plan, we forecast costs for these activities as set out below across Opex and Capex.

Network	DPLA and ALD roll our costs			
	Opex			Capex
	Business Support £m (23/24 prices)	Work Management £m (23/24 prices)	Total Opex £m (23/24 prices)	Other Capex £m (23/24 prices)
Eastern	[cost-sensitive data]	[cost-sensitive data]	[cost-sensitive data]	[cost-sensitive data]
North London	[cost-sensitive data]	[cost-sensitive data]	[cost-sensitive data]	[cost-sensitive data]
North West	[cost-sensitive data]	[cost-sensitive data]	[cost-sensitive data]	[cost-sensitive data]
West Midlands	[cost-sensitive data]	[cost-sensitive data]	[cost-sensitive data]	[cost-sensitive data]

Table 10: RIIO-3 DPLA and ALD rollout costs by network (source: Cadent analysis)

DPLA alongside ALD are intended to replace the current SLM measurement of emissions across networks from modelled emissions to observed emissions data. This data is captured through leveraging new and emerging technologies to detect methane leaks using both fixed asset sensors and vehicle mounted equipment. This data is then combined with machine learning and advanced hydraulic modelling techniques to provide a current, observed, view of leakage across GDN networks. Within RIIO-GD2 Cadent was funded via the SIF to develop the approach to using this technology alongside other networks, testing this initially within our London network. We have used this learning to inform our RIIO-GD3 business plans, and shared costing information from our work undertaken within RIIO-GD2 with all GDNs.

[20] HSE (2024) "Proposed Revisions to the Iron Mains Enforcement Policy 2026 -2032"

Why these costs should be excluded (how they meet Ofgem's criteria):

As we have shared the basis of our cost forecasts (i.e. the costs for sensors, vehicles and other technologies) with other GDNs and understand these are being used for their forecasts, it is inappropriate to include these costs within comparative regression benchmarking – as the true efficiency of the cost estimates will likely be common across GDNs. Were these costs to be included in Ofgem's regression model, based on the RIIO-GD2 approach they would be modelled by MEAV with any differences in 'efficiency' being purely artificial due to differences in GDNs' scale, so would not account for any real efficiency differences (i.e. they would not be well modelled by cost drivers within regression analysis). In addition, from recent Ofgem working groups it has become clear that different GDNs are at different stages of maturity in understanding rollout requirements for their particular networks. As a result, there are likely to be different approaches to treating costs associated with DPLA and ALD in plans. We have included these costs in our base Totex, but others may suggest that they sit within uncertainty mechanisms, for example, while they work to mature their understanding of their requirements. This would mean the size and scope of costs potentially included in regressed costs would differ across GDNs for reasons other than efficiency (again meaning they are unlikely to be well modelled by cost drivers within the regression). Any assessment should not unduly punish networks which are more mature in this area or benefit those that have not engaged more actively in the need for rollout to date. It is important that a consistent assessment of these costs is undertaken. Due to the (likely) common basis of costs across GDNs, different levels of maturity in GDNs' understanding, and potentially different regulatory treatment in Business Plans, we propose DPLA and ALD rollout costs are excluded and assessed separately from comparative analysis.

[commercial-sensitive data]

3.1.3. Net zero and vulnerability activities within baseline Totex

At RIIO-GD2 Ofgem provided separate UIOLI allowances to GDNs to support activities related to: (i) vulnerability initiatives (the VCMA) and (ii) Net Zero related activities (the Net Zero and Re-opener Development (NZARD)), which to date, have been utilised by GDNs to different extents. Cadent also received a Bespoke Output for Personalised Welfare provisions. Moving into RIIO-GD3, GDNs have been asked to include more of these activities within baseline Totex as they are now considered 'Business as Usual' (BAU). For example:

- for vulnerability – campaigns and education on the Priority Services Register; provisions of Carbon Monoxide (CO) / specialist alarms; additional checks following CO reports / alarms; funded alterations for access to the Emergency Control Valve /meter; eligibility checks for a range of BAU and VCMA projects; maintenance and development of Social Return on Investment tools, relevant memberships and events; alternative heating and cooking solutions; safeguarding services; and internal training and dedicated teams to support customers during works[21].
- for net zero – the RIIO-3 SSMD specifies that GDNs include coordination and engagement costs with RESPs, within their baseline allowances. In this respect we have included plans for network modelling and customer support and stakeholder management. In addition to support the delivery of Ofgem's outcome to deliver 'Infrastructure for a low-cost transition to net zero' we have also included in our plans activities to support the development of engineering policy as well as activities to develop the associated market frameworks under different future states.

Some of the activities listed above are wholly new or significantly increased from RIIO-GD2. Others are already being undertaken by GDNs within RIIO-GD2 via UIOLI funds determined outside of Ofgem's core comparative regression benchmarking of GDN costs in setting the current price control. For RIIO-GD3, no matter if costs are proposed to be funded via UIOLIs, or if included in baseline, we believe all should receive a consistent cost assessment approach outside of comparative regression benchmarking. For RIIO-GD3, we forecast the following levels of costs to support these activities across our networks:

[21] Ofgem (2024) "Guidance on GDNs' proposed BAU Vulnerability and CO safety initiatives for funding through baseline allowances"

Network	Net Zero and Vulnerability activities funded through baseline Totex	
	Net Zero Opex-Work Management £m (23/24 prices)	Vulnerability Opex-Work Management £m (23/24 prices)
Eastern	[cost-sensitive data]	[cost-sensitive data]
North London	[cost-sensitive data]	[cost-sensitive data]
North West	[cost-sensitive data]	[cost-sensitive data]
West Midlands	[cost-sensitive data]	[cost-sensitive data]

Table 11: RIIO-3 Net Zero and Vulnerability activities within baseline Totex by network (source: Cadent analysis)

Why these costs should be excluded (how they meet Ofgem's criteria):

If costs associated with vulnerability and net zero in our plan are not excluded from comparative regression benchmarking then they would be modelled by MEAV based on Ofgem's RIIO-GD2 Totex regression. This implicitly assumes the costs are purely driven by network scale. However, for the reasons set out below, costs are in fact not driven by this variable and so, will not be accurately captured by this cost driver within Ofgem's regression. Whilst Ofgem has provided guidance over which types of activities GDNs should include in baseline Totex forecasts, the implementation approach by GDNs of that guidance may vary, meaning some GDNs include costs within proposals for UIOLI allowances, while others include activities in base Totex. Therefore, the size and scope of costs potentially included in regressed costs would differ across GDNs for reasons other than efficiency, and as such, only assessing proposals for UIOLI allowances separately may unintentionally benefit or punish certain networks. Furthermore, whilst network scale will have some impact on these costs, it is unlikely to be the only, or most prominent driver of costs, and will not capture differences across networks:

- For vulnerability activities – the drivers of need are actually, the potential need for support (i.e. volume of vulnerable customers) – which does not necessarily correlate to network scale (for example, small networks serving urbanised areas may see proportionately larger numbers of vulnerable customers, than larger rural networks) and requirements of particular stakeholders and organisations in particular areas who work with us to deliver enhanced support.
- For net zero activities – these will largely be exogenously driven by and dependent on: RESP and LA-specific needs for developing their future energy system plans (and the associated data, modelling and input they require from GDNs), location of net zero transition-related projects in specific networks (for blending, repurposing or decommissioning) as well as NESO, Ofgem and Government requirements for analysis, engagement and input from GDNs across the RIIO-GD3 period.

[commercial-sensitive data]

3.1.4. Large and atypical Capex and Repex projects for RIIO-GD3

In line with Ofgem's SSMD and the criteria set out above, we have reviewed our RIIO-GD3 portfolio of Capex and Repex projects and identified those that (i) exceed £5m and (ii) are atypical for cost exclusion for RIIO-GD3 cost assessment. The table below summarises these projects and their rationale for exclusion, along with where further information on the projects can be found in our Business Plan. [security-sensitive data]

[redacted]

[redacted]

[redacted]

Table 12: [cost & security sensitive data]

3.1.5. Other potential areas for cost exclusion or alternative treatment at RIIO-GD3

Robotic intervention

Robotic Intervention relates to Repex workload undertaken using a specific intervention method which relies upon cast iron joint rehabilitation robots. It is often utilised to repair joint leaks, rather than fractures – where traditional mains replacement techniques are used – and is often a more efficient method than the alternative (e.g., with less road space needing to be closed for work to be undertaken). The cost associated with this activity are reported in BPDT table CV6.12 Robotic Intervention. For RIIO-GD3 we forecast the following levels of expenditure across our networks:

Network	Repex-Robotic Intervention £m (23/24 prices)
Eastern	[cost-sensitive data]
North London	[cost-sensitive data]
North West	[cost-sensitive data]
West Midlands	[cost-sensitive data]

Table 13: RIIO-3 Robotic Intervention costs by network (source: Cadent analysis)

At RIIO-GD2 Ofgem's BPDTs treated costs and volumes in this table as a 'memo' whereby they were included in other core Repex tables which were then summed to derive overall costs and volumes. As a result, this type of Repex work was modelled at RIIO-GD2 by the Repex synthetic cost driver. However, in the RIIO-GD2 RRPs and RIIO-GD3 BPDTs, the Robotic Intervention table is now treated in the same way as other Repex tables and is now not a memo table. This change in reporting approach means that a change in assessment approach is required to either: (i) feed volumes within CV6.12 into the synthetic and develop a specific synthetic unit cost, or (ii) if this is not feasible, exclude costs and volumes from comparative assessment and assess this separately. Either approach could be appropriate depending on the nature of submitted business plan data, but for our comparative modelling set out in section 5 below, as there is no synthetic unit cost available when developing our work, we have excluded these costs.

It is important that a change is made to the RIIO-GD2 method. Otherwise, costs for this work will be treated as an effective 'overhead' within modelling, giving an inaccurate efficiency assessment. This is particularly problematic as robotic intervention costs are incurred disproportionately among a small number of networks, largely serving London customers and customers in urban settings, where its advantages are most pronounced. Not amending the RIIO-GD2 approach would therefore penalise these networks unfairly and disincentivise them from using the technology in period.

[commercial-sensitive data]

Pension Administration costs

Since the finalisation of our totex forecasts, the costs we incur associated with pension administration are now projected to increase significantly over the RIIO-2 period and into RIIO-3. Cadent is disproportionately impacted in comparison to the other GDNs, because we bear the cost to administer a number of legacy pension arrangements for employees from the period prior to the gas distribution networks being sold by National Grid. Therefore, it is important these costs are also considered for alternative cost treatment relative to RIIO-2, where it they are funded ex-ante and included within Ofgem's totex regression.

3.2. Proposals for continued cost exclusion from RIIO-GD2

Ofgem excluded costs/activities set out in the table below from comparative regression assessment in setting RIIO-GD2. We believe these should continue to be excluded from benchmarking at RIIO-GD3 for the reasons outlined. The table also sets out the value of each of these costs/activities where present in RIIO-GD3 for exclusion (some exclusions relate to costs only present for RIIO-GD1 and RIIO-GD2) and where further information on these cost areas can be found in our plan. Note that where the items below represent whole activities we undertake, rather than specific projects, we are proposing that costs are removed for all networks before they are comparatively assessed.

Cost area / activity	Expenditure Area and Cost (GD3)	Description	Justification for exclusion for RIIO-GD3 price control	Location of further information
Tier 1 Stubs	[cost-sensitive data]	Stubs are short lengths of Tier 1 iron mains that are connected to a Tier 2 or 3 'parent' main. Downstream of the stub, the Tier 1 main is part of the Tier 1 IMRRP whereas the larger diameter parent main is not replaced. Stubs must all be made safe by 2032 in line with the Tier 1 programme. Stubs can be made safe through different approaches (replacement, remediation – bagging techniques or assessed and left in situ). It is not known a priori exactly how many stubs are present and what interventions will be required on each to ensure they are made safe, in line with HSE regulations. Additionally, stubs are often more costly to make safe than traditional mains, as their function of connecting mains means they are located in areas where gaining access and undertaking works is difficult (e.g., located in the carriageway and beneath road junctions).	At RIIO-GD2, Tier 1 iron stubs were excluded from comparative assessment for some networks, including NGN and SGN's due to uncertainty over costs and volumes, being technically assessed. In addition, a re-opener for all GDNs was specified to provide funding for all GDNs in period. Whilst GDNs now have greater experience in undertaking stubs work, those that require intervention in the RIIO-GD3 period remain uncertain. If Tier 1 stubs are not removed from Ofgem's Totex regression model, their assigned cost driver would be the Repex Synthetic. Without changes to this driver for RIIO-GD3, it will be unable to accurately capture cost variations between GDNs, as it has no volume or cost driver related to Stubs, only mains and services. Irrespective of this, however, we do not believe an additional stubs synthetic element would accurately capture variation in GDNs' stubs costs, even if it could be specified, as the required intervention mix is uncertain. This could result in any synthetic driver, therefore, being set potentially too high or too low. Unless the RIIO-GD3 model introduces new cost drivers that are able to better explain these costs and capture this uncertainty, these costs should continue to be excluded from comparative benchmarking.	[commercial-sensitive data]
Streetworks	[cost-sensitive data]	Streetworks costs are activities that enable and support works in the public domain, such as the cost of closing streets to undertake works, and allowing safe navigation of works by traffic and pedestrians (e.g., barriers, traffic management equipment including lights, and the payment of fees to undertake works). They are incurred by all utility providers, including GDNs. After determining works it intends to undertake, GDNs apply for and pay for permits from LAs or Highway Authorities – set at their discretion, in line with applicable legislation. For each piece of work, GDNs also need to comply with certain conditions/ restrictions, which are also specific to the relevant area authority (e.g., hours of work). If a GDN does not comply with these conditions, it incurs penalties and/or fines from the authorities. As such, while the overall level of streetworks costs is somewhat related to the underlying level of workload being undertaken by networks, they are largely outside of GDNs' control and vary significantly between regions.	As streetworks costs depend on external factors related to local policies within each GDN's area, workload and/or scale drivers cannot capture cost variation across GDNs. Therefore, at previous RIIO price controls Ofgem has consistently excluded streetworks costs from comparative regression assessment. Most recently for RIIO-ED2, Ofgem excluded Streetworks Costs for separate assessment stating that the costs were "*not adequately explained by cost driver*" and were excluded previously as costs are impacted by *"different charging mechanisms in different areas and [are] not fully within control of the company"*.[22] [commercial-sensitive data] Therefore, unless the RIIO-GD3 model introduces new cost drivers that are better able to explain these costs across the entirety of the GDN cost base, they should continue to be excluded from comparative benchmarking. In addition to costs not being well represented in Ofgem's Totex regression model, for RIIO-GD3 there is also uncertainty over legal and policy changes which are likely to come into effect within the RIIO-GD3 period and impact cost levels. For example, the Department for Transport (DfT) plans to onboard new Highway Authorities, and we expect the expansion of lane rental schemes across the country. Ofgem has accepted this uncertainty and is retaining a re-opener in RIIO-GD3 to flex funding when these changes come into effect. This uncertainty also underpins why streetworks costs should be excluded from comparative assessment at RIIO-GD3, consistent with Ofgem's criteria.	[commercial-sensitive data]

[22] Ofgem (2022), "RIIO-ED2 Draft Determinations – Core Methodology Document" P. 241, Table 24

Cost area / activity	Expenditure Area and Cost (GD3)	Description	Justification for exclusion for RIIO-GD3 price control	Location of further information
Cyber resilience	[cost-sensitive data]	[security-sensitive data]	[security-sensitive data]	[security-sensitive data]
MOBs[23]	[cost-sensitive data]	Costs associated with risers supplying gas to Multiple Occupancy Buildings (MOBs) are incurred across the connections (Capex), maintenance (Opex) and Repex cost areas. The costs of undertaking these activities varies significantly depending on the characteristics of building being either connected, maintained, or having its risers replaced. This means a comparison of costs across networks is difficult as even cost drivers which pick up the volume of MOBs/risers are unable to pick up cost differences due to the building stock varying significantly within and across GDNs' regions	At both RIIO-GD1 and RIIO-GD2, Ofgem excluded MOBs costs from the regression modelling, stating at RIIO-GD2, that "*the varying and unique nature of many MOBs means the costs of maintaining and replacing/refurbishing the risers varies significantly between location and GDN*".[24] [commercial-sensitive data]We have not identified any reason for this to change in RIIO-GD3. Therefore, unless the RIIO-GD3 model introduces new cost drivers that are able to better explain these costs, they should continue to be excluded from comparative benchmarking.	[commercial-sensitive data]
Physical Security [security-sensitive data]	[cost-sensitive data]	[security-sensitive data]	[security-sensitive data]	[security-sensitive data]

23 Costs were also incurred for Connections MOBs in previous periods, but for RIIO-3 we are forecasting no costs for these activities. These should, however, be excluded for RIIO-1 and RIIO-2 periods
24 Ofgem (2023), " RIIO-3 Sector Specific methodology Consultation – GD Annex", P. 87

Cost area / activity	Expenditure Area and Cost (GD3)	Description	Justification for exclusion for RIIO-GD3 price control	Location of further information
Land Remediation	[cost-sensitive data]	GDNs incur costs to undertake statutory and non-statutory land remediation activities on inherited land sites. These activities involve identifying, evaluating/assessing, monitoring and mitigating environmental contamination and risk caused by operations at gasholder and non-gasholder sites. This work also involves returning land to productive use where possible and where the land is surplus to operational requirements.	At RIIO-GD2, Ofgem excluded these costs from comparative benchmarking due to "*the variation of these costs across different networks and that they were not well represented by the proposed cost drivers*".[25] If these costs were not to be excluded from benchmarking Ofgem's cost driver for these activities would be MEAV, based on the RIIO-GD2 model. However, the driver of Land Remediation costs depends on the specific sites present on a network and their level of contamination. For these reasons, and because GDNs have decommissioned gasholders across different time periods, the levels of costs vary widely across networks for reasons unrelated to scale. [commercial-sensitive data] Therefore, absent changes in cost drivers to recognise these factors, these costs should continue to be excluded from comparative benchmarking.	[commercial-sensitive data]
Smart Metering	[cost-sensitive data]	GDNs do not install smart meters, but may incur costs in addressing issues and faults upstream of meters, either during or after a smart meter installation. These costs generally relate to escapes and exogenous factors outside of GDN control impacting emergency and repair activities. They also vary significantly across regions as they are dependent on the extent of smart meter rollout within each GDN's region.	Ofgem previously excluded smart metering costs at RIIO-GD2. The smart metering programme is supplier driven meaning that, the number of meters installed in a given network is outside of GDN control, and as a result, the need to undertake work on smart meters due to escapes is also outside of GDN control. As they sit across the cost base, were Ofgem to leave smart metering costs within Totex for comparative assessment they would be modelled by the CSV. However, the CSV as a measure of workload and network scale is unable to capture these exogenous factors which lead costs to vary widely across networks. [commercial-sensitive data] Moving into RIIO-GD3 Ofgem has removed the Smart Metering re-opener as the current framework for installation is set to finish in 2025. While there is still some uncertainty over whether targets will be achieved, or whether the need for installations will continue, not excluding costs incurred historically that are not present or are significantly smaller in RIIO-GD3 will distort benchmarking outcomes. Hence, they should continue to be excluded from comparative benchmarking.	[commercial-sensitive data]
Personalised Welfare	[cost-sensitive data]	As set out above, at RIIO-GD2 Cadent received a bespoke output for providing Personalised Welfare provisions to vulnerable customers across all our networks. For RIIO-3 these costs have been included in our baseline Totex forecasts for vulnerability and form part of 'vulnerability activities within baseline Totex' referenced above.	This bespoke output was excluded at RIIO-GD2 in line with Ofgem's criteria as it represented an activity with associated costs that would only be incurred by Cadent networks, with no associated workload driver able to recognise these costs, within Ofgem's Totex regression model. As this is still the case for costs incurred and activities undertaken in the RIIO-GD2 period, we believe this exclusion should still apply to applicable RIIO-GD2 costs for setting the RIIO-GD3 price control. It is important to note that this is consistent with our proposed exclusion of vulnerability costs within baseline Totex for RIIO-GD3.	[commercial-sensitive data]

[25] Ofgem (2020), RIIO-2 Draft Determinations – GD Sector Annex, Paras. 3.108-3.110

Cost area / activity	Expenditure Area and Cost (GD3)	Description	Justification for exclusion for RIIO-GD3 price control	Location of further information
Repex Diversions (mains and associated services)	[cost-sensitive data]	Repex diversions are the equivalent diversion of smaller and lower pressure mains pipes (and where applicable, services) to the larger LTS diversions discussed above. They are mostly driven by third-party infrastructure development or other external factors to maintain asset health and safety. Like LTS diversions, they can be rechargeable to the third party that requests diversions. However, in some cases, GDNs are unable to recover all, or part, of the costs from third parties.	At RIIO-GD2, Ofgem excluded all Repex diversions costs from Totex benchmarking modelling as it was unable to find a robust driver for these costs,[26] and due to uncertainty over volumes and costs that are predominantly third-party driven and vary materially between projects. If Repex diversions were not removed from Ofgem's Totex regression model, the assigned cost driver would be the Repex Synthetic. Ofgem found this was not a robust cost driver at RIIO-GD2, presumably due to the highly variable and bespoke nature of costs for each Repex diversion project, largely outside of GDN control. Hence, unlike other Repex work that is comparable across GDNs, including a representative unit cost in the Repex synthetic cost driver for diversions is not possible. Furthermore, given the uncertainty in these costs, it is difficult to specify volumes and costs ex-ante. As these characteristics still prevail, unless the RIIO-GD3 model introduces new cost drivers that are able to better explain these costs, Repex diversions costs should continue to be excluded from comparative benchmarking.	[commercial-sensitive data]
Loss of Land Development	[cost-sensitive data]	Loss of land development claim costs are incurred by GDNs to compensate land owners for continuing to have gas pipelines run through their property, curtailing development of said land from its present condition. They are typically incurred as an alternative to LTS or Repex diversions. As with diversions, the main need for these claims is third-party driven through wider infrastructure development.	Consistent with the removal of diversions at RIIO-GD2, these costs were also excluded as they are determined by factors outside of GDNs' control. If these costs were, however, included in regressed Totex then they would be modelled by MEAV as they sit within the 'other' category of costs in Ofgem's GD2 Totex regression. However, network scale is unable to adequately pick up cost variation among GDNs due to: (i) the wide variety in claim costs which are case-by-case specific and (ii) the wide variety of volumes of claims across networks driven by factors outside of GDN control. [commercial-sensitive data]. Unless the RIIO-GD3 model introduces new cost drivers that are able to better explain these costs, they should continue to be excluded from comparative benchmarking.	[commercial-sensitive data]
Gasholder demolition	[cost-sensitive data]	All GDNs have an obligation to demolish gasholders on their networks by 2026. Different networks have taken different approaches to undertaking this work, with some selling holders and the obligation to decommission them, and others undertaking this work themselves.	Ofgem has previously excluded gasholder demolition costs at past price controls with the number of holders to demolish not being related to network scale and number varying wildly across networks due to the make-up of inherited historical asset bases. Whilst we understand all networks' gasholders will be demolished by the start of RIIO-GD3, it is important to exclude historical costs incurred to not bias the estimation of the regression line within any comparative Totex assessment as these will not being incurred within the RIIO-GD3 period.	[commercial-sensitive data]

[26] CMA (2021) "*Cadent Gas Limited, National Grid Electricity Transmission plc, National Grid Gas plc, Northern Gas Networks Limited, Scottish Hydro Electric Transmission plc, Southern Gas Networks plc and Scotland Gas Networks plc, SP Transmission plc, Wales & West Utilities Limited vs the Gas and Electricity Markets Authority: Final determination Volume 3: Individual Grounds*", P. 22, Para. 9.73, see here: Final determination Volume 3: Individual Grounds (publishing.service.gov.uk) Accessed: 19/04/2024

Cost area / activity	Expenditure Area and Cost (GD3)	Description	Justification for exclusion for RIIO-GD3 price control	Location of further information
GD2 Large and Atypical Projects > £5m	[cost-sensitive data]	When setting RIIO-GD2 Ofgem excluded costs and technically assessed four major project across Cadent networks (Capacity upgrades > 7 bar (all networks), FWACV (all networks), Lowestoft (EoE) and London Medium Pressure (Lo). Details on each of these can be found in Ofgem's RIIO-GD2 Final Determinations: Cadent Annex. [commercial-sensitive data]	These projects were previously excluded as they are large and atypical in nature and/or related to bespoke outputs. Given they were previously excluded for setting of RIIO-GD2 they should also be excluded from benchmarking at RIIO-GD3 for consistency. Actual costs incurred and forecast for RIIO-GD2 for these projects are set out for each specific project and expenditure activity in BPDT M8.14. [commercial-sensitive data]	[commercial-sensitive data]
GD1 Large and Atypical Projects > £5m	[cost-sensitive data]	When excluding costs for large and atypical Capex projects for technical assessment for RIIO-GD2 Ofgem also "*excluded Capex relating to historical large projects (above £5m),in order to align with our approach for forecast large projects, and maintain a consistent dataset over the 13-year period*."[27]	In setting the RIIO-GD2 price control, Ofgem did not provide details of the specific projects it excluded from costs in the RIIO-GD1 period to ensure consistency with exclusions made where projects for RIIO-GD2 were being technically assessed, based on the application of its criteria. Therefore in Table M8.14 we have set out the same levels of cost to be excluded (in 23/24 prices) as excluded by Ofgem for the RIIO-GD1 period as excluded previously as we are unable to discern the precise projects Ofgem excluded.	[commercial-sensitive data]
Thames Tunnel/IP	[cost-sensitive data]	In RIIO-GD1 and the first year of RIIO-GD2 we incurred a very high level of cost for bespoke intermediate pressure reinforcement work to dig a tunnel under the River Thames for use of a 630mm main as part of a large cross-price control project. Further detail can be found in our RIIO-GD2 Regional and Company-Specific Factors submission.[28]	We submitted a Regional/Company-Specific Factor claim for the incremental reinforcement costs of this project over and above the average unit costs for reinforcement of mains also categorised as > 180mm across all GDNs (captured by Ofgem's reinforcement synthetic cost driver). This was accepted by Ofgem, who stated that "*it is not appropriate to include this project in our modelling due to the significant difference in unit costs*".[29] The incremental difference in unit costs for historical costs was then excluded from Totex before application of other regional/company-specific factors with forecast London IP reinforcement costs separately assessed for the same reason. We propose the same treatment applies for GD3 and in Table M8.14 set out the same excluded costs (in 23/24 prices) Ofgem excluded for GD1 years, supplemented with costs incurred for 2021/22 for this project to also be excluded. Excluding total costs for this additional year is consistent with Ofgem's GD2 approach as, where no volumes are stated, full costs are excluded.	[commercial-sensitive data]

Table 14: Cost exclusions to maintain from RIIO-GD2

[27] Ofgem (2020) *RIIO-GD2 Final Determinations: Step-by-Step Guide to Cost Assessment*, Para 1.9
[28] Cadent (2019) *Cadent RIIO-2 Business Plan – Appendix 09.21: Cadent's Regional Factors*, P. 17-19
[29] Ofgem (2020) *Draft Determinations: RIIO-GD2 Regional and Company Specific Factors Annex*, Para 1.46-1.50

In addition to these cost exclusions, at the RIIO-GD2 price control, Ofgem also applied its loss of meterwork adjustment to costs incurred by GDNs for emergency activities within RIIO-GD1 years. To support consistency in cost levels over time, we think it is important Ofgem preserves this adjustment for that period. In addition, we also think given continued metering activity by some GDNs, Ofgem should consider whether the adjustment is also warranted for after the RIIO-GD1 period as part of RIIO-GD3 cost assessment.

3.3. Proposals for inclusion of costs in comparative regression benchmarking, excluded at RIIO-GD2

We also believe some activities previously excluded should be included within comparative benchmarking at RIIO-GD3.

Growth (reinforcement) Governors

As set out in our RIIO-3 Sector Specific Methodology Consultation (SSMC) response, where an exclusion from comparative regression benchmarking is made, consideration is required for whether other activities can deliver the same output as the excluded activity, but that which are left within the cost base that is benchmarked. Where this is the case, the exclusion is not appropriate – as is the case for Growth Governors, as per our submissions during the RIIO-GD2 price control consultations[30]. Growth Governors support the reinforcement of the network, but the reinforcement of a network can also be achieved through longer and/or bigger pipe lay which is included within the benchmarked costs and modelled via the reinforcement synthetic cost driver in Ofgem's Totex regression model. As such, we believe the exclusion of growth governors creates bias in the regression benchmarking assessment by overstating the efficiency of networks which predominantly use growth governors, and understating the efficiency of those using pipe lay solutions. We believe growth governor costs should therefore be considered for inclusion in GD3 regression benchmarking analysis.

This is only further confirmed in reviewing Ofgem's exclusion criteria – which Growth Governor spend does not meet. Growth Governor spend could be captured via an amendment to the reinforcement synthetic cost driver (as described below), they do not relate to a large or abnormal Capex or Repex projects and they are not bespoke or uncertain. In our comparative efficiency analysis set out below, when applying our proposed exclusions/inclusions, we amend the reinforcement synthetic cost driver to include growth governor volumes for all networks and utilise annual historic average unit cost across GDNs from 2013/14-2023/24 as a synthetic unit cost (for Ofgem's GD3 modelling it could adopt a similar approach).

Electric/Zero-Emission vehicles

At RIIO-GD2, Ofgem asked GDNs to make a separate submission related to the incremental costs of purchasing and using electric and zero-emission vehicles. This was used to formulate the Commercial Fleet PCD to incentivise and provide distinct funding for GDNs to convert their existing fleets. However, the existing costs of traditional Internal Combustion Engine vehicles were included within Totex and assessed via comparative regression benchmarking. Given the removal of the Commercial Fleet PCD to fund the incremental costs of electric and zero emission vehicles, and as all GDNs are expected to bring their fleet to a zero-emission state, we believe all vehicle costs should be included within comparative regression benchmarking. This also makes sense as this type of vehicle spend does not meet any of Ofgem's exclusion criteria – non-electric and zero-emission vehicles are already within regressed costs, costs of purchasing electric and zero-emission vehicles do not relate to large or abnormal Capex or Repex projects and they are not bespoke or uncertain. Including these costs within regressed costs additionally would make the comparison of fleet costs more consistent between GDNs, which may use different procurement approaches to ensure cost efficiency (i.e. buy vs. lease).

3.4. Assessing exclusion proposals post business plan submission

Our views on the appropriate segmentation of costs for regression and separate assessment, at this stage in the price review process, can only be based on our own plan. Upon receipt of others' plans, there may be different projects or categories of spend that require separate assessment under Ofgem's criteria, but of which we are currently unaware, as we do not have visibility of others' plans. For example, if our GDNs forecast an activity or project that others do not. As such, we would welcome engagement with Ofgem and other GDNs following business plan submission to consider potential exclusions. Should new information emerge that other exclusions are needed, we believe GDNs should be given the opportunity to submit supplementary evidence to support Ofgem's assessment.

[30] For example, see Cadent's Response to Ofgem's RIIO-GD2 Draft Determinations – Cadent (2020) "RIIO-2 Draft Determination – Cadent Consultation Response: Gas Distribution Sector Questions", P.79-80

4. Regional and company-specific factors to be applied before comparative benchmarking

4.1. Required adjustments to ensure robust comparative efficiency analysis

Even with appropriate cost exclusions, comparative benchmarking models are unlikely to capture all exogenous variation in GDNs' costs sufficiently for efficiency scores to be robust. In particular, due to 'omitted variables', exogenous drivers of costs not explicitly modelled via variables in the regression model(s), any inference drawn has the potential to be misleading. To mitigate this 'omitted variable bias', it is important to account for drivers of costs outside of GDN control and not modelled appropriately within the comparative regression model(s).

There are two ways this can be achieved: (i) making pre-modelling adjustments to costs before they enter the regression to 'remove' the impact on costs so they are comparable, and/or (ii) capturing these cost drivers via additional variables in the regression. Each approach has advantages and disadvantages, as set out in our SSMC response[31]. Given this, we believe using both approaches together would allow for a more holistic and accurate assessment to be made of GDN efficiency rather than purely relying on one over the other[32]. Ofgem's current framework uses pre-modelling adjustments exclusively – termed 'regional and company-specific factor claims'. This Section sets out our claims for these for the RIIO-3 period, which should be deducted from levels of costs across our networks before they are comparatively assessed. The following section then sets out our views on a 'density model' which could be used to take account of such factors 'within' the regression.

Principles of Ofgem's approach to regional and company-specific factors at GD2

At RIIO-GD2, Ofgem used pre-modelling adjustments to account for regional factors, adjusting costs to attempt to account for differences in:

- Labour costs – to reflect exogenously driven regional wage disparities in and around London which increase costs relative to other GDNs operating elsewhere within GB.
- Urbanity factors – to reflect reduced productivity and incremental reinstatement costs incurred for GDNs operating within London, where these pressures are felt significantly more than in other areas
- Sparsity factors – to reflect additional costs incurred by GDNs operating in sparse areas to meet emergency response standards and to attend repairs

Ofgem also accepted a small number of company-proposed adjustments to costs, applied in addition to the above.

The principle behind making such adjustments was to reduce costs such that, after the adjustments, any modelled differences in costs between networks are more likely to reflect underlying efficiency differences. To achieve this, Ofgem's adjustments are applied to particular networks in a specific way:

- Labour and urbanity adjustments are applied to networks operating within and around the London region to reduce costs to an average level common across other GDNs operating outside this area.
- Company-proposed adjustments were applied to the specific networks that claims were related to, but most accounted for the additional impact of operating in a dense urban environment (not accounted for via Ofgem's other factors).
- Sparsity adjustments are applied to all networks except the London GDN. The reason for this approach is that the adjustments made for labour and urbanity will reduce costs experienced within the London region below a comparable basis relative to other networks (as London does not experience sparsity driven cost pressures, but other networks do). Therefore, all other networks except London receive a reduction in costs for sparsity effects pro rata to the sparsity of the areas they serve above the national average (the most sparse/least dense overall receiving the maximum adjustment). Eastern and Southern also receive sparsity adjustments; while they operate in London, in contrast to the London GDN, they also serve much sparser areas, as shown by their overall levels of population sparsity/density.

[31] Cadent (2024) "RIIO-3 Sector Specific Methodology Consultation: Cadent Response to Ofgem GD Annex" P. 70-78

[32] Specifically triangulating between the results of multiple totex regression models – for example, one using pre-modelling adjustments exclusively and a separate model including a density driver (and other adjustments required)

Our approach to assessing regional and company-specific factors

In setting the RIIO-GD2 price control, Ofgem largely rolled forward its RIIO-GD1 framework for regional and company-specific factors centring on adjustments for regional wages, urbanity productivity and urbanity reinstatement effects and sparsity, supplemented with the acceptance of a small number of additional adjustments proposed by companies. As we now move into RIIO-3 we have sought to bring a fresh perspective and re-evaluate the appropriateness and structure of these adjustments, specifically considering:

- whether previous evidence is still valid? – adjustments for urbanity productivity and sparsity impacts respectively were based on analysis put forward for GD1 and GDPCR1 price controls respectively meaning that they are now significantly outdated;
- whether adjustments made to costs accurately reflect the factor they are seeking to capture? – considering whether previous factors accepted by Ofgem accurately reflect the impacts on costs they seek to control for; and
- how the current framework needs to evolve to take account of recent precedent? – the RIIO-ED2 price control saw several cost impacts previously highlighted by Cadent at RIIO-GD2, and based on gas network evidence, accepted within UKPN's London Distribution Network Operators (DNOs) regulatory outcome (but for which Cadent previously did not receive an adjustment).

In respect of the latter point, we have sought to ensure consistency with current electricity controls, and so have rooted our claims in the same underlying framework and analysis that was utilised by UKPN at RIIO-ED2, accepted by Ofgem.[33] This was itself based on the cross-utility study "Understanding the Baseline Level of Efficiency in London" (referred to as the "UBLE" report hereafter) commissioned by Cadent, SGN, Thames Water and UKPN – included as Annex 3c to our appendix. This has then been supplemented with additional and more up-to-date data where possible to provide further evidence.

Through our work, we have developed a proposed framework for recognising regional and company-specific factors, which builds on the RIIO-GD2 approach constructively, brings adjustments in line with those accepted at RIIO-ED2 and adds additional evidence to ensure greater robustness in our claims. We have also discussed this in detail with Ofgem, including how our proposals could be adopted ahead of our business plan submission.

Our proposed framework for factors

Our four networks span a diverse range of geographies, with each presenting unique characteristics which impact cost bases in different ways, which need to be captured appropriately within the cost assessment approach.

Our London network and, to a lesser extent our Eastern network (the southern tip of which also covers areas within London – as far into the city as Tottenham), serve customers living within and in the direct vicinity of the densely populated UK capital[34]. Building on Ofgem's approach at RIIO-GD2, we have identified three factors which increase costs faced by our networks (and other utilities more generally) operating within and around the UK capital, as compared to elsewhere in the country:

- **Labour Costs** – a high proportion of GDNs' costs are local labour costs as work must be undertaken 'on-site' at the location of fixed network assets. As a result, where labour costs are higher in a particular region, a GDN located in the high wage region incurs a higher level of efficient costs for reasons beyond its control. Following analysis at previous price controls, we find this continues to be the case for our GDNs serving London and its surrounding area, with higher costs resulting from higher market wage levels paid to staff, and increased employer National Insurance Contributions.
- **Specific conditions faced by London utilities**:
  - **Nature of Streets** – The majority of work carried out by GDNs requires: the excavation of the street, underground working, and subsequent reinstatement of the street. In undertaking this work, utilities have no choice as to the nature and quality of materials to be excavated and reinstated and no control over working conditions they face. Consequently, where GDNs face additional complexity of delivering works, the efficient cost of doing so is higher than elsewhere.

[33] UKPN (2021) "Placing customers and communities at the heart of net zero", RIIO-ED2 Business Plan 2023-2028", P. 184-185, see here: UKPN RIIO-ED2, Accessed 07.12.24, Ofgem (2022) "RIIO-ED2 Draft Determinations – Core methodology Document", Para 7.51-7.59

[34] 76% of London's population and 5% of Eastern's population lives within the ITL region 'London' used by the ONS as of 2021. ITL is an abbreviation for International Territorial Level – the name of the regional statistical boundaries typically used by the ONS

- **Network Specific Factors** – Serving London requires unique operating practices and the unavoidable need to incur additional costs as a result of significantly greater population and property density than elsewhere in GB. The impacts of this are felt across our cost base, including: property costs, emergency response costs, third-party driven maintenance costs, underground maintenance costs and cost to comply with transport schemes.

These conditions are outside of management control and cause significantly higher costs in our London and Eastern networks as compared to elsewhere. As such, before costs are comparatively assessed, so that our two networks are put on a 'level footing' with others, the effect of these conditions must be removed from costs.

Utilities also incur costs to conduct and plan Streetworks that are, in part, determined by prevailing local procedures and charges. These vary significantly between networks and are significantly higher in London and Eastern for factors beyond our control. Were these costs to be included within comparative benchmarking, additional factor adjustments would be required. However, as we are proposing (consistent with RIIO-GD2) that Streetworks costs are excluded from benchmarking we do not make any claims for these factors, but note they should be taken account of in any non-benchmarked assessment of our Streetworks costs.

There are also separate and distinct impacts on costs across networks which serve customers where there is significant population **Sparsity**. GDNs must meet emergency standards which require responses to controlled and uncontrolled incidents within short response times. As such, where populations served are more geographically disparate, greater labour is needed to locate staff strategically so they are able to respond within required timescales. Sparsity also increases travel times for repair teams to remediate asset post escapes. Both of these effects lead to higher costs to serve sparse areas, for reasons outside of management control. Differences in cost as a result of sparsity impact all GDNs to differing extents except our London network who serves customers in a significantly more dense area. Hence, to bring all networks to a comparable basis, consistent with Ofgem's RIIO-GD2 approach, we propose proportionally reducing costs of non-London networks to recognise the impacts of sparsity.

Our proposals and how they build on the approach taken by Ofgem at RIIO-GD2 is set out in table 15 below.

Driver of higher level of efficient cost captured	RIIO-GD2 Approach	Proposed Approach for RIIO-GD3
Impact of higher labour costs in and around the London region	Regional Labour Adjustment applied to the London, Eastern and Southern GDNs (only accounting for wages)	'Labour Costs' factor, applying the Regional Labour Adjustment to London, Eastern and Southern GDNs – reflecting updated data, a more accurate reflection of the geography impacted by the London labour market and accounting for Employers National Insurance Contributions.
Impact of operating in London on GDNs' productivity	Ofgem applied two adjustments: • Urbanity productivity • Urbanity reinstatement (extended to include Repex reinstatement and Repex plant hire based on company proposals at the time)	A singular adjustment to reflect the impact of the 'Nature of Streets' in London, aligned with the approach adopted at RIIO-ED2.
Impacts of population and property density not accounted for by the 'Nature of Streets'	Ofgem accepted that the density of London impacted London's emergency job times and extended its urbanity productivity adjustment to emergency activities.	A 'Network-Specific Factors' claim to take account of the pervasive impact of population and property density across our cost base.
Impact of serving sparse populations	Sparsity adjustment applied to all GDNs except London.	'Sparsity' adjustment applied to all GDNs except London (reflecting updated data and analysis on the size of cost impacts)

Table 15: Summary of our proposed framework and comparison to Ofgem's RIIO-GD2 approach

Summary of our claims

The value of our regional and company-specific factor claims are set out within the table below for the RIIO-GD3 period and are in line with data set out within BPDT M8.13. Throughout the remainder of this Section we set out the rationale for these factors, our quantification approach and why they meet Ofgem's criteria from RIIO-GD2, which it confirmed it would apply at RIIO-GD3 in SSMD[35]:

- materiality (be at least 0.5% of a GDN's gross unnormalised Totex);
- be unique in nature to a single or small number of GDNs;
- be outside the control of the GDN;
- be excluded from the cost drivers used in regression modelling; and
- be excluded from other adjustments such as regional factors.

Regional Factors 23/24 prices	Eastern		North London		North West		West Midlands	
	£m	% of Totex	£m	% of Totex	£m	% of Totex	£m	% of Totex
Labour costs	30.54	1.11%	207.88	8.97%				
Nature of streets	13.02	0.47%	180.34	7.79%				
Network-specific Factors			30.30	1.31%				
Sparsity	10.21	0.37%			4.92	0.25%	3.40	0.24%
Total	53.78	1.96%	418.52	18.07%	4.92	0.25%	3.40	0.24%

Table 16: Summary of our Regional and Company-Specific factor claims over RIIO-3 (source: Cadent analysis)

We have quantified our claims above before applying any exclusions (i.e. based on unnormalised Totex), and accounting for interactions between factors, given Ofgem is yet to determine exclusions and apply factors to costs. This approach is consistent with the definition of costs to be used when applying Ofgem's materiality criterion, which all our claims meet, with the exception of the Nature of Streets for Eastern (very marginally) and Sparsity for all networks. However, we believe Ofgem should still accept claims for these factors for reasons set out further in this sections 4.3.1. and 4.4.

We recognise, however, that Ofgem will need to account for exclusions and interactions between factors when applying our proposals within its models. To provide an indication of the size of the factors when they are applied together, we have assumed all of our proposed exclusions are made and all our recommended regional and company-specific factors are accepted. Based on these and our approach, the value of factors removed is as follows in the table below. The majority of the movement between the two tables is due to exclusions reducing the cost base to which factor claims are applied.

Regional Factors 23/24 prices	Eastern	North London	North West	West Midlands
Labour costs	25.51	152.69		
Nature of streets	10.66	115.22		
Network-specific factors		26.82		
Sparsity	9.52		4.73	3.21
Total	45.68	294.73	4.73	3.21

Table 17: Estimated claims over RIIO-3, accounting for exclusions and factor interactions (source: Cadent analysis)

As set out above in section 2, owing to the page limit on this appendix, we have insufficient space to set out all of the mathematical detail for how we have applied cost exclusions and factors to generate the figures above. We have prepared a document containing this detail, that is available to Ofgem, if helpful to ensure that all relevant information is taken into account when reaching a final determination on this issue. However, in the remainder of this Section we provide only summary detail on where factors overlap and how they should be adjusted within modelling to take account of this.

In section 5.4, we also show our claims are conservative and entirely reasonable in size. Indeed, when adopting a 'within model' approach to account for exogenous cost factors via density, we find that when including a density driver on top of our proposed factors, the coefficient on the density variable is smaller than when included in a model without appropriate factor claims applied, but still statistically significant. This shows that, although our proposed claims take account of some of the impacts of density (as the size of the coefficient reduces) they do not capture all (as the density coefficient remains statistically significant), meaning there may be even more unaccounted for factors not captured by our claims.

[35] Ofgem (2024) "RIIO-3 Sector Specific Methodology Decision – GD Annex", P. 108-112

4.2. Labour costs

Overview of the Factor

Within BPDT M8.13 we are submitting a single factor claim for Labour Costs for our London and Eastern GDNs. This builds on Ofgem's approach at previous controls to recognise exogenous labour pressures.

A high proportion of GDN costs are labour costs – Ofgem assumed 70% at RIIO-GD2. Furthermore, given the nature of utilities, most of the work undertaken needs to be done where the assets are located. As a result, in regions where labour costs are higher, work cannot be moved to lower cost locations, and the cost of delivering work in these locations is higher than in other areas across the country.

Across different regions of GB there are a variety of local labour market forces impacting prevailing wage rates that GDNs must pay to their local labour forces. Whilst labour mobility and other market forces may reduce wage differentials between geographies, they nonetheless remain evidenced in macroeconomic data. For this reason, Ofgem has for many years accepted that exogenous factors (outside of gas and electricity distributors' control) lead to significant and persistent wage differentials between London and the surrounding areas, compared to the rest of GB[36].

Most recently at RIIO-GD2 and ED2, Ofgem accounted for labour cost differentials between (i) London and the South East regions, and (ii) elsewhere in GB. At the most recent price control review, RIIO-ED2, Ofgem explained the continued logic for this adjustment, maintaining its position that there was "sufficient mobility of labour to mitigate wage differentials throughout GB, however productivity and cost of living factors in London, and to a lesser extent in the South-East, lead to persistent wage inequality[37]." Our updated analysis of Ofgem's approach shows that these wage differences continue to persist today as they are related to the structural make-up of the UK economy, which is outside of GDN control. However, our work also shows that Ofgem's GD2 approach requires amendment, so that it can: (i) accurately reflect the area in and around the London region where there are clear wage disparities that are not currently controlled for in Ofgem's approach, and (ii) capture non-wage labour cost disparities that are outside of GDNs' control, notably employers' National Insurance Contributions.

The table below sets out the value of our factor claim for Labour Costs.

Network	RIIO-GD3 Total (£m, 23/24 prices)
Eastern	30.54
North London	207.88

Table 18: Labour costs factor by network, pre-exclusions and interactions, RIIO-GD3 total (source: Cadent analysis)

Our claim is further detailed below.

Drivers of Additional Costs Faced by Cadent

The primary driver of higher efficient labour costs incurred within and around the London region are higher regional wage rates, with GDNs serving customers in and around London facing unique upward pressures on wage rates (specifically, Cadent's London and Eastern GDNs and SGN's Southern GDN).

Verifying continued wage disparities in and around London by updating Ofgem's RIIO-GD2 analysis

To assess whether the wage disparity between London/the South East and elsewhere continues today, we have replicated and updated Ofgem's RIIO-GD2 analysis of wage differentials across GDN operating areas using the latest wage data from the ONS' Annual Survey of Hours and Earnings (ASHE) dataset, up to and including provisional earnings data for 2023. This data covers work-place based Gross Hourly Earnings for surveyed individuals, split by the ONS' Standard Occupational Classification (SOC) definitions and by UK region (according to the 11 International Territorial Level (ITL) Statistical Regions). We have also used updated ONS population data in calculations, available up to 2021 (with 2021 data assumed to apply to 2022 and 2023).

The ONS's ASHE dataset contains labour cost data with differing levels of granularity, ranging from 'one digit' (the least granular) to 'four digit' (the most granular). There are advantages and disadvantages of the different levels of granularity. The more granular SOC codes can be more closely aligned with individual jobs in specific

[36] Ofgem (2022), "RIIO-ED2 Draft Determinations – Core Methodology Document" P. 232, Para. 7.38

[37] IBID, Para. 7.39

industries. However, they are subject to more data quality issues. For simplicity, and to align with Ofgem/CMA precedent, we continue to use two-digit SOC code data for this analysis. At RIIO-GD2 Ofgem collected data from all GDNs on the composition of their labour, for employees and contractors, using the ONS SOC code definitions and has required this to be updated for RIIO-GD3. At the time of compiling our plan, we do not have a consistent view on all GDNs' updated labour force composition data. As such, we assume the same composition as submitted by GDNs previously at RIIO-GD2 (including our own). To update calculations for the latest period, however, we have adjusted ONS ASHE data for the years 2021-2023 to reflect the redefined 'SOC20' classifications that came into effect in 2021 (previous to this occupational earnings data was classified under 'SOC10' definitions). This is necessary as the data collected from GDNs on labour force composition, and still being used for our analysis, was based on SOC10 definitions. The adjustment involves remapping ASHE data based on SOC20 classifications for 2021-2023 to the SOC10 classification. To do this, we have used the same approach Ofgem outlined in their email to networks on 22 August 2024, utilising an ONS study to remap specific codes between the two sets of definitions[38].

Applying the adjusted ONS ASHE data to the notional GDN labour force composition, we then generate notional labour costs for three areas: the London ITL Region and 'South East' ITL regions, and Elsewhere in GB. Comparing these regions to Elsewhere by calculating 'relative wages' – dividing figures for London and the 'South East' by Elsewhere values – we find that between 2013/14 to 2022/23, labour costs within the London ITL and the South East ITL regions are 21.98% and 5.83% (respectively) above Elsewhere. Following Ofgem's approach, because these regions are served by three GDNs, to estimate how much wage differentials increase costs for each GDN, we pro-rate these differences by the population GDNs serve within these regions. We use ONS population data at LA level and Ofgem's GD2 file, mapping GDNs' customer bases to LA areas[39].

The table below shows the results of this analysis. While more up-to-date data has slightly reduced the size of wage cost differential in recent years, there continues to be a material wage disparity across regions, leading to higher labour costs for GDNs operating in and around London. Whilst we accept this change in the underlying data reflected in these calculations, this is not a change we have observed in our operations, with the differential remaining at similar levels over time, with little indication of it increasing or decreasing in future.

Network	Updated analysis											RIIO-GD2 levels	Difference
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	10 yr avg.	10 yr avg.	
Eastern	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	**-0.07%**
North London	1.19	1.18	1.17	1.18	1.20	1.19	1.19	1.16	1.16	1.12	1.17	1.18	**-0.98%**
Southern	1.11	1.11	1.10	1.09	1.11	1.11	1.09	1.09	1.08	1.06	1.09	1.10	**-0.90%**

Table 19: Updated RIIO-GD2 regional labour adjustments using Ofgem's approach (source: Cadent Analysis, ONS and Ofgem data (RIIO-GD2 price control)

Accurately reflecting the area of wage disparities in and around London

Whilst our analysis shows that GDNs serving the area in and around London still face unique wage pressures that are outside of their control, we do not think the approach taken by Ofgem at GD2 fully reflects the area affected by high wages driven by the unique London labour market. The regions used in Ofgem's analysis are determined by the underlying ONS ASHE dataset. This splits GB into 11 ITL Statistical Regions, which represent commonly used sub-national geographical areas adopted by the ONS to present a range of socioeconomic data.

Figure 11 below sets out the geographical boundaries of the London and South-East ITL regions that receive a regional labour cost adjustment – with all other GB ITL regions receiving none under Ofgem's approach. As shown, the current regions used lead to a counterintuitive outcome. Specifically, due to the definition of the South-East ITL, rural Kent and areas as geographically far away from London as Milton Keynes receive a regional labour adjustment, but areas in Hertfordshire, Bedfordshire and Essex, which actually border London, receive no adjustment. Were this to be accurate, it would imply wage dispersion across the South-East and areas to the North and East of London (in the East ITL) are asymmetric, with areas directly bordering London to

[38] ONS (2021) "The relationship between Standard Occupational Classification 2010 and Standard Occupational Classification 2020: SOC2020-SOC2010 relationship tables July 2021". To note - The ONS study provides a separate mapping for male and female workers. In our calculation, we take a weighted average of the male and female mapping to create an overall mapping.

[39] For example, London GDN was found to be typically around 76% in the London Region of the ASHE dataset, 10% in 'South-East' Region, and 14% Elsewhere.

the North and East , having materially lower wages than the adjacent areas to the South and South West of London.

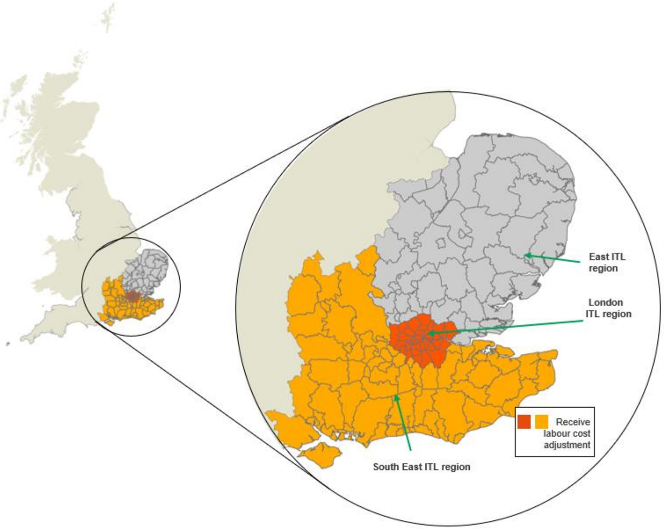

Figure 11: Regions currently receiving a labour cost adjustment under Ofgem's RIIO-GD2 approach (source: Cadent analysis)

To assess whether this bears out in practice, from the same ONS ASHE dataset used by Ofgem, at the more granular LA level, for all occupations (SOC code data not being available at this level), we have calculated levels of 'relative wages' (gross hourly earnings in a LA divided by the population weighted average for GB). The results of this work for the year 2022/23 are shown in the map below:

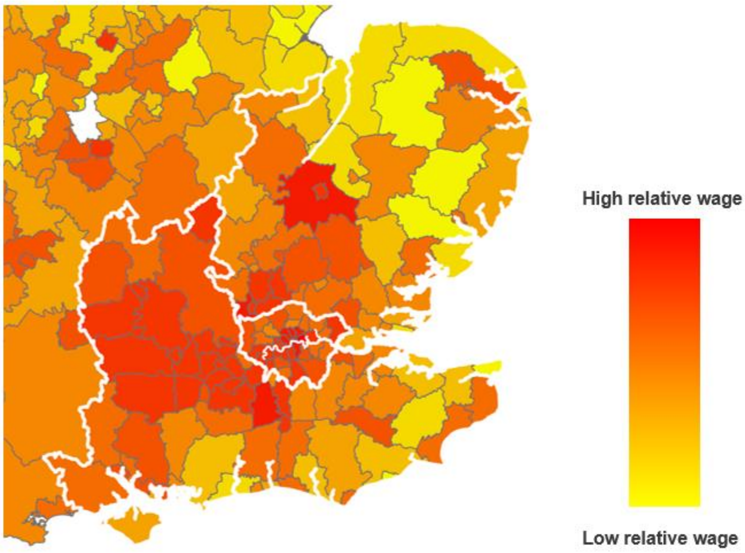

Figure 12: General wage dispersion in and around London (2022/23) (source: Cadent analysis)

As the map shows, wage dispersion across both the South-East ITL region and areas to the North and East of London (in the East ITL) are similar. Wages in the latter (across LAs in Hertfordshire, Bedfordshire and Essex), range from 14% below the GB average to 27% above it[40]. Similarly, in the South-East ITL region wages across LAs range from 19% below the GB average to 28% above it. Furthermore, we find that there is no specific geographical cutoff to the North and East of London where wages drop, just as there is no specific geographical cutoff in wages to the South or West of London. LAs bordering and in the direct vicinity of London to the North and East and in the East ITL region have a population weighted average wage level that is 8% above the GB

[40] The GB average wage in this analysis is calculated as the population-weighted average of LA wage levels

average wage in 2022/23. This compares to the 11% calculated for those LAs bordering London that fall in the South-East ITL region.

As a result, for regional wage differences to reflect the "cost of living factors in London, and to a lesser extent in the South-East, (which) lead to persistent wage inequality[41]", it is important that regional wage adjustments apply to all areas in and immediately surrounding London, not just those to the South and West which happen to be captured in the South East ITL region. Indeed, to persist with the current approach, which excludes adjustments for areas to the North and East of London, would be both arbitrary and unfounded in statistical evidence, and would also materially penalise Cadent's Eastern and London networks in comparative efficiency assessment.

Additional labour cost pressures as a result of higher Employer National Insurance Contributions

In addition to wages, GDNs must also incur labour costs due to employers National Insurance Contributions. However, these contributions only need to be made by GDNs for earnings by employees over a certain threshold, currently £9,100 per annum. As a result, where wages of employees in certain geographies are materially higher due to exogenous labour market forces, GDNs must not only pay these higher wage rates, but they also must pay proportionally more National Insurance Contributions. Owing to timescales for finalising our plan, our assessment of additional costs due to National Insurance Contributions does not account for changes made on October 30th by the UK Government budget, and neither does our Totex plan.

As an example, assume that, for a certain job, the efficient level of pay is £30,000 per annum Elsewhere, and 20% higher in the London region. The level of Employers National Insurance Contributions is 13.8%, payable by employers on pay in excess of £9,100 p.a. The table below shows that Employers National Insurance Contributions arising in London are proportionately higher, increasing the effective wage cost premium from 20.0% to 20.8% due to a larger amount of earnings above the threshold before Employers start to pay National Insurance Contributions. Whilst the percentage difference in the labour cost premium may seem small, given the size of labour costs this would be applied to, this represents a significant level of additional cost in the London region which is not currently reflected in Ofgem's regional labour adjustment.

	Elsewhere	London	London excess	
	£	£	£	%
Gross pay	30,000	36,000	6,000	20.00%
Employers NI threshold	-9,100	-9,100	0.00	0.00%
Subject to Employers National Insurance Contributions	20,900	26,900	6,000	28.71%
Employers National Insurance Contributions @ 13.8%	2,884	3,712	828	28.71%
Cost to employer				
Gross pay	30,000	36,000	6,000	20.00%
Employers National Insurance Contributions	2,884	3,712	828	28.71%
	32,884	39,712	6,828	20.76%

Note: Employers National Insurance Contributions - 13.8% of earnings above threshold of £9,100 p.a.

Table 20: Example of the impact of Employers National Insurance Contributions on Labour Costs (source: Cadent analysis)

Proposed Approach to Quantification

To capture the additional mechanisms driving higher labour costs in and around London, we have built on Ofgem's approach in two ways highlighted below. We have discussed proposals collaboratively with Ofgem in the lead up to our RIIO-3 plan submission and shared underlying working spreadsheets to fully articulate our calculations. However, owing to the page limit on this appendix, we have insufficient space to set out all of the mathematical detail. If helpful, final versions of our underlying spreadsheets can be provided to Ofgem on request.

Amending the geographies captured within Ofgem's previously used regional labour factor adjustment

We propose to amend the geographical boundary of the areas receiving an adjustment to costs. Specifically, we propose that the areas of Hertfordshire, Essex and Bedfordshire (which currently sit in the East ITL region and

[41] Ofgem (2022), "RIIO-ED2 Draft Determinations – Core Methodology Document" P. 232, Paras. 7.39

account for c.60% of the region's population) are included within the area that receives a regional labour cost adjustment. Doing so would then mean that in totality, the areas receiving an adjustment would reflect the previously used Standard Statistical Region (SSR) known as 'South-East'. This is shown in figure 13 below (the South East SSR aligning to the sum of the green, orange and yellow areas)

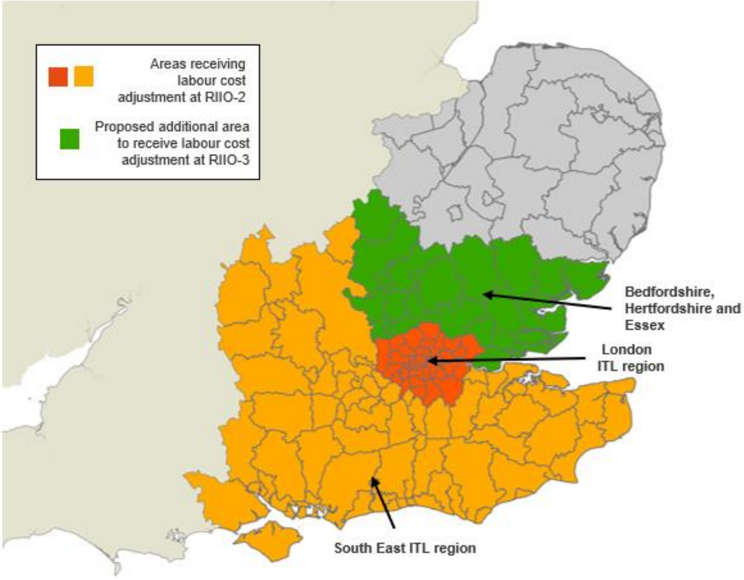

Figure 13: Proposed areas to receive a regional labour adjustment for RIIO-GD3 (source: Cadent analysis)

The SSRs were regional geographical areas used by the UK Government from the 1960s to the mid-1990s, that reflected regional and economic planning areas. They were replaced in the mid-1990s by what became ITLs to allow for: (i) the re-organisation of local government in England, Wales and Scotland; (ii) better alignment between areas used for administrative and statistical purposes; and (iii) to produce regional areas with more similar populations[42]. None of the reasons for replacing SSRs with ITLs for standard statistical reporting affect the validity of the underling wage data. In fact, the South East SSR better captures the area immediately around London that is affected by this unique labour market (as shown above in the map which presents levels of wage dispersion at the Local Authority level – with higher relative wages seen radiating concentrically from the London region). Hence, utilising the SSR South East region provides a more robust approach to calculating regional wage adjustments than ITLs.

To implement this proposed improvement, we have used the same occupation-specific dataset used in previous price controls, combined with an additional LA level ASHE dataset to 'move' the regional boundary of the areas receiving a regional labour adjustment, so they include the areas indicated above. This is achieved by using the LA version of the dataset to estimate the population weighted average wage for the East ITL as a whole, and for the two sub-regions of Hertfordshire, Essex and Bedfordshire, and the remainder of the East ITL region. Dividing the average wage of the two sub-regions by the East ITL figures generates the percentage by which the average level of wages is above/below the East ITL average. These percentages can then be applied to the less granular, but occupation-specific dataset used by Ofgem for East ITL region in combination with population splits across the two sub-regions of East ITL to calculate an implied relative wage to the national average for the Hertfordshire, Essex and Bedfordshire area, which can then receive an adjustment.

As a result of these changes, the pay adjustments for all GDNs which receive a labour adjustment increase relative to our updated view of Ofgem's RIIO-2 approach (i.e. when purely only updating with new ONS data). Specifically such that on average between 2013/14 – 2022/23 wages are 2.39% for Eastern, 18.59% for London and 9.91% for Southern above wages Elsewhere. There are two reasons all three GDNs receiving an increased adjustment . Firstly, Eastern and London networks contain areas to the North and East of London, that now receive an adjustment but which did not previously. Secondly, for Eastern, London and Southern, the size of their adjustments also increases, as the 'Elsewhere' region that wages are being compared to, now has a lower wage level than under Ofgem's approach (as higher wages present in the area to the North and East of London are now not within Elsewhere).

[42] Twigger, R. and Morgan, B. (1997) "*The New Statistical Regions: research paper 97/67*", House of Commons Library, 22 May 1997, see here: New Statistical Regions (parliament.uk) Accessed: 28.12.23

Capturing the impact of regional labour cost differences on Employers National Insurance Contributions

Two further adjustments to Ofgem's approach are needed to capture the impact of wage differentials increasing the level of employers' National Insurance Contributions:

- Converting GDN hourly earnings into annual earnings, using the same ONS figure for each GDN on the number of hours worked per annum at the national average level, so that the labour cost adjustment only reflects variations in the cost of labour per hour, not in hours worked per annum; and
- Calculating and adding-in the additional employers' National Insurance Contributions (as these are levied on annual pay) and recalculating the percentage difference in labour costs between the areas receiving a regional labour adjustment and Elsewhere. To achieve this requires application of minimum earnings thresholds for National Insurance Contributions and applicable rates over time (as illustrated in the example above[43]).

When applying this change on top of our other proposal, this increases the regional labour cost adjustments for all three GDNs further on average between 2013/14 – 2022/23 to 2.48% for Eastern, 19.27% for London and 10.27% for Southern above wages Elsewhere. These are the final differential labour adjustments we believe should be applied to the costs of these GDNs before comparative assessment as our Labour Costs Factor.

Applying the factor to our costs

To quantify the impact that our Labour Costs Factor has on our costs we have followed an analogous approach to how Ofgem applied its regional labour cost adjustment at RIIO-GD2. Specifically:

1. Having calculated new Labour Cost adjustment factors above on an annual basis up to and including 2023, we use the latest five-year average of each of these for adjustments to be made to subsequent years. This is consistent with Ofgem's RIIO-GD2 approach, and results in adjustment factors of 18.20% for London and 2.21% for Eastern.
2. As per Ofgem's RIIO-GD2 approach, we calculate GDN specific and GDN average labour ratios based on long-term averages of our own costs combined with those of other GDNs used at the RIIO-GD2 control, updated where possible with new data. These are used to convert gross Totex figures (pre-exclusions and application of other regional/company-specific factors) per activity into gross normalised labour costs per activity.
3. We then multiply gross normalised labour costs per activity by the Regional Labour Cost adjustment factors and Ofgem's RIIO-GD2 assumptions for the percentage of labour that is used locally to deliver works. However, we now do not apply the adjustment to 'Other Non-Network Capex - IT & Telecoms' as this is now separated out of other Capex, when at previous periods it was not.

Applying these steps results in a factor claim of £6.11m per annum in RIIO-GD3 for our Eastern network and £41.58m for London (which equates to 1.11% of Totex for Eastern and 8.97% for London, clearly meeting Ofgem's materiality criterion). [cost-sensitive data]

[redacted]

Table 21: [cost-sensitive data]

An indication of the size of the factor when our proposed exclusions are applied and interactions between factors taken account is set out above in table 17 (section 4.1)

Why An Adjustment is Needed within GD3 Comparative Benchmarking Models

As explained above, there is a continued need to recognise that efficient GDN Labour costs to serve the areas in and around London are higher than serving customers in other regions, for reasons outside of GDN control. It is also clear that the factor is material and unique – only affecting the area in and around London. Furthermore, our

[43] We have already collated these thresholds and rates for the RIIO modelling period and can share these upon request

work shows that Ofgem's RIIO-GD2 approach insufficiently recognises the impact the factor has, due to the geographical boundaries used, and the exclusion of the differential cost of employers' National Insurance Contributions. Therefore, in taking account of exogenous labour cost pressures in RIIO-GD3 cost assessment Ofgem should amend its regional labour adjustment, by applying the factor across our new proposed geographical boundaries and by recognising employers NICs in its calculations.

The final of Ofgem's criteria that a factor claim needs to fulfil is that it is excluded from drivers in econometric modelling and is excluded from other adjustments. In Ofgem's RIIO-GD2 Totex regression model, the explanatory variable (a CSV composed of 7 drivers) only accounts for network scale and workload and not those wider macroeconomic and labour market factors which drive Labour Costs to be higher to serve customers in and around the London region and increase efficient labour costs for a small number of GDNs relative to others. As such, it is excluded from econometric model drivers. We are also unaware of any other adjustments made through other cost normalisations (exclusions, regional and company-specific factors) which account for the impact of regional labour cost differences driven by the external regional labour market. Furthermore, we note that (i) this factor compounds with the Nature of Streets Factor (explained in section 4.3.1 below), acting to increase the size of the adjustment and (ii) due to calculation approaches utilised, elements of our Network-Specific Factors claim overlap with this factor claim. We provide details for how these latter elements should be reduced when incorporated in modelling, in section 4.3.2 below.

4.3. Specific Conditions Faced by London Utilities

4.3.1. Nature of Streets

Overview of the Factor

Within BPDT M8.13 we are submitting a single factor claim for the Nature of Streets for our London and Eastern GDNs. This is consistent with the claim accepted by Ofgem at RIIO-ED2 proposed by UKPN[44].

For utility companies with network assets located under the street surface, a significant proportion of the cost to construct and maintain these assets relates to excavating, working underground and reinstating the street surface to its original condition. Utilities have no choice as to the nature, quality and cost of materials they use to reinstate the street surface, and no control over the working conditions they face when carrying out work:

- Utilities must remove and restore the same standard of pre-existing street surface material installed prior to its excavation works. As such, the cost and complexity of planning, excavation and reinstatement activities depends on the street structure.
- Utilities also cannot control the density of the built environment they must work within to undertake underground works. Utility companies that operate in high density areas are more space constrained, so are more likely to locate network assets under carriageways rather than pavements and grass verges. There is also likely to be higher congestion of assets from different utilities (e.g., gas, electricity, water, telecoms) in the same location within the street. A high density built environment is therefore likely to increase the cost and complexity of underground work.

Evidence presented in the UBLE report shows that utilities' efficient costs of working underground are materially higher in the London region than elsewhere as a result of the precise of make-up of streets. We use this evidence to generate our factor claim for the 'Nature of Streets'.

The table below sets out the value of our factor claim for Nature of Streets.

Network	RIIO-GD3 Total (£m, 23/24 prices)
Eastern	13.02
North London	180.34

Table 22: Nature of Streets factor by network, pre-exclusions and interactions, RIIO-GD3 total (source: Cadent analysis)

Our claim is further detailed below.

[44] UKPN (2021) "Placing customers and communities at the heart of net zero", RIIO-ED2 Business Plan 2023-2028", P. 184-185, see here: UKPN RIIO-ED2, Accessed 07.12.24, Ofgem (2022) "RIIO-ED2 Draft Determinations – Core methodology Document", Para 7.51-7.59

Drivers of Additional Costs Faced by Cadent

The UBLE report identified several aspects associated with the make-up of streets in London and its surrounding areas which drive additional costs for utilities only operating in London. As such, they are unique to GDNs that serve customers within the London region. The report also established these are outside of GDN control. Below we present analysis from the UBLE report, including updated and supplementary evidence where possible.

Location of Assets

Locating utility assets under the footway or grass verges makes them easier to access and subjects them to less vibration from passing traffic. This reduces the costs to operate, maintain and replace these assets. The high density of the built environment in London often means utility companies must locate their assets under the carriageway, rather than under footways or grass verges. The presence of coal cellars and other basement structures under many London streets, also leads to a greater percentage of assets under the carriageway. This increases excavation, traffic management, and other costs, relative to other areas of the country.

The UBLE report shows London has a significantly higher proportion of gas assets which require work located in the carriageway than in the footway/under grass verges. For example, the UBLE Report shows that for Cadent's London GDN, 39% of repair works and 48% of Repex works were completed in the carriageway. This is 8 and 11 percentage points higher respectively than the average volume of repair and Repex works completed in the carriageway across all Cadent's networks. SGN data within the report also reports a similar differential[45]. [commercial-sensitive data]

Type of carriageway surface

The UBLE report also established that carriageway surfaces within London have a higher proportion of red tarmac (for bus lanes), green tarmac (for cycle lanes) and anti-skid coating. NERA and Arcadis used data on anti-skid coating from SGN to show that the percentage of work orders that contained anti-skid coating in London is double that of work orders for similar work outside of London.

	Southern GDN outside of M25	Southern GDN inside M25
Frequency of application of Anti-skid coating	215	260
% of all work orders	0.7%	1.5%

Table 23: Frequency of Application of Anti-skid Coating for SGN Reinstatements (source: UBLE, table A.15)

Further, data collected from UKPN showed the greater prevalence of red tarmac in its London network compared to the two non-London networks that it operates.

	EPN	LPN	SPN
Average (2015-2018)	171	283	160

Table 24: Number of Red Tarmac Reinstatements by UKPN Networks (source: UBLE, table A.12)

The cost of breaking up and reinstating these special types of surfaces is higher than typical materials. In addition, the UKPN report shows that, based on UKPN data, the unit cost of reinstating red tarmac within London is 22% higher than across UKPNs' other networks[46].

Type of Road Structure: A higher proportion of concrete used beneath surfaces

As a result of the heavy usage of footways and carriageways within London, a greater proportion of areas have a layer of concrete set below the street top surface to provide additional structural strength and to protect underground assets, such as those operated by utilities. This was shown in the UBLE report based on data obtained from SGN. As the table below shows, across both footways and carriageways, the proportion of jobs where a concrete overlay was needed was between 3-4.7x greater within London (denoted as within the M25 in the report) as compared SGN's Southern network outside it.

[45] NERA and Arcadis (2019) "Understanding the Baseline Level of Efficiency in London", P. 86-87
[46] NERA and Arcadis (2019) "Understanding the Baseline Level of Efficiency in London", P. 88

	Outside London (M25)	Inside London (M25)
Footway	1.5%	7% (4.7x higher)
Roads	4%	12% (3x higher)

Table 25: Percentage of Overlay on Concrete in SGN Reinstatement Jobs (source: UBLE table A.43 and table A.42)

This layer of concrete causes utilities to incur additional efficient costs, both for additional excavation (for example, through use of additional resources and/or larger and more powerful excavation equipment) as well as materials and labour costs associated with reinstatement of the concrete layer, when works are completed.

Underground utility congestion

In addition to a higher percentage of network assets located within the carriageway, the UBLE report also notes that the greater density of both the buildings in London, as well as the volume of utility infrastructure necessary to service them, could lead to greater underground utility congestion. Congestion of utility assets is particularly unique to London. For example, we understand that other utilities (e.g., electricity DNOs) that operate outside of London will often locate network assets above ground (e.g., overhead electricity wiring). However, high urban density in the London network means that UKPN is one of the few DNOs that must locate a large proportion of its network assets underground. Figure 14 shows examples of high utility congestion in our London GDN.

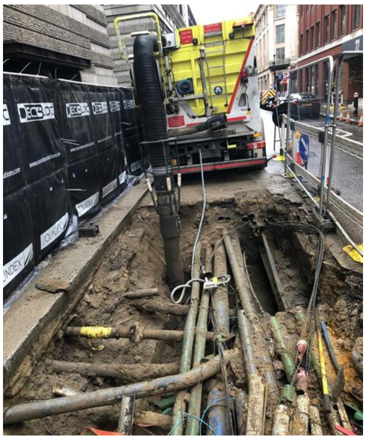

Figure 14: Congestion of Utility Assets in London (source: Cadent)

High congestion of underground utility infrastructure can on the one hand can lead to the need to excavate larger areas within streets so that different utility infrastructure can be navigated to work on buried gas assets, and on the other hand it also prevents teams in London from using some excavation techniques to access underground assets. Both of these effects reduce the productivity of utility companies operating in London for reasons outside of their control.

Large diameter mains

As well as those impacts listed in the UBLE report, we have also analysed the diameters of non-polyethylene (PE) mains across networks. What this shows is that London has a far higher proportion of very large, non-PE mains compared to other GDNs. This is likely the result of historical needs for pipe size to serve the underlying size and density of the customer base. [commercial-sensitive data] Whilst higher workload is captured within Ofgem's RIIO-GD2 regression model (via repair and Repex cost drivers), the fact that larger diameter mains require larger excavation areas causes additional excavation and reinstatement costs as compared to other regions of the country. This is not captured by the External Conditions Reports driver for the repair activity, which treats each repair type equally no matter the diameter being worked on.

Proposed Approach to Quantification

Quantifying the Nature of Streets factor

To capture the impacts of the Nature of Streets on the efficient level of GDN costs within London we propose an adjustment to costs before they are comparatively assessed that is aligned with the approach Ofgem applied at RIIO-ED2. This approach reduces costs for all activities which involve underground working within London, as set out within the UBLE report. For GDNs which operate in London this amounts to reducing all costs for repair Opex, reinforcement Capex, connections Capex and Repex.

The value of our Nature of Streets factor claim is underpinned by analysis within the UBLE report which utilises Cadent and SGN Repex productivity data to compare the productivity of this work in London to equivalent work undertaken elsewhere in the country. The Repex programme is the largest programme across all utility sectors that requires work under the street surface. As such, the productivity data is based on the largest sample of projects that could be assembled in the study. The UBLE report finds that, for every 100m of work undertaken elsewhere in GB, only 84.5m of work can be undertaken in London in the same amount of time (i.e. productivity for completing underground work in the London region is 15.5% below that of elsewhere). This is then supplemented with additional analysis of contractor rates and unit costs across GDNs' Repex and repair activities, and water and electricity reinstatement works to cross-check the outcomes. Based on this, the UBLE report concludes that, "the most likely estimate of the London effect for excavation and reinstatement work is 15.5%[47]". Therefore, we propose scaling down costs for GDNs which operate within the London region to reflect a 15.5% reduction in the productivity for work undertaken within London, before comparative benchmarking.

Application of the Nature of Streets Factor would supersede Ofgem's previous urbanity productivity and reinstatement factors (including the extension of the productivity adjustment to Repex plant hire, based on Cadent's factor claim at RIIO-GD2) as the impacts they capture overlap with the Nature of Streets factor. Taking our proposed approach to account for factors ultimately driven by the Nature of Streets, is advantageous as it is both simpler and more robust than existing adjustments:

- The previous urbanity reinstatement adjustment assumed that all reinstatement expenditure is labour (and adjusted costs in an equivalent way to the regional labour cost factor, as explained above), which is simply not the case in reality. It omits the cost pressures faced by London utilities in some non-labour cost categories and may overstate cost pressures from working in London in others. Using an aggregated percentage reduction which covers all cost types, as we are proposing, is therefore more robust.
- The previous urbanity productivity adjustment is based on evidence SGN submitted for RIIO-GD1 (meaning it is over a decade old) which compared productivity differences of operating in a set of areas within and outside London from a single contractor. This suggested labour costs for investment works involving underground working are at least 15% less productive within London. Our proposed Nature of Streets Factor is based on a similar approach, but incorporates a wider and more up-to-date dataset, taking into account datapoints across different cost areas and multiple GDNs plus other utilities. Therefore, it represents a more robust adjustment to account for underpinning drivers of additional efficient costs than evidence already accepted at RIIO-GD1 and is valid to be applied across all costs associated with underground working.

Applying the factor to our costs

As set out above, the Nature of Streets factor establishes that the productivity of work in London is 15.5% lower than elsewhere. However, this does not mean that costs incurred in London are 15.5% higher than elsewhere (i.e. it does not mean that $Cost_{London} = 1.155\ x\ Cost_{Elsewhere}$). To derive the figure needed, we must convert what is a productivity difference into a cost difference to apply this adjustment to costs. Assuming all else is fixed, **what the Nature of Streets Factor establishes is that to complete an equivalent amount of work in London will take 18.3% additional time compared to Elsewhere, and hence 18.3% of additional cost** as shown below:

$$\text{Nature Streets Establishes that: } Productvity_{London} = 0.845\ x\ Productvity_{Elsewhere}$$

$$\therefore Cost_{London} = \frac{1}{0.845}\ x\ Cost_{Elsewhere} = 1.183\ x\ Cost_{Elsewhere}$$

$$or\ equivalently\text{:}\ \frac{Cost_{London}}{1.183} = Cost_{London}\ x\ 0.845\ = Cost_{Elsewhere}$$

Equation 2: Required cost adjustment for the Nature of Streets

47 NERA and Arcadis (2019) "Understanding the Baseline Level of Efficiency in London", P. 48, 108-110

Applying the factor in this way to costs is consistent with the approach taken by UKPN in its factor claim that Ofgem accepted for RIIO-ED2.[48]

The additional cost impact for operating in the London region is then only applied to the workload undertaken within London for our GDNs. Consistent with Ofgem's approach to the regional labour cost factor (above), we use the proportion of the population that is within the London ITL region, out of the total within the areas that each of our London and Eastern GDNs serve (as a proxy for workload undertaken within the London region), and apply this to the 18.3% adjustment to generate the required adjustment for each GDN. Therefore, the factors we need to apply to our GDNs' costs are 14% for London and 0.93% for Eastern[49].

To apply these, we take actual and business plan forecast repair Opex, reinforcement Capex, connections Capex and Repex gross unnormalised costs (before cost exclusions or application of other regional/company-specific factors i.e. gross unnormalised costs) and divide them by one plus each of the factors respectively (and consistent with the equations above) to estimate the equivalent costs of undertaking these activities outside of London. We then subtract this from actual/forecast costs to generate a **factor claim of £36.07m per annum in RIIO-GD3 for the London GDN, which equates to 7.79% of London GDN Totex and £2.60m per annum for the Eastern GDN, which equates to 0.47% of Totex.** [cost-sensitive data]

[redacted]

Table 26: [cost-sensitive data]

This factor clearly meets the materiality threshold set by Ofgem for London GDN. However, for our Eastern GDN, the size of the factor is very marginally below Ofgem's materiality threshold at 0.47% compared to 0.5%. Nonetheless, we still put this forward as a claim and believe it should be accepted as:

1. The Nature of Streets factor relates to the locality of London, not just our London network. Therefore, if the factor is accepted as applying to the region of London, all networks that serve customers within the London region should receive the adjustment regardless of how much of their network is actually within the region. If the claim is accepted for the London GDN, Ofgem should apply it to all three networks that serve the London region. To only apply it to a subset would create distortions within benchmarking.
2. This factor would supersede Ofgem's existing urbanity factors. During RIIO-GD2, Ofgem applied these urbanity factors to the Eastern GDN despite the adjustment values being below its materiality threshold. Therefore, this precedent should also hold when applying the Nature of Streets Factor consistently across networks.
3. [cost-sensitive data]
4. Whilst we understand the rationale for the materiality threshold, its value is ultimately arbitrary, so it is important not to rule our factors which may have a substantial impact on Ofgem's cost assessment, but marginally miss this criterion[50].

An indication of the size of the factor when our proposed exclusions are applied and interactions between factors taken account was set out above in table 17 (section 4.1)

Cross-checks of our quantification

[cost-sensitive data]

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[48] UKPN (2021) "Placing customers and communities at the heart of net zero", RIIO-ED2 Business Plan 2023-2028", P. 184-185, see here: UKPN RIIO-ED2, Accessed 07.12.24, Ofgem (2022) "RIIO-ED2 Draft Determinations – Core methodology Document", Para 7.51-7.59

[49] We note that for consistency this adjustment will also need to be applied to SGN's Southern network within modelling

[50] We note taking a pragmatic approach and considering factors just below the materiality threshold is consistent with Ofgem's exclusions at GD2 for major projects which met other criteria for exclusion, but were below the £5m threshold (such as Cadent's Lowestoft project).

Why An Adjustment is Needed within GD3 Comparative Benchmarking Models

The above establishes that the Nature of Streets factor is outside of GDNs' control, unique (impacting only GDNs which serve the region of London) and material relative to Ofgem's arbitrary threshold. Ofgem's final criterion is that the relevant cost adjustment is not captured in its benchmarking model, or through a separate factor adjustment. In Ofgem's RIIO-GD2 regression model, the explanatory variable (a CSV composed of 7 drivers) does not take account of the effect of the Nature of Streets on GDNs' costs; it simply controls for:

- Volumes of work undertaken (external condition reports);
- Synthetic workload drivers – using volumes of distinct work types multiplied by common, industry-wide unit costs, (connections synthetic costs, reinforcement synthetic costs and Repex synthetic costs); and
- Measures of network size (Customer numbers, Maintenance MEAV and MEAV).

As a result, the modelled relationship between expenditure and Ofgem's Totex CSV does not control for differences in GDNs' operating environments due to the Nature of Streets. We have also not identified any drivers in GDNs' RRPs or BPDTs which could be utilised to, or other adjustments made in the cost assessment framework that, directly account for differences in the Nature of Streets between GDNs. Therefore, our evidence justifies why an adjustment is needed. This is consistent with Ofgem's past price control decisions, which have a long history of controlling for these within the cost assessment framework (including exactly this same factor put forward and accepted at RIIO-ED2). Furthermore, we also note that:

- this factor interacts with the Labour Costs factor with each compounding (i.e. increasing) the other's effect on costs. This was accepted by Ofgem at the RIIO-GD2 price control as its calculation approaches take into account that the urbanity productivity adjustment (which we propose superseding with the Nature of Streets Factor) this results in increased labour requirements. As such, the Labour Cost factor needs to be applied to both a normalised level of labour across GDNs, and the additional labour required; and
- due to calculation approaches used, elements of our Network-Specific Factors claim overlap with this factor claim – we provide details for how these elements should be adjusted in incorporating in modelling in section 4.3.2 below.

4.3.2. Network-Specific Factors

Overview of the Factor

Within the BPDT M8.13 we are submitting a single factor claim for Network-Specific Factors for our London GDN. This has been compiled using a consistent approach to the claim (also called 'Network-Specific Factors') accepted by Ofgem at RIIO-ED2 proposed by UKPN[51].

The high population and property density within the London region results in higher efficient costs incurred by our London GDN. Population and property density have a pervasive impact across our cost base so to calculate our factor claim and assess the totality of its impact, we have analysed several component parts:

- Operational Property Costs: High population density within London has led to significant demand for land and property space, that in turn drives higher purchase prices and rental rates which increase the costs of leasing property that must be located within London. Whilst this can be mitigated for centralised functions, by moving activity outside of London, this is not possible where property is required for operational purposes, increasing costs outside of our control.
- Emergency Costs: A core part of a GDN's work is responding to reported gas leaks ('emergencies'). As a result of operating in the capital, responding to emergencies in London is more costly than elsewhere in the country due to population and property density for three reasons:
    - Longer Emergency Job Times: Emergency job times, specifically the working time to complete an emergency job when on-site, are longer than elsewhere in the country, as the number of properties within the radius of the area to be checked in the event of an escape is higher in London than elsewhere, increasing resource cost per incident.
    - Necessary alternative shift patterns: High residential property costs mean a greater proportion of our workforce lives outside of London and as a result, further away from the location of emergencies. This prevents us from operating cheaper 'call out and standby' arrangements that are used by other networks to fulfil emergency licence obligations.
    - Greater use of locksmiths: In the event that no one is present at a property when an escape is reported, we rely on locksmiths to gain entry to ensure emergencies can be made safe. Within London we need to utilise locksmiths more frequently due to: (i) higher property density (leading to more properties needing to be inspected), and (ii) higher property vacancy rates.
- Third-party driven maintenance costs: Greater population, and levels of building activity within London lead to higher levels of third-party (chargeable) work to re-locate our assets to accommodate property alterations and land development. This creates additional costs at the benchmarked gross cost level, relative to other GDNs.
- Costs to maintain a greater amount of underground assets: Greater property density/land scarcity within London has historically led to the location of a greater proportion of utility assets underground. The need to locate assets underground is out of the control of utilities (as is the case for assets located in LA Tunnels) or was viewed at the time of commissioning as the most cost-effective solution[52]. This drives additional cost relative to other GDNs for:
    - Underground Governors: District governors can either be housed above or underground. The London GDN has a disproportionately high proportion of underground governors, compared to other GDNs – which are more expensive to maintain.
    - Underground LA Tunnels: To minimise disruption, the government delegated power to LAs in London to develop a shared tunnel network (LA Tunnels) to house network utilities' infrastructure[53]. Utilities have to house their assets in these tunnels and incur incremental, and unavoidable costs, from doing so.
- Costs to comply with transport schemes: High population and property density have led to high traffic concentration and as a result, congestion and environmental emissions. Transport for London (TfL) operates three primary transport payment schemes to mitigate the impact of congestion and environmental emissions: the Ultra Low Emission Zone (ULEZ), the Low Emission Zone (LEZ) and the Congestion Charging zone[54]. Cadent must pay charges associated with these schemes to conduct operations in London, which are either not present or of a much smaller value in other areas.

[51] UKPN (2021) "Placing customers and communities at the heart of net zero", RIIO-ED2 Business Plan 2023-2028", P. 184-185, see here: UKPN RIIO-ED2, Accessed 07.12.24, Ofgem (2022) "RIIO-ED2 Draft Determinations – Core methodology Document", Para 7.51-7.59

[52] The work required to re-locate these assets is prohibitively complex or disruptive.

[53] See (i) London City Council (Subways) Act, 1983; and (ii) City of London (Various Powers) Act (1900)

[54] Transport for London, ULEZ: Where and When, URL: ULEZ: Where and when, LEZ: Where and When, URL: LEZ: Where and when, Congestion Charge, URL: Congestion Charge (Official), Accessed: 15 August 2024

[cost-sensitive data]

[redacted]

Table 27: [cost-sensitive data]

Our claim is further detailed below.

Drivers of Additional Costs Faced by Cadent

We describe the drivers of additional cost faced by our London GDN for each component of the Network-Specific Factors claim. These together holistically reflect the impact of high population and property density on London.

Operational Property Costs

Higher levels of operational property costs within London manifest themselves in a number of ways, but predominantly through higher purchase and rental costs caused by high population density and investment in the capital spurring demand where land and property are scarce. Data from the Valuation Office Agency (VOA) on average rental rates by region is presented below for relevant property types (and ‘all businesses’ for comparison), showing these persistent differences over time.

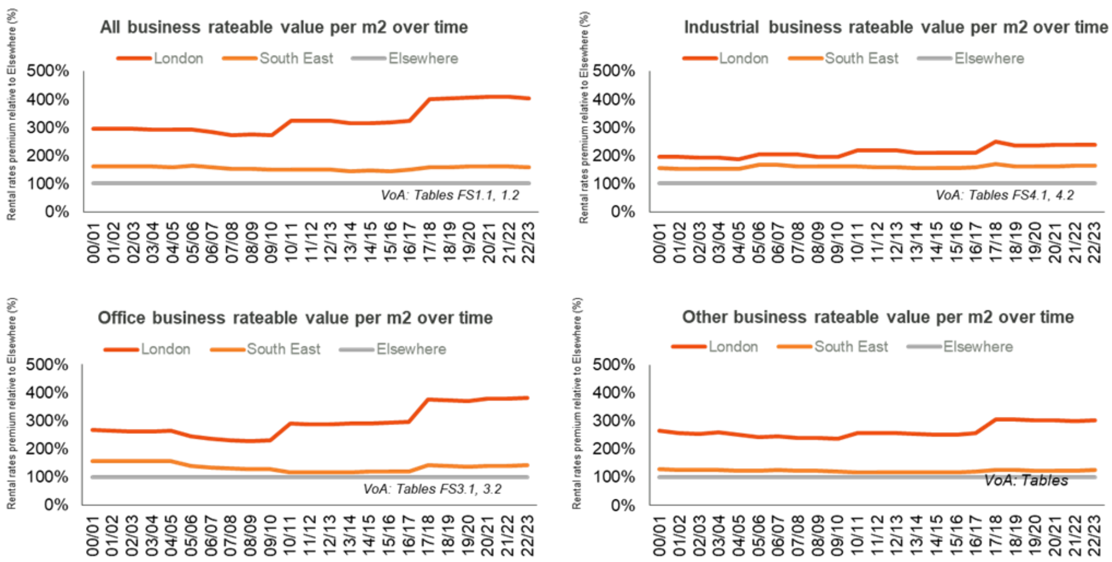

Figure 15: Rental rates premia: 2000-2023) (source: Cadent analysis of Valuation Office Agency data)

We quantify additional rental costs in London using VOA data for the most recent five years, as well as population data from the ONS (also used to derive the Labour Cost and Nature of Streets factors). From this analysis, we estimate that there is an incremental level of rental cost for the London GDN of between 131%-223%. The incremental level of rental cost depends on the type of property assumed to be needed by GDNs.

[cost-sensitive data]

In addition to higher rental costs, some of the difference may also arise because our London GDN faces higher property costs associated with facilities and waste management services. Our properties require these services for maintenance, cleaning, security and reception. Whilst not classified as labour in our BPDT cost reporting, the cost of these services is driven by higher labour costs for working in London. However, as these costs are not categorised as labour cost, they do not receive a Labour Costs adjustment (as discussed above).

Emergency Job Times

A comparison of internal and external job times between the London GDN and Cadent's three other GDNs across 2020-2023 (unweighted average) shows that the London GDN experiences job times approximately [cost-sensitive data] higher for internal escapes and around [cost-sensitive data] higher for external escapes than non-London GDNs.

[redacted]

Figure 16: [cost-sensitive data]

These longer job times result in increased working time when at an emergency job, due to the need to check a larger number of densely located properties. Aligned with safety protocols we have agreed with the HSE that all properties within 15 metres – vertical and horizontal - of an escape must be checked for the presence of gas by taking readings on the building line. We must also take readings at points where air can escape from the property, such as air bricks, window vents, and letter boxes.

Data on the composition of the housing stock across regions of GB shows that London has a significantly higher proportion of properties that have been divided into smaller living units (i.e. flats, purpose built or not purpose built) than any other region. In London, 71% of the housing stock is composed of flats, while the next highest region, the South East, contains only 37% flats in its housing stock. This is indicative of greater property density in London compared to the rest of GB. As a result, First Call Operatives (FCOs) must check more properties, and hence spend longer responding to an emergency call outside of their control.

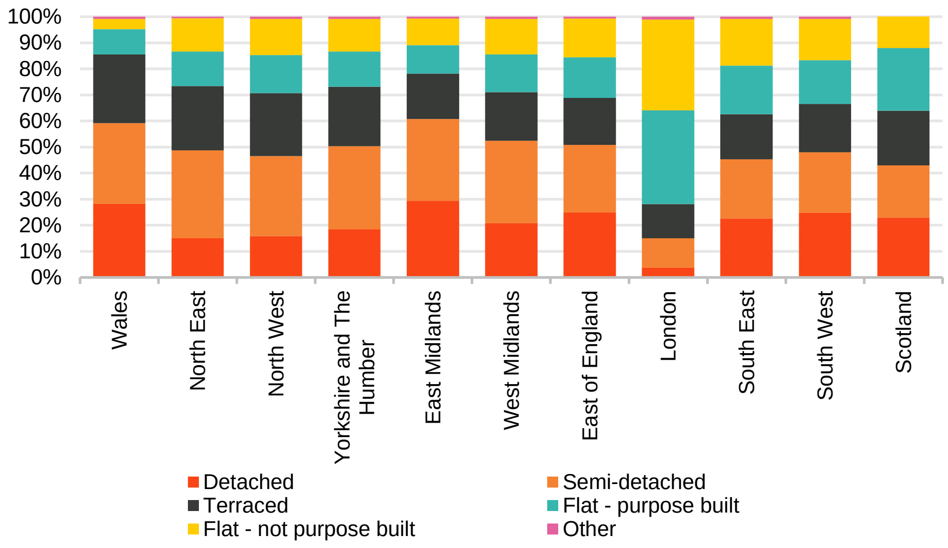

Figure 17: Housing Type by Region in Great Britian (source: Cadent analysis of ONS and Scottish Government data)[55]

Additional regression analysis undertaken confirms this by estimating the relationship between population density (as proxy for property density) and emergency job times across the 55 Cadent operational 'patches'

55 For England and Wales: Office of National Statistics (30 March 2023), Number of dwellings by housing characteristics in England and Wales – Table 2a, For Scotland: Scottish Government (30 May 2023), Scottish House Condition Survey: 2021 Key Findings: Chapter 01 Key Attributes of the Scottish Housing Stock – Table KA1a.

across all our networks as presented in the chart below. Patches are our smallest level of operational geography within each network. [cost-sensitive data]

[redacted]

Figure 18: [cost-sensitive data]

Emergency Shift Patterns

To fulfil our emergency call out obligations we must operate specific shift patterns for out of hours operations. In most networks throughout GB a ‘call out and standby’ approach can be used. Under this approach a set number of staff are available to attend emergencies out of hours but are able to remain at home and then travel out to attend an emergency within the required timeframes in accordance with our Emergency Standards of Service (ESOS). Those standards require us to attend and inspect 97% of escapes within two hours of the customer reporting a controlled escape, or one hour if uncontrolled.

In our London network, we are unable to operate such a regime, as our London operatives live further away from the patch in which they attend emergencies due to high residential property prices. Further, as they must attend incidents using a van, there is no way they can reduce their commute time using faster modes of travel (e.g., trains, London Underground, etc). As a result, it is not possible for them to stay at home on standby, as they would not be able to meet the required response times.

This pattern is clearly shown in publicly available data from the DfT[56]. DfT publishes average car commute times by region, using data from the ONS Labour Force Survey, which shows for 2022 that car commute times are on average 13 minutes (54%) longer than the unweighted average of elsewhere across GB. [commercial-sensitive data]

[56] Department for Transport (2024) “Average time taken to travel to work by region of workplace and usual method of travel in Great Britain”, Department for Transport data table code: TSGB0111, see here: Modal comparisons (TSGB01) - GOV.UK, Accessed: 02/12/2024

[redacted]

Figure 19: [cost-sensitive data]

This data shows that there is a general pattern of workers living outside of London, who actually work within the capital. It is also clearly not specific to Cadent or gas networks, emphasising that our need to operate shift patterns out of hours in London is outside of our control.

In addition to longer commute times, a higher proportion of our London GDN's escapes are received overnight given the nature of the capital as a '24-hour city' – requiring additional resource at this time compared to other networks. [commercial-sensitive data]

As a result of these external drivers, we necessarily have to run a '24-hour shift' pattern whereby we have staff working throughout all hours of the day and night within London to attend emergency incidents in required timescales. At RIIO-ED2, UKPN also claimed it incurred higher costs to operate an overnight shift system due to a low number of its employees living in London. **In its determinations for RIIO-ED2, Ofgem accepted that there was a need to operate an alternative shift pattern in London, leading to higher costs for UKPN compared to other DNOs beyond its separate regional labour adjustment**[57].

Locksmith costs

In fulfilling our emergency call out obligations, we have two options to gain access when we encounter a vacant property: (i) Contact a locksmith service provider to gain access, which we do if the property does not meet immediate access criteria; or (ii) use emergency services (Police or Fire Brigade) to break down the door, which we do if the property does meet immediate access criteria (e.g., an uncontrolled escape). In either situation, we incur costs to gain access to the vacant property (in the latter case, to repair damage we cause in breaking down the door). Failure to gain access to the vacant property would violate our ESOS. Once we encounter a vacant property during an escape inspection, incurring costs to access the property is, therefore, inevitable and outside of our control.

These costs are not unique to our London network. However, there are two primary drivers that lead to our London network incurring higher locksmith costs than other networks.

- Firstly, higher housing density in London results in a larger number of properties needing to be investigated in the case of escapes (as shown and referenced above regarding longer emergency job times). This increases the likelihood of needing to gain entry to multiple properties.
- Secondly, based on data from 2021, London has a higher proportion of unoccupied properties (a vacancy rate of 9.19%) than elsewhere in GB (the non-London regional average, being 6.29%). Therefore, FCOs attending emergencies in London, are more likely to encounter a vacant property than in any other GB region.

[57] Ofgem (2022), RIIO-ED2 Draft Determination Core Methodology, Para. 7.58

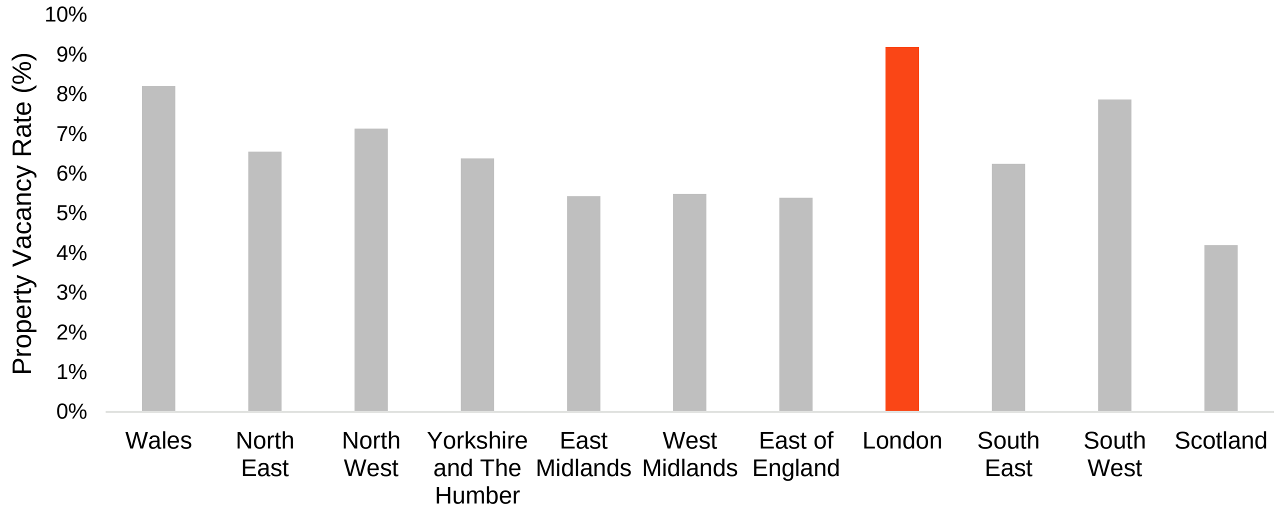

Figure 20: Dwelling Vacancy by Region in GB (2021) (source: Cadent analysis of ONS and Scottish Government data)[58]

Both of these in combination lead to the need for greater use of locksmiths for reasons outside of our control, which increase the costs we incur to discharge our emergency obligations.

Third-party driven works

GDNs have licence obligations to fulfil requests from third parties and provide services to alter our network under certain circumstances. These services include, for example, connections to allow people to access the gas network, and other services (including service alterations and disconnections). Focussing on the latter two:

- Alterations occur where a third party asks for a gas meter to be relocated because a gas supply needs to be increased or (more commonly) because of renovation or alterations to a property.
- Disconnections occur where a third party seeks to have the pipes providing their gas supply removed. This could be for a number of reasons including changing fuel type, demolition, renovation or reconstruction, no longer having a requirement for a gas supply and theft.

Of the costs incurred/charges levied on third parties for alterations and disconnections, direct costs/charges are reported within the Maintenance activity. These costs are therefore explained by Maintenance MEAV within Ofgem's RIIO-GD2 benchmarking model. Maintenance MEAV only captures the scale of assets within each GDNs network that require maintenance. However, the need for these alternations and disconnections is driven by third parties, and entirely outside of the control of GDNs. Therefore, without any adjustment, where GDNs incur volumes exogenously and disproportionately higher than their level of Maintenance MEAV compared to other GDNs, their level of gross maintenance costs will be inaccurately deemed 'inefficient' by Ofgem's model.

We would expect the number of requests for alterations and disconnections to be higher in regions where there is a greater number and density of customers (as this creates a greater potential for requests). We would also expect a higher number of requests where there is more building and development activity that require alterations to the network. Both of these apply disproportionately to our London GDN.

It is therefore unsurprising that when we compare volumes of alterations and disconnections across our four networks over 2021/22 – 2023/24 relative to Maintenance MEAV, alterations volumes are [commercial-sensitive data] higher in London than our other networks, and disconnections volumes are [commercial-sensitive data] higher. This extra, exogenously driven volume relative to the size of the asset base leads to extra costs that are not captured by Ofgem's driver. We therefore propose that Ofgem applies a pre-modelling adjustment to capture this excess cost.

Underground Governors

Higher property density within London historically has led to more district governors in the London GDN being located underground, relative to other networks. [commercial-sensitive data]

[58] For England and Wales: Office of National Statistics (30 March 2023), Number of dwellings by housing characteristics in England and Wales – Table 2a. For Scotland:, National Records of Scotland (23 June 2022), Households and Dwellings in Scotland, p.13.

A primary driver of the higher unit cost of maintaining an underground governor versus an above ground governor is the additional time it takes to conduct maintenance activities. This includes the time required to gain access to the governor and additional labour costs incurred for additional staff to support the engineer servicing the governor to ensure their safety. This driver of additional costs was referenced in the UBLE report:

"Confined spaces cause utilities to incur relatively high costs, such as in respect of underground governor and substation maintenance, tunnel rental costs and higher costs of inspection, maintenance and repair inside tunnels[59]."

As a result of housing a higher proportion of its governors underground, the London GDN therefore incurs additional cost to maintain these governors, relative to other GDNs. Furthermore, the additional costs incurred are outside of the London GDN's control as relocating these assets above ground would not be cost efficient (due to the capital cost of doing so), or feasible in some instances due to (i) the criticality of supplies being conveyed via these Governors and (ii) the dense, urban nature of London.

The need for underground assets and the extra cost they impose is consistent with the principles of the similar accepted claim for UKPN's LPN DNO at RIIO-ED2.[60] The LPN DNO similarly has extra costs driven through the need to operate and maintain underground assets such as substations, cables, and cable pits[61].

Underground LA Tunnels

The Subways Act of 1983 requires that utility companies, including Cadent, cannot break the surface of a street to build or maintain network assets, where that street has an LA Tunnel underneath. Instead, where part of the network runs through a street with an LA Tunnel, the utility company must house its network assets within the shared Tunnel. London is the only city in which utility companies must house assets in shared utility tunnels. Approximately 18 km of mains pipeline in our London network are located within tunnels owned by the City of London, Westminster, Camden, and Tower Hamlets LAs. Whilst some LA Tunnels located in London are not within the London GDN area of operations, the cost associated with owning and operating pipes located within LA Tunnels is unique to utilities operating in the London area. As a result, costs the London GDN incurs associated with LA Tunnels are not comparable to any other GDN, except the Southern GDN, which also partially operates in London[62].

Due to this requirement, we incur additional costs to inspect and maintain pipes within LA tunnels, over and above those not within a Tunnel. This cost differential is driven by:

- the cost of training staff to work within Tunnels. This training must be repeated every 3 years to ensure staff working in the tunnels are trained to do so safely. We incur the direct cost of training staff, and an opportunity cost as staff are not undertaking their usual work schedule.
- the cost of procuring specialist equipment for working in the Tunnels, such as specialist breathing apparatus to ensure staff safety.
- the cost of paying charges to the LAs for Tunnel maintenance and capital costs (these costs do not relate to our network assets located within the Tunnel); and
- the cost of additional staff to be present whilst undertaking maintenance work in the LA Tunnels to ensure the safety of Cadent staff (e.g., a 'top-man' who stays at surface level in case of emergency).

The UBLE report recognised that working with assets located in LA Tunnels drives additional costs for utilities operating in London, compared to non-London utilities (as set out in the previous discussion of underground governors from the UBLE report set out above). The extra cost driven by the need to maintain assets in these tunnels is also consistent with those incurred by UKPN who maintain cables in the same tunnels.

UKPN received a cost adjustment to reflect these additional costs as part of their Network Specific Factors claim at RIIO-ED2[63].

Transport Schemes

[59] NERA and Arcadis, Understanding the Baseline Level of Efficiency in London (31 October 2019), P. 42

[60] UKPN (2021) "Placing customers and communities at the heart of net zero", RIIO-ED2 Business Plan 2023-2028", P. 184-185, see here: UKPN RIIO-ED2, Accessed 07.12.24, Ofgem (2022) "RIIO-ED2 Draft Determinations – Core methodology Document", Para 7.51-7.59

[61] Ofgem (2022), RIIO-ED2 Draft Determination Core Methodology, P. 237

[62] Cadent cannot confirm how many km of pipe the Southern GDN operates within LA Tunnels. [cost-sensitive data]

[63] UKPN (2021) "Placing customers and communities at the heart of net zero", RIIO-ED2 Business Plan 2023-2028", P. 184-185, see here: UKPN RIIO-ED2, Accessed 07.12.24, Ofgem (2022) "RIIO-ED2 Draft Determinations – Core methodology Document", Para 7.51-7.59

High population and property density in London have led to traffic concentration and resulting congestion, as well as environmental emissions from vehicles. The ULEZ and LEZ charging schemes are clean air initiatives that TfL has implemented to mitigate this pollution in London. The ULEZ and LEZ charges are only applicable to vehicles that do not meet the Euro 4 (for petrol) and Euro 6 (for diesel) emissions standards[64]. While most vehicles in Cadent's fleet meet the emissions standards required for a ULEZ/LEZ exemption, there are a small number of vehicles ([cost-sensitive data]) that still incur ULEZ/LEZ charges. As Cadent's fleet modernises, the number of vehicles incurring these charges will decrease. TfL also enforces the congestion charging zone to ease traffic in only the most central parts of London. It therefore covers a much smaller area than the ULEZ/LEZ scheme, and applies to almost all vehicles irrespective of emissions standards. In December 2025 TfL will discontinue its electric vehicle exemption for the congestion charge, meaning all vehicles in Cadent's fleet will be liable to pay congestion charges.

As a result of these transport payment schemes, the London GDN incurs additional costs when its vehicles travel within the ULEZ/LEZ zone and congestion charge zone. The areas covered by each charge are shown in the figure below (also including the expansion of the ULEZ/LEZ charging zone expanded in August 2023). Cadent's London network covers almost the entire ULEZ/LEZ charging region north of the Thames.

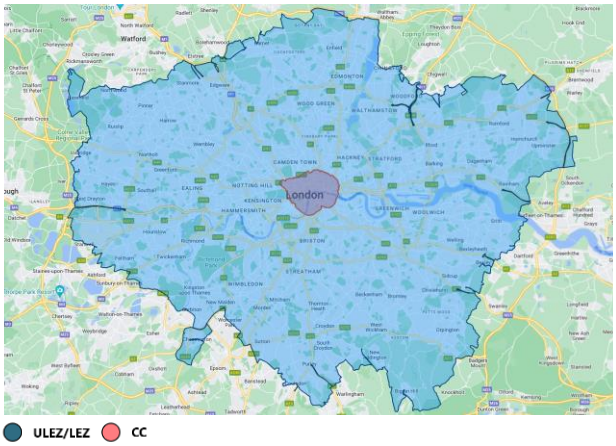

Figure 21: ULEZ/LEZ and Congestion Charge coverage of London (source: TFL website, ULEZ: Where and When)

Transport charging schemes are not unique to Cadent's London network. SGN's Southern network also covers parts of both the ULEZ/LEZ charging zone, and congestion charging zone located south of the Thames. Furthermore, since the beginning of RIIO-GD2, several other cities in GB have introduced Clean Air Zones (CAZs). However, we understand that London is the only GB city to enforce a congestion charge to almost all vehicles that enter the charging zone. Further, while London is no longer the only city in GB to have a transport charging scheme, the coverage of the charging schemes in Cadent's London network is much larger than for other GDNs. Figure 22 shows the percentage of each GDN's population that live within a clean air charging zone (such as ULEZ/LEZ) and/or a congestion charging zone[65]. As shown, our London GDN is affected materially more than other networks with 74.29% of population subject to one (the second highest being 24.47%, for Southern).

[64] European emissions standards are legal requirements governing the pollutants emitted by vehicles in the UK and the EU.

[65] Since the location of gas distribution assets exists to serve the local population in each region of the country, the share of population living within a charging zone is a good proxy for the relative impact on GDNs' costs from transport schemes. This approach is also consistent with calibration of the Labour Cost and Nature of Streets factors detailed above.

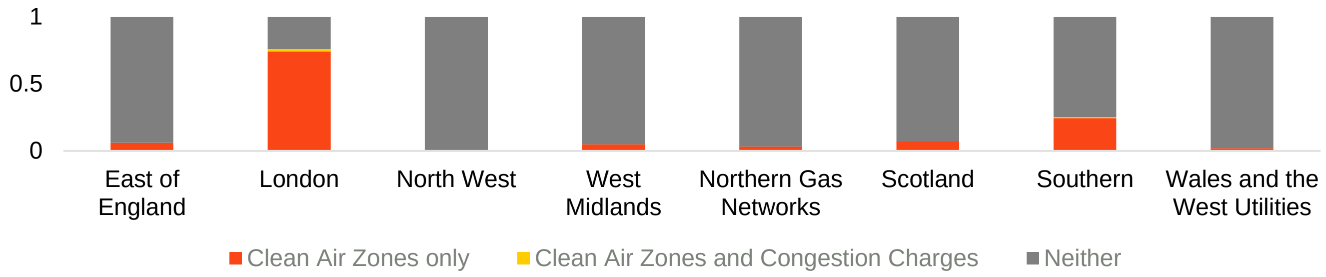

Figure 22: Population by Network Within a Transport Charging Zone (source: Cadent analysis of ONS data)

Cadent has limited ability to mitigate the transport scheme charges it incurs. As the ULEZ/LEZ operate at all times, on all days, and the congestion charge operates partially on Saturdays and Sundays, we cannot avoid the congestion charge unless we undertake our works during certain hours. Working outside of charging hours would impose additional labour costs and prevent us from meeting required emergency response times. However, we can reduce the costs incurred through modernising and electrifying our fleet. Both of which we are leading the industry on through RIIO-GD2 as we are the only network to make significant progress towards transitioning our fleet to net zero under the Commercial Fleet PCD[66]. Despite this, from 25 December 2025 all vehicles (including electric vehicles) must pay the congestion charge so even these actions will not eliminate the cost entirely. **The extra cost driven by the need to pay charges associated by these schemes also affects other utilities and we note that as part of its Network Specific Factors claim, UKPN received a cost adjustment for these costs at RIIO-ED2**[67].

Proposed Approach to Quantification

Below, we quantify each component of the Network-Specific Factors claim. These components together holistically reflect the impact of the high population and property density of the London GDN operating area.

Quantifying additional costs

Operational Property Costs

As shown above, we incur additional costs for operational property within our London network relative to others. These higher property costs sit across both our property Opex lines and Repex lines within the BPDTs. This is because a portion of our property costs are allocated to Repex to reflect the usage of the property by staff and contractors undertaking Repex activities. [cost-sensitive data]

[cost-sensitive data]

[redacted]

Table 28: [cost-sensitive data]

[66] See 2023/24 Regulatory Reporting packs from all GDNs for further information
[67] Ofgem (2022) "RIIO-ED2 Draft Determinations – Core methodology Document", Para 7.51-7.59

[cost-sensitive data]

[cost-sensitive data] To apply this adjustment to our costs across all years within the RIIO-GD1 – RIIO-GD3 period, such that the factor can be accounted for throughout the modelling period, we investigated backcasting this from the RIIO-GD3 period using levels of MEAV. However, as MEAV was higher in previous periods compared to RIIO-3 this would imply a reducing adjustment over time. By contrast, the primary driver leading to this adjustments, rental rates, rises over time. Therefore, to be conservative, and reflect reality, beginning with the GD3 average, we scale the estimated incremental cost backwards in time pro-rata to our London GDN's level of rentals for operational sites. [cost-sensitive data]

[redacted]

Table 29: [cost-sensitive data]

These costs should be removed from operational property costs and Repex before benchmarking GDNs' costs.

Emergency Job Times

Ofgem recognised the impact of longer emergency job times on efficient emergency costs at RIIO-GD2 when it applied the urbanity productivity adjustment to London's emergency labour costs. However, this adjustment was based on Repex productivity differences, which have different drivers to emergency jobs. Ofgem's RIIO-GD2 approach is therefore likely to be inaccurate as a basis for controlling for emergency job times.

For RIIO-3 we have undertaken new analysis to quantify the additional costs associated with longer emergency job times due to the impact of population and property density. We build on the emergency job time differential between our London network and the average of our three other networks set out earlier in this section, which shows that jobs are [cost-sensitive data] longer in the London GDN for internal escapes and [cost-sensitive data] for external escapes. Based on these figures we make three adjustments:

- Based on internal Cadent data we observe that [cost-sensitive data] of external escapes (not internal) require the swift attendance of a repair team, due to the risk associated with the escape. During this time the FCO is required to stay on site. Using Cadent GDNs' job time data for 2020/21 – 2022/23, we removed the additional time spent by FCOs in London waiting for Repair teams to arrive, as we could not definitively demonstrate that this was outside management control. Thus, we have maintained a conservative approach. After this adjustment, the difference in external job times between the London GDN and our other networks reduces to [cost-sensitive data]. This does not affect Internal job times, as no Repair team is required.
- We also adjust the job times to reflect time spent by FCOs travelling, as these are similar across the four GDNs and act to dilute the additional time. The resulting difference between the London GDN and other GDNs for external job times is reduced [cost-sensitive data] for internal job times.

- Finally, we estimate the weighted additional time of jobs undertaken by the London GDN by multiplying the internal and external job times by the percentage of total workload for each of these job types. Based on this we estimate the weighted additional job time for the London GDN compared to our other three GDNs is [cost-sensitive data] longer.

[cost-sensitive data]

Emergency Shift Patterns

To estimate the incremental costs that our London GDN faces from needing to operate a 24-hour shift pattern, we estimate the difference between the cost of operating a 24-hour shift pattern versus the cost of running an alternative ‘call out and standby’ regime. We then apply the difference in cost between the two systems to our base Totex. [cost-sensitive data]

Moving from the current shift regime to a call out and standby regime has three effects on costs:

- The first is to remove the need for [cost-sensitive data] FCOs that we require to deliver the London shift pattern. We would not require these FCOs to deliver a ‘call out and standby’ regime. The saving from not needing these resources is a reduction in salary costs and other additional payments made to work the 24-hour shift system, Employers pension contributions and National Insurance costs.
- The second effect is the loss of additional payments paid to all employees working the shift system to compensate them for the different hours they work and working conditions they are working under.
- The third effect is the counterbalancing increase in costs from the move to a call out and standby regime. While costs do reduce as additional payments on top of base compensation are removed, there are equivalent additional payments made to staff for being on standby that we account for.

[cost-sensitive data]

[redacted]

Table 30: [cost-sensitive data]

[cost-sensitive data]

[redacted]

Table 31: [cost-sensitive data]

[cost-sensitive data]

Locksmith costs

We have quantified the additional costs we incur for locksmith use in the London GDN as follows:

1. We collected locksmith costs across all four of our networks for 2021/22 to 2024/25[68].
2. We accounted for the relationship between emergency workload and locksmith costs by dividing the annual locksmith costs by the Emergency CSV (ECSV) for each network. Ofgem uses the ECSV in its RIIO-GD2 Totex regression model to explain emergency costs. As shown below, locksmith cost per unit of ECSV is consistently higher in London than in the other three Cadent networks.

[redacted]

Figure 23: [cost-sensitive data]

3. We calculated the average annual locksmith cost per unit of ECSV across all our non-London networks.
4. We calculated a London excess locksmith cost, per unit of ECSV, as the London cost per unit of ECSV less the average cost per ECSV across the other three Cadent networks.
5. Based on this excess cost, we calculated the total excess locksmith cost per annum in the London network as the average London excess cost per unit of ECSV across the four years of GD2 to date (2021/22 – 2024/25), multiplied by the average London ECSV value for the same period.
   - Table 29 shows the estimated annual excess locksmith cost for London to be [cost-sensitive data] per annum.

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68 [cost-sensitive data]

Step	Method	Calculation	Value (£, 23/24 prices)
1	Collected annual locksmith cost by network.	NA	[cost-sensitive data]
2	Calculated average annual locksmith cost per unit of ECSV in London.	A	[cost-sensitive data]
3	Calculated average annual locksmith cost per unit of ECSV in each non-London Cadent GDN.	B	[cost-sensitive data]
4	Calculated London excess locksmith cost per unit of ECSV.	A – B = C	[cost-sensitive data]
5	London ECSV	NA	[cost-sensitive data]
6	Calculated London excess locksmith cost.	C * London ECSV = D	[cost-sensitive data]

Table 32: Estimated Annual Excess Locksmith Cost in the London GDN (RIIO-GD2 to date) (source: Cadent analysis)

6. To apply this value forward and backward for other years in the RIIO period (as is required to apply the factor to all years within the modelling period) we applied the percentage change between the GD2-to-date average (2021/22 – 2024/25) ECSV and the ECSV for each subsequent and previous year to the excess locksmith cost value.

Based on this approach we generate an average adjustment value across the RIIO-3 period of [cost-sensitive data] per annum. Ofgem should deduct this value from the London GDN's submitted emergency costs to ensure a like-for-like comparison with other GDNs who do not incur this level of emergency costs. It is also important to note that this estimate is conservative as it does not include costs for repair when we have to break down a property entrance to gain entry.

Third-party driven works

To calculate the additional costs incurred by the London GDN to fulfil exogenously driven third party work, we use workload data for disconnections and alternations between 2021/22-2023/24 across each of our GDNs (i.e., the latest years for which we have actual data). To ensure we only capture excess third-party driven works, we divide this workload volume by Maintenance MEAV. We use this to calculate the number of additional third-party driven jobs undertaken in the London GDN, relative to that of our non-London networks.

We then multiply the excess number of third-party driven jobs by (i) the average charge to customers for delivering these works outside of the London GDN, having subtracted (ii) both attributed and allocated overheads which are not incurred within the Maintenance activity. From this, we calculate the additional level of cost incurred within the London GDN[69]. The calculation is set out below separately for the two types of work.

[redacted]

Table 33: [cost-sensitive data]

[69] Using non-London charges ensures the calculation is both conservative and does not conflate the factor with additional costs as a result of the Labour Cost factor set out above.

[redacted]

Table 34: [cost-sensitive data]

[cost-sensitive data]

[redacted]

Table 35: [cost-sensitive data]

[cost-sensitive data] Ofgem should deduct this value from the London GDN's submitted maintenance costs before benchmarking.

Underground Governors

To quantify the additional cost incurred by the London GDN to maintain underground governors, we have:

A. constructed the maintenance schedule for underground governors based on model types in the London GDN (e.g., Model X must be maintained once every 12 months);
B. identified the unit cost of maintaining underground governors by type;
C. constructed the maintenance schedule for above ground governors based on model types in the London GDN (e.g., Model Y must be maintained once every 12 months);
D. identified the unit cost of maintaining above ground governors by type (including associated overheads);
E. Based on A and B, we have calculated the annual cost incurred by the London GDN to maintain underground governors in the region [cost-sensitive data];
F. Based on C and D, we have calculated the annual cost incurred by the London GDN to maintain above ground governors in the region [cost-sensitive data]; and
G. Finally, using the values of E and F, we have calculated a "London excess" value, which quantifies the additional cost the London GDN incurs compared to the other three Cadent GDNs due to its disproportionately high proportion of underground governors. We do this by taking the differential in London maintenance costs for underground versus above ground governors (i.e. E-F) and multiply this by the excess number of underground governors the GDN operates [commercial-sensitive data][70].

[70] We calculate the number of excess governors as the difference between the percentage of underground governors in the London GDN, compared to the average percentage of underground governors in the three non-London Cadent GDNs.

[cost-sensitive data]. This value represents all additional labour costs and should be deducted from the London GDNs submitted maintenance costs for each year of the RIIO period to ensure a like-for-like comparison with other GDNs with a more typical mix of above/underground governors.

Underground LA Tunnels

To quantify the additional costs that the London GDN incurs due to the requirement to use LA tunnels, we have compiled the sum of the associated costs for use of the tunnels based on historical data, shown below:

[redacted]

Table 36: [cost-sensitive data]

In this quantification we have not included the cost of the additional staff cost to be present whilst work is being undertaken within tunnels (for safety) as the value for this is uncertain. As such, the quantification represents a conservative estimate of the extra costs that LA Tunnels drive. Furthermore, given the nature of the costs, the value does not fluctuate significantly year-on-year, as the costs associated with training and safety equipment must be incurred each year to maintain the safety of the engineers operating in the Tunnels. The charges must be incurred for Cadent to continue operating in the Tunnels, and hence comply with the Subways Act 1983.

The additional cost incurred by the London GDN [cost-sensitive data] should be deducted from the London GDNs submitted maintenance costs for each year of the RIIO period to ensure a like-for-like comparison with other GDNs who do not have to incur this expenditure.

Transport Schemes

[cost-sensitive data] Approximately [cost-sensitive data] of this value was ULEZ/LEZ charges, and the remaining [cost-sensitive data] of incurred costs were congestion charges. However, to calculate the required adjustment to reflect this component of additional costs within the London region only we must take account of the presence of similar schemes to ULEZ/LEZ in other areas of the country. As set out above, the percentage of gas customers outside of London which live within a CAZ is approximately 3.88%, compared to 74.29% for the London GDN. Using these figures, we have adjusted our incurred ULEZ/LEZ charges (and forecast ULEZ/LEZ charges) to reflect the CAZ charges incurred by other GDNs[71]. Our quantification, therefore, represents the cost incurred by the London GDN in excess of what it would incur if it were not operating in London[72]. To then apply this over forecast and previous years, we have made the following adjustments:

[71] We adjust costs by scaling London LEZ/ULEZ spend by a factor capturing the difference of the percentage of population covered by CAZ schemes in the London GDN relative to the weighted average of the non-London GDNs.

[72] Different CAZ schemes were introduced at different times. To produce a conservative estimate, we have assumed that all CAZ schemes have been operational since the start of the modelling period (2013/14).

- ULEZ/LEZ came into force in April 2019, so all charges before the 2019/20 financial year are zero[73].
- We forecast ULEZ/LEZ to follow the actual downward trend between 2021/22 and 2024/25. This trend reflects the decreasing level of charges as the Cadent fleet continues to modernise[74].
- Historical congestion charges are based on the average incurred congestion charge between 2021/22 and 2024/25, given that the structure of the congestion charging zone has been stable over the period.
- Forecast congestion charges are adjusted upwards from 1 January 2026 to reflect that Cadent's electric vehicle fleet, which will comprise [cost-sensitive data] of its total vehicle fleet, will also incur the congestion charge from that date.
- The forecast and backcast charges for ULEZ/LEZ and the congestion charge are indexed to the cost drivers for the activities where they are incurred in the RIIO-GD2 Totex regression[75] to reflect that the charges vary based on the level of workload undertaken or forecast to be undertaken.

[cost-sensitive data]

[redacted]

Table 37: [cost-sensitive data]

The total associated costs reported above should be deducted from the London GDN's annual costs for each activity each year before costs are compared to other GDNs.

Quantifying the Network-Specific Factors factor

[Due to commercial sensitivity, this section has been redacted. For more information, please see our Redaction Statement]

[redacted]

Table 38: [cost-sensitive data]

[73] TfL previously operated the Toxicity Charge scheme. However, since it is no longer in place, we exclude its costs from the calculation.

[74] To apply this trend we calculate the average historic annual change in ULEZ/LEZ charges incurred for each cost area (Emergency, Maintenance, Repair, and Other) and apply this reduction to each subsequent year.

[75] Emergency costs are indexed to the Emergency CSV, Maintenance costs are indexed to Maintenance MEAV, Repairs costs are indexed to external condition reports, and Other costs are indexed to MEAV

An indication of the size of the factor when our proposed exclusions are applied and interactions between factors taken account was set out above in table 17 (section 4.1)

Why An Adjustment is Needed within GD3 Comparative Benchmarking Models

The above has established that our Network Specific Factors claim is outside of GDNs' control, unique (impacting only GDNs which serve the region of London) and material. Ofgem's final criteria is that the relevant cost adjustment is not captured in its benchmarking model, or through a separate factor adjustments. Below we summarise why this is the case for the different components of additional cost across different activities.

Operational Property Costs

Operational property costs sit within the Property Opex and Repex cost activities. In Ofgem's RIIO-GD2 Totex regression model, these costs were modelled by MEAV and the Repex synthetic cost respectively. Neither driver differentiates between the cost of owning, renting and utilising operational property across networks (i.e. their unit costs). Ofgem's drivers only explain cost variation due to the number of properties each GDN operates (to the extent that this is driven by scale of networks or workload). Hence, the incremental efficient costs borne only by the London GDN to rent and utilise its operational property will not be captured by the regression model and should be adjusted for.

Emergency Job Times, Shift Patterns and Locksmith costs

Emergency costs are explained by the ECSV, which is itself a weighted average of customer numbers and external condition reports. The London network incurs higher emergency costs due to (a) longer emergency job times, (b) the inability to operate a 'call out and standby regime' and (c) the need to utilise locksmith services more frequently in the London network. The ECSV does not capture these cost drivers in either customer numbers or external condition reports.

Third-party driven works

Service alterations and disconnections costs sit within the maintenance cost activity and were modelled by Maintenance MEAV by Ofgem at RIIO-GD2 in its Totex regression. However, as shown above, maintenance MEAV does not capture differences in third-party driven workload for alterations and disconnections between networks as these are ultimately driven exogenously, outside of GDNs' control, rather than the amount of assets that require maintenance activity. Furthermore, services are excluded from Maintenance MEAV. As the London GDN experiences more than third-party driven works than other GDNs relative to its level of Maintenance MEAV, an adjustment is required to reflect this before comparative benchmarking is undertaken.

Underground Governors and Underground LA Tunnels

The cost of maintaining district governors and utilising LA Tunnels are incurred in the maintenance cost area. In Ofgem's RIIO-GD2 Totex regression model, maintenance costs were explained by the Maintenance MEAV cost driver. However, Maintenance MEAV does not differentiate between underground and above ground governors and does not capture whether assets are located in LA tunnels. Hence, Maintenance MEAV will not explain the additional maintenance costs incurred due to the London GDN's higher proportion of governors housed underground, relative to other GDNs. Furthermore, given GDNs outside London do not incur additional costs to house assets within LA Tunnels, Maintenance MEAV will not explain the additional maintenance costs incurred by the London-based GDNs. Therefore, an adjustment before benchmarking is needed.

Transport Schemes

Transport Scheme costs are spread across our cost base. In Ofgem's RIIO-GD2 Totex regression model, the explanatory variable (a CSV composed of 7 drivers) does not take account of the additional costs required to deliver GDN activities that the London GDN incurs through transport scheme charges, which are significantly higher than other GDNs. These drivers capture the scale of the network and/or the volume of work, without any recognition of how the costs of meeting these requirements is affected by road pricing schemes.

As a result, the drivers within Ofgem's Totex regression model are not able to control for differences in GDNs' operating environments due to Network Specific Factors. We have also not identified any drivers available from data reported by all GDNs in RRPs or BPDTs or other adjustments made in the cost assessment framework that directly account for Network-Specific Factors identified above facing the London GDN. Therefore, our evidence justifies why an adjustment is needed.

We note that this is consistent with Ofgem's past price control decisions, most notably RIIO-ED2 which adjusted costs for a similar Network Specific Factors claim for UKPN's LPN DNO[76].

We do note, however, that applying these adjustments within Ofgem's benchmarking models will require adjustments to a small number of the amounts listed above owing to calculation approaches we have used and application of the Labour Costs and/or Nature of Streets Factors to costs for the same activities impacted by Network Specific Factors. Specifically:

- in applying the reduction to Repex as a result of higher Operational Property costs, the amount of additional cost to be removed must be reduced to reflect the Nature of Streets factor (which we propose is applied first to all of Repex) to avoid double-counting the impact;
- in applying the reduction to repair costs due to the additional costs borne by the London network due to Transport Schemes, the amount of additional cost to be removed must be reduced to reflect the Nature of Streets factor (which we propose is applied first to all of repair costs) to avoid double-counting the impact; and
- in applying the reduction to maintenance costs as a result of additional costs incurred in London due to Underground Assets, the amount attributable to Underground Governors (total), and the labour portion of the additional costs incurred due to use of Underground LA Tunnels need to be reduced to reflect the Labour Costs factor (which we propose is applied first to maintenance labour costs) to avoid double-counting the impact.

Third Party Works also have a labour component, meaning in theory there is an overlap in the adjustment needed to recognise these additional costs with the Labour Costs factor. However, as the additional costs have been estimated using non-London unit costs such an adjustment is not required.

4.4. Sparsity

Overview of Regional Factor

Within BPDT M8.13 we are submitting a single factor claim for Sparsity for our Eastern, North-West and West Midlands GDNs. This builds on Ofgem's approach at previous price controls to recognise sparsity impacts on emergency and repair activities.

Under Ofgem's current framework, sparsity adjustments are applied to all networks except the London GDN so that costs are entered on the same comparable basis into regression analysis. We believe these adjustments are still required, should our above proposals be accepted, to control for the costs incurred by GDNs like Eastern serving sparser areas, as compared to London that does not experience sparsity cost pressures.

At previous price controls Ofgem has provided sparsity related cost adjustments to account for:

- Increased emergency costs owing to productivity losses, whilst maintaining ESOS. As set out above, gas networks need to attend 97% of PREs within two hours of the customer reporting the escape if controlled, or one hour if uncontrolled. In sparse areas, to reach escapes within these target times, more labour resource is required per unit of work than in more urban areas, as staff need to be located strategically in the required vicinity to where emergencies might be reported. This leads to incremental costs as more staff need to be available in total relative to less sparsely populated areas to attend the same level of potential escapes. Therefore, the cost impact emerges from the need for more staff, rather than increased working or travel times.
- Increased repair costs owing to productivity losses. Repair teams do not need to be strategically located as they do not work within the same binding licence requirement as emergency response teams. However, the costs of undertaking repair work in more rural areas can be higher than Elsewhere as they may involve greater time and cost to travel to sites than in less sparse areas. Therefore, the cost impact emerges from excess travel time, as opposed to extra staffing costs (as with emergency) or additional working time.

Previous sparsity adjustments made by Ofgem at GDPCR1, RIIO-GD1 and RIIO-GD2 have controlled for these impacts. However, the analysis underpinning them is based on an original submission by WWU for GDPCR1, meaning that at the time of setting RIIO-3 it will be based on data which is over 15 years old. The adjustment size is also assumed to apply only to emergency and repair activities[77]. We have therefore sought to re-assess

[76] UKPN (2021) "Placing customers and communities at the heart of net zero", RIIO-ED2 Business Plan 2023-2028", P. 184-185, see here: UKPN RIIO-ED2, Accessed 07.12.24, Ofgem (2022) "RIIO-ED2 Draft Determinations – Core methodology Document", Para 7.51-7.59
[77] John Spiller Associates (2007) "Network Cost Drivers A "Bottom Up" Approach – A Report on Behalf of Wales & West Utilities"

whether cost pressures caused by sparsity continue to affect Emergency and Repair activities, what level of additional cost is caused, and whether there are any additional activities that are impacted by exogenous sparsity effects. The only impacts of sparsity we have identified are those recognised in Ofgem's pre-existing adjustments, and we propose new adjustments based on more up-to-date and granular data than used in WWU's GDPCR1 submission.

Drivers of Additional Costs Faced by Cadent

Emergency productivity losses

To quantify the loss in productivity of emergency staff experienced by operating in more rural areas, we have gathered data on publicly reported escapes (PREs) per FCO (a measure of productivity) for both internal and external escapes from 2020/21 to 2022/23 and compared this against levels of population density. This analysis was conducted at the 'patch' level. Undertaking this analysis at a sub-network level is important, as it allows us to assess the fundamental economic relationships at play which might otherwise be obscured by (ultimately arbitrary) network boundaries. [cost-sensitive data]

[redacted]

Figure 24: [cost-sensitive data]

As shown in the figure, for internal escapes we find a strong, positive relationship between greater sparsity and reduced productivity, for the reasons outlined above. However, the picture is far weaker for external escapes where there is little to no relationship. This is unsurprising given that internal escapes themselves are driven largely by customer numbers, while external escapes are driven by the length, material, age and condition of the gas distribution network. This is recognised in Ofgem's emergency CSV driver, as internal PREs (assumed 80% of total) are modelled using customer numbers, and external PREs (20% of total) are modelled by external condition reports.

Repair productivity losses

To assess the relationship between sparsity and travel times for repair teams, we have compared population sparsity with job travel times, scaled by overall working time. In our analysis, we do not assess the relationship between travel times and population sparsity as there are a number of factors that could mask the underlying relationship (for example multiple visits to a job to complete it – which would raise total travel time to complete the job but not the actual time taken to travel from a base location to site). Scaling travel times by overall working time removes this potential data distortion. The result of this analysis is shown below and indicates a negative relationship where increased sparsity increases travel time. [cost-sensitive data]

[redacted]

Figure 25: [cost-sensitive data]

Property and mains replacement costs

We also assessed the potential for sparsity to drive incremental property and mains replacement costs, but found no evidence of these effects, or any evidence that they should not be captured by other regional and company-specific factor adjustments. For example, while mains replacement contractors may be required to travel longer distances and be paid premia for working in sparse areas, these should be captured in contractor rates which would be adjusted implicitly through the Labour Costs factor, and the relative wage difference between the area in and around London and elsewhere in GB.

Proposed Approach to Quantification

Emergency productivity losses

To quantify additional emergency costs due to the impact of sparsity on productivity we have:

- Used the regression above between Internal PREs per FCO and population sparsity to predict the number of Internal PREs expected for each patch.
- Summed the predicted values across patches to produce Internal PREs per FCO for each network.
- Compared these to those of the London GDN (consistent with Ofgem's current approach to providing a sparsity adjustment for all networks except the London GDN). [cost-sensitive data]; and
- Combined the results of the steps above with internal and external PRE times and travel times, taken from our Emergency Job times work set out in the previous section, using Ofgem's 80/20 split embodied in the emergency CSV.

[cost-sensitive data]

[redacted]

Table 39: [cost-sensitive data]

[cost-sensitive data] These figures are somewhat larger than Ofgem's RIIO-GD2 sparsity factors for emergency (being respectively 8%, 1% and 6% assumed for the RIIO-2 period when setting the RIIO-GD2 price control)[78].

To estimate the impact this reduction in emergency productivity has on costs, we multiply the level of gross normalised labour costs for the emergency activity (as derived for and used within the Labour Cost factor) by the percentage amounts set out above. [cost-sensitive data]

Repair productivity losses

To quantify additional repair costs due to longer travel times in sparse areas, we have:

- Used the regression above between travel times (scaled by working time) and population sparsity to predict levels of travel time (scaled by working time) for each patch (excluding London patches due to potential issues with shift length as noted above);
- Summed predicted values across patches for each network, and combined this with working time figures to generated predicted travel time values per network;
- Calculated the additional predicted travel time each network has compared to London by subtracting the number of minutes each network would be expected to incur for travel if they had London's travel time (scaled by working time) as compared to that predicted for each network; and
- Calculated the percentage this additional time accounts for (i.e. working time + travel time).

[cost-sensitive data]

[redacted]

Table 40: [cost-sensitive data]

[cost-sensitive data] These in general are significantly lower than Ofgem's RIIO-GD2 sparsity factors, although with North West being relatively similar, for repair (assumed previously to be equivalent to emergency and respectively 8%, 1% and 6% assumed for the RIIO-2 period when setting the RIIO-GD2 price control)[79].

To estimate the impact this reduction in repair productivity has on costs, we multiply the level of gross normalised labour costs for the repair activity (as derived for and used within the Labour Cost factor) by the percentage amounts set out above. [cost-sensitive data]

Quantifying the Sparsity factor

Based on the analysis set out above our claim for the sparsity factor is set out in the table below [cost-sensitive data] for the RIIO-3 period.

Network *(£m)*	RIIO-GD3 Total		
23/24 prices	[cost-sensitive data]	[cost-sensitive data]	**Total**
Eastern	[cost-sensitive data]	[cost-sensitive data]	10.21
North West	[cost-sensitive data]	[cost-sensitive data]	4.92
West Midlands	[cost-sensitive data]	[cost-sensitive data]	3.40

Table 41: Sparsity factor by cost category and network, pre-exclusions and interactions, RIIO-3 (source: Cadent analysis)

[78] Ofgem (2020) "RIIO-GD2 Final Determinations: Step-by-Step Guide to Cost Assessment", Table 10
[79] Ofgem (2020) "RIIO-GD2 Final Determinations: Step-by-Step Guide to Cost Assessment", Table 10

An indication of the size of the factor when our proposed exclusions are applied and interactions between factors taken account was set out above in table 17 (section 4.1)

Why An Adjustment is Needed within GD3 Comparative Benchmarking Models

Under Ofgem's current framework, sparsity adjustments are applied to all networks except the London GDN so that costs enter on the same comparable basis into regression analysis. These adjustments are made even though (by definition) they are not unique to one or a small number of GDNs (being applied to all non-London GDNs) and for some networks the adjustment applied falls below the materiality threshold (as it does for all our networks which in RIIO-GD2 receive this adjustment). However, they are made regardless as:

- nothing within Ofgem's cost assessment framework (including the assigned cost drivers for emergency and repair activities in the RIIO-GD2 Totex regression) controls for the impacts on sparsity on network costs; and
- these adjustments are needed for all networks as, absent them, and acceptance of other factor claims, sparse networks would be unduly disadvantaged in benchmarking relative to the London GDN which is assumed to not experience these pressures on costs.

Based on our analysis above we support retaining these adjustments. Specifically, in combination with our other factor claims for networks who serve London, these adjustments required for all non-London GDNs should establish a comparable basis for costs to be assessed via regression analysis. However, in line with our claim above, we believe the precise quantum of these adjustments should be updated to reflect the latest evidence, with the repair adjustment falling in size compared to Ofgem's RIIO-GD2 adjustment value.

As discussed further in section 5 below, an alternative approach to controlling for density and sparsity effects would be to include explanatory variables in the regression equation to captures these effects. This alternative approach could be used alongside an approach exclusively utilising pre-modelling adjustments to provide a more rounded view on the impact of these factors.

5. An improved modelling framework to assess comparative efficiency

The starting point for developing our RIIO-GD3 plan has been our existing RIIO-GD2 cost base. To establish the efficiency of our plan we have therefore sought to benchmark our costs against other GDNs across the RIIO-GD2 period, aligned with the principles of the approach Ofgem utilised in setting the RIIO-GD2 price control, and which it will use as the starting point for setting allowances for RIIO-GD3 (when data for all GDNs is available)[80].

In comparatively assessing our costs we have first replicated Ofgem's RIIO-GD2 Totex regression with updated data, before then considering improvements to the RIIO-GD2 modelling approach. Bringing these improvements together with our proposals for cost exclusions and regional and company-specific factors we then:

- show the improvement that these methodological changes make to the performance of Ofgem's regression model and recommend that each of these improvements be used for Ofgem's cost assessment at RIIO-GD3, assuming that they still result in improved model performance; and
- establish our leading position as the most efficient GD ownership group across RIIO-2, and hence, given our use of RIIO-2 costings to develop our forecasts, evidence the efficiency of our RIIO-3 plan[81]; and
- detail how we have driven this level of efficiency within the RIIO-GD2 period.

In addition to the analysis presented below, as part of the cost assessment process Ofgem should also review: (i) its use of MEAV for costs not assigned a specific driver as this continues to exhibit low explanatory power[82] in the bottom-up modelling of these areas and (ii) the construction of the Repex Synthetic cost driver so it is able to robustly model exogenous variation in costs between GDNs, and reflects pressure on Repex unit costs across

[80] We cannot provide forward-looking benchmarking evidence to demonstrate our efficiency as we do not have access to the non-Cadent GDNs business plans at the time of submission, and do not know what costs and outputs/activity levels other GDNs will propose for GD3.

[81] Supplementary information on excluded costs can be found in other areas of our business plan cited in our cost exclusions section 3

[82] In this context, explanatory power means the ability of a regression model to explain the variation in the dependent variable (costs) through a modelled relationship of the independent variables (cost drivers). This is often measured by Adjusted R Squared (which has a value between zero and one) with a higher value implying higher explanatory power.

the industry moving into RIIO-GD3. It is also important Ofgem takes into account the robustness and statistical performance of its finalised models when selecting the level at which to set the catch-up efficiency challenge.

5.1. Improving Ofgem's RIIO-2 modelling approach with a new Composite Scale Driver and our exclusions and regional and company-specific factors

At RIIO-GD2, Ofgem relied on a single Totex model (as set out in section 2 above). Using actual and forecast data for all eight GDNs over the RIIO-GD1 and GD2 periods[83], we have re-run Ofgem's GD2 model and compared the results to those Ofgem published in its GD2 final determination (when all data for GD2 and the remaining year of GD1 were forecasts), and to the GD2 model which implemented the remedies instructed by the CMA (CMA FD model). As shown in table 42 below, the explanatory power (measured by adjusted R-squared) of the updated model is lower than both previous models, meaning **the performance of Ofgem's RIIO-GD2 model has decreased relative to when setting the price control**, with similar performance across other statistical tests.

	GD2 Final Determination[84]	CMA Final Determination Model[85]	Update of GD2 Model with Outturn Data
Constant	-0.076	-0.278	-0.686*
Totex CSV	0.787**	0.821***	0.866***
Time Trend 1	-0.004***	-0.007	0.003
Time Trend 2	0.006***	0.006	0.023
Adjusted R-squared	0.927	0.947	0.904
No. observations	104	104	104

** Indicates significant at the 10% significance level, ** 5% significance level, *** 1% significance level*

Table 42: Update of GD2 Regression Model with updated Data. (source: Cadent analysis)

Further, we have run the implied 'bottom-up' cost models for the seven cost areas within the Totex regression using their respective cost drivers in Ofgem's CSV to test the explanatory power of each driver[86]. As shown below, the estimated cost driver coefficients (which represent the elasticity between the cost and driver) and adjusted R-squared varies significantly across the cost areas, implying these drivers have different impacts on cost areas and a varying ability to capture differences across GDNs' costs.

Bottom-Up Regression Cost Area	Main Cost Driver	Coefficient on Main Cost Driver	Adjusted R-Squared
Emergency	Emergency CSV	1.03	0.77
Repair	Repairs Reports	0.82	0.69
Maintenance	Maintenance MEAV	0.81	0.63
Connections	Connections Synthetic	0.77	0.91
Repex	Repex Synthetic	0.84	0.83
Reinforcement	Reinforcement Synthetic	0.70	0.81
Other	MEAV	0.77	0.65

Table 43: Bottom-Up Regression Modelling Results (with Updated Data) (source: Cadent analysis)

As a result of the poor statistical performance of the bottom-up models, we have not used the bottom-up modelling results to assess our efficiency (specifically the explanatory power as measured by the adjusted R-squared). As discussed in our SSMC response, if bottom-up models were used in the GD3 cost assessment approach, but their collective econometric performance continues to be worse than Totex models, then (i) Ofgem should put less weight on these models compared to others with higher explanatory power and/or (ii) set the efficiency benchmark for the industry at a lower level than the 85th percentile[87].

[83] The last two years of RIIO-GD2 rely on forecasts from the Regulatory Reporting Packs of each GDN following completion of 2023/34 supplemented with additional assumptions and forecasts where required (i.e. where data required for modelling is not set out in packs)
[84] Ofgem (February 2021), RIIO-2 Final Determinations – GD Annex (Revised), Table 16
[85] CMA Final Determination model was not published – Cadent estimated the model based on Ofgem's modelling files used to set Cadent's ultimate RIIO-GD2 allowances and the CMA's final determination documentation.
[86] The bottom-up model runs rely on disaggregated model specifications used in the GD1 price control, with slight deviations from the drivers used in the Totex CSV (e.g., the reinforcement synthetic is smoothed over 4 years, not 7 years).
[87] Cadent (March 2024), RIIO-3 Sector Specific Methodology Consultation – Cadent Response to Ofgem GD Annex, Q53

Improving Ofgem's RIIO-GD2 regression with updates to CSV weights

The first improvement which we have made to the GD2 model specification relates to the method used to weight the cost drivers within the CSV. In Ofgem's GD2 model, each cost driver is weighted based on industry average expenditure shares over the modelling period for each cost area. However, this does not capture three key features of the sector and results in a biased efficiency assessment:

- Different GDNs have different efficient expenditure compositions for reasons beyond their control, not reflected in the industry average, assumed by CSV weights. The GDNs with an expenditure composition further from the average will tend to be disadvantaged in the benchmarking[88]. As such, by weighting the Totex CSV by industry average weights, this incentivises GDNs to target an expenditure composition close to the industry average, even if it would be more efficient to have a different expenditure composition. Hence, the GD2 modelling approach at present does not allow GDNs to efficiently trade-off between Opex and Capex spend, as the RIIO framework is intended to, without suffering disallowances[89].
- GDNs' expenditure composition will change over time to reflect industry trends, such as reduced connections, and/or increased Repex workload and/or unit costs. This is particularly important moving from RIIO-2 to RIIO-3 with significant changes in the profile for specific activities compared to historical periods. Therefore, using the average expenditure shares over the period to weight the CSV will mean that in years for which GDNs' expenditure composition is different from the modelling period average, even for efficient reasons, the CSV will not accurately explain GDNs' efficient costs[90].
- Each of the cost drivers is intended to explain a particular area of cost and Ofgem's GD2 model assumes a common elasticity (as represented by the regression coefficient) of costs to changes in the relevant driver, across all cost categories included in the CSV. However, the real relationships between each cost driver will not be the same; the elasticity of each cost area to changes in its driver will vary. This is demonstrated by the range of coefficients estimated via the bottom-up modelling shown above.

To address these problems, we propose weighting elements of the CSV by annual, network-specific expenditure shares, each multiplied by an estimate of the cost area's elasticity to changes in the cost driver from bottom-up modelling. To explain this, by way of an example: if the Eastern GDN spends 30% of Totex (post-exclusions and regional and company-specific factors) on Repex in 2027, and the elasticity between Repex and the Repex Synthetic driver (based on bottom-up modelling) is 0.9, then for the East of England GDN in 2027, the Repex Synthetic should be weighted by 0.27 in the Totex CSV (0.3 x 0.9). This approach would be applied to calculate a weight for each cost driver, with the resulting weights normalised to ensure they sum to 1 for each GDN in each year. The same method would be applied for each value of the CSV for each GDN, in each year.

When implementing this approach, a final important adjustment is also required to standardise cost drivers, given each is measured in different units[91]. If the units of cost drivers were not standardised, then a GDN with more spend in areas that have cost drivers with larger units (e.g., Emergency) will have a higher CSV than a GDN with identical driver values but lower spend in these areas. This will lead to the model being biased in favour of the former GDN, as a higher CSV will lead to higher modelled costs[92]. To address this, we standardise cost drivers by dividing the value of each, in each year, by the average value across the modelling period.

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[88] We have produced a simulation model which objectively shows that use of industry average CSV weights results in a bias against networks with expenditure shares more different from the average. This analysis is presented in our SSMC response. See: Cadent (March 2024), RIIO-3 Sector Specific Methodology Consultation – Cadent Response to Ofgem GD Annex, Q51

[89] Ofgem (February 2021), RIIO-2 Final Determinations – GD Annex (Revised), Para 3.84.

[90] This is an additional change to the weighting method proposed in our SSMC response, but consistent with our simulation analysis for network-specific weights due to the pooled OLS regression approach used in estimating the Totex regression

[91] Emergency CSV is measured as the combination of customer numbers and external condition reports (with the latter measured as no. of reports), and Maintenance MEAV, MEAV and Synthetic cost drivers are each measured in million GBP

[92] Cadent (March 2024), RIIO-3 Sector Specific Methodology Consultation – Cadent Response to Ofgem GD Annex, Q 50

Applying revised CSV weights and standardising units improves the explanatory power of the Totex regression compared to the updated RIIO-GD2 model (with updated data) as shown below[93].

	Update of GD2 Model with Outturn Data	Model with Improved Method to Weight the Totex CSV
Constant	-0.686*	5.509***
Totex CSV	0.866***	0.903***
Time Trend 1	0.003	-0.004
Time Trend 2	0.023	0.030*
Adjusted R-squared	0.904	0.914
No. observations	104	104

*Note: * Indicates significant at the 10% significance level, ** 5% significance level, *** 1% significance level.*

Table 44: Improving Model Robustness with an Improved Method to Weight the Totex CSV (source: Cadent analysis)

Implementing our cost exclusions and regional and company-specific factors

Building on the above, we then apply cost exclusions and regional and company-specific factors set out in the previous two sections, including applying these adjustments to non-Cadent networks where needed[94]. As shown, **application of our proposed exclusions and regional and company-specific factors further improves the performance of the Totex model over Ofgem's RIIO-2 approach**, as explanatory power increases. This, hence, further validates the need for change:

	Update of GD2 Model with Outturn Data	Model with Improved Method to Weight the Totex CSV, Updated Regional Factors, and Updated Exclusions
Constant	-0.686*	5.504***
Totex CSV	0.866***	0.890***
Time Trend 1	0.003	-0.004
Time Trend 2	0.023	0.031*
Adjusted R-squared	0.904	0.920
No. observations	104	104

*Note: * Indicates significant at the 10% significance level, ** 5% significance level, *** 1% significance level.*

Table 45: Improving Model Robustness with an Improved method to Weight the Totex CSV and proposed cost exclusions and regional and company-specific factors (source: Cadent analysis)

5.2. Adopting a density modelling approach to address limitations of models which exclusively use pre-modelling adjustments

As discussed above, differences in costs caused by GDNs facing different operating environments can be controlled for using pre-modelling adjustments (as detailed in our proposals for regional and company-specific factors), or by the inclusion of relevant drivers within the regression. Ofgem has historically relied on the former. Controlling for the impact of density on cost through pre-modelling adjustments is only possible if all exogenous factors which impact GDNs' costs are identified, accurately quantified, and any interactions between these factors are accounted for. Given the difficulty of achieving this, and because we have presented new evidence above for increased cost adjustments that was not available at GD2, the pre-modelling adjustments applied at GD2 were likely insufficient to capture the full impact of density on GDNs' costs.

A 'within-model' approach allows the model to quantify the relationship between costs and density/sparsity, avoiding the challenges of identifying and quantifying specific factors, assessing their materiality, accounting for their interactions, and creating a robust, objective, and consistent way of controlling for differences between regions. This approach has previously been used by Ofwat through the inclusion of a range of density measures,

[93] Whilst this increase in Adjusted R-squared could be seen by some as modest, the main reason these changes are justifiable is to make the assumptions underlying the CSV model more realistic, compared to the GD2 approach.
[94] For example, applying our regional factors for Labour, Nature of Streets and Network-Specific Factors proportionally to SGN's Southern GDN as part of its network is within the London region

capturing costs driven by population density and network density in different models. We raised the possibility of employing this approach as part of the GD2 CMA appeals process[95]. Whilst the CMA concluded Ofgem's approach to using pre-modelling adjustments was *"appropriate in the circumstances and within the bounds of its margin of discretion*", it noted that "*there is no clearly superior approach*" to doing so – with each of the two approaches (i.e. pre-modelling adjustments and within model approaches) having merits and drawbacks[96]. Therefore, as part of our work to identify improvements to the RIIO-GD2 cost assessment framework, and evidence the efficiency of our networks, we have continued to develop within-model approaches to accounting for differences in density/sparsity in GDNs' operating areas.

To assess whether use of density variables is appropriate we have followed the five-step process that we highlighted in our SSMC response[97], considering a range of density-based variables that might capture exogenous regional cost variation, including:

- Network density, measured as customers per length of mains;
- Weighted average population density, as developed by Ofwat; and
- High density, measuring the proportion of population living in dense areas, also developed by Ofwat[98].

Determining if any pre-modelling adjustments are still required when using density variables

Having identified candidate variables, to test them we first considered whether any of the proposed regional and company-specific factors put forward in section 4, are unlikely to be captured by them. Where this is the case, these pre-modelling adjustments should continue to be made before costs are compared across GDNs, even with the inclusion of a density variable in the regression.

Based on a review of our factor proposals, **it is only the Labour Costs factor which will not be captured by a density variable, and so should continue to be applied**. We have reached this conclusion by assessing the theoretical and statistical relationship between regional labour costs and density, as well as examining regulatory precedent.

The theoretical and statistical relationship between regional wages and density

Differences in both regional wages and the density of the network area a GDN serves impact the efficient level of cost they incur, as illustrated by the long-standing practice of including a regional wage adjustment in Ofgem's econometric benchmarking for gas and electricity distributors, and by the statistical significance of the density cost driver shown in Table 47. If regional wages and density are highly correlated at the GDN level, it is likely that any attempt to disentangle the two effects using regression modelling would not be able to identify the effect of higher wages in London and its surrounding areas and density, which is also very high in London. Similarly, including only one of these variables as a driver (e.g., density in a model without labour adjustments to cost), would lead to omitted variable bias in which the coefficient on the included variable would be materially overstated. In fact, the two effects (density and wages) influence GDNs' costs in different ways, and for different reasons (as evidenced by our analysis in the section 4 above related to Labour Costs and our other factor proposals). As shown in the previous section, GDNs operating in regions with higher wages face higher per unit labour rates, while density has a range of effects including on the costs of property, the extent and complexity of emergency response services, and productivity.

Despite the appearance of some correlation between wages and density at the GDN level, this correlation is spurious and driven by the small cross-sectional sample size in the GDN dataset, as shown by more granular LA level data. As shown in the table and chart below, population density and regional wage rates are only weakly correlated at this more granular level. Moreover, the correlation coefficient between population density and regional wages in GB (using both Ofgem's regional wage index and the index's underlying source data), significantly weakens when the London GDN, that with the highest wage and population density, is excluded. This is wholly intuitive, as wages are higher than the GB average in areas surrounding London, driven by proximity to the London labour market, but these areas do not suffer the higher costs experienced in London due to its density. It is also consistent with our regional and company-specific factor proposals, where Labour Costs are relevant for London and its surrounding areas, but the Nature of Streets and Network-Specific Factors claims are only relevant only to London itself.

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[95] Ofwat (December 2019), PR19 Final Determinations – Securing Cost Efficiency Technical Appendix, P. 14

[96] CMA (28 October 2021), Final Determination Volume 3: Individual Grounds, Para 10.265

[97] Cadent (March 2024), RIII-3 Sector Specific Methodology Consultation – Cadent Response to Ofgem GD Annex, Q 57

[98] For more information see CEPA (2018) "PR19 Econometric Benchmarking Models", P. 123. See here : Microsoft Word - CEPA cost assessment report (clean) (ofwat.gov.uk) Accessed 19/04/2024

Density Variable	Wage Variable	Granularity of Data	Correlation Coefficient (including London)	Correlation Coefficient (excluding London)
Weighted Average Density (WAD) (#)	Labour Index (#)	GDN	0.922	0.685
High Density (HD) (%)	Labour Index (#)	GDN	0.800	0.355
Customers per km of Network Length (#)	Labour Index (#)	GDN	0.900	0.561
People per km^2 of land	Gross Hourly Pay (£)	LA	0.445	0.204

Notes: WAD is calculated as LA density (people per km^2 of land area) weighted by the percentage of the LA that the GDN covers. HD is calculated as WAD including only LAs with a population concentration of over 2,000 people per km^2. People per km^2 is calculated as LA population divided by land area. Labour Index variable is based on Ofgem's regional wage index. We calculate the correlation coefficients for each specification based on historical data from 2014 to 2023.

Table 46: Correlation between Population Density and Regional Wages by Variable and Granularity (source: Cadent analysis)

Figure 26: Relationship between Population Density and Regional Wages (LA Level, excluding London) (source: Cadent analysis of ONS data)

Regulatory precedent and statistical performance of density in a model where pre-modelling adjustments for Labour cost differences are applied

The fact that both regional wages and the density of the network impact GDN costs through different mechanisms has also historically been accepted by Ofgem through their long-standing practice of including a regional wage adjustment and adjusting costs for density-related factors (i.e. current urbanity and sparsity adjustments). It is unsurprising then, that when including density drivers in a model where wage adjustments have been applied, the variables and models statistically perform well (see the following sub-section below).

To capture the impact of both variables on efficient costs, therefore, each should be accounted for by pre-modelling adjustments for labour, combined with either (i) regional/company-specific factors related to density, or (ii) the inclusion of density variable in the regression model(s).

Assessing the statistical robustness of including density variables

Having established which pre-modelling adjustments need to be applied to costs even with the inclusion of a density variable, we have then assessed alternative density variables against a set of 'acceptance criteria' to determine if their use improves model robustness. These criteria build on that developed by Ofgem for considering whether any variable should be included in its model(s). The criteria require that a cost driver:

- makes economic and/or engineering sense;
- is accurately and consistently measurable;
- has a relatively stable relationship with the costs over time and incorporates as much relevant information as possible;

- where possible, is beyond the control of the network company, to avoid distorting company incentives in ways which might be inefficient[99]; and
- any model that includes a density driver should achieve a similar level of statistical performance to a model that relies upon pre-modelling adjustments.

We have also considered concerns raised previously by Ofgem that within-model approaches could result in 'overfitting' of the model. Overfitting in this case would occur if the estimated relationship between costs and density only appears because the London GDN has a higher level of density and a higher level of costs vs. the other networks, with no underlying relationship between costs and density for the industry as a whole. Based on our evidence we find no concerns with overfitting in relation to the use of density variables and the London GDN (see below).

Further, we acknowledge that Ofgem has previously raised concern that the density model presented within the GD2 CMA appeal did not exhibit a 'U-shape' that it expected (i.e. with costs increasing in areas of higher sparsity and higher density). However, **we do not believe that the shape of the relationship between density and costs should be included as part of the acceptance criteria for the use of density models** as:

- having an a priori requirement on the shape of the relationship between density and costs is inappropriate as the relationship between density and cost will vary between areas of expenditure, meaning that it is uncertain what the expected shape would be at the Totex level.
- whilst our regional and company-specific factor proposals above recognise that both density and sparsity drive exogenous cost pressures for GDNs, our evidence shows the impact of sparsity to be much smaller than the impact of density, as it impacts a much smaller element of GDNs' cost base and to a lesser extent. This is also reflected in Ofgem's GD2 pre-modelling adjustments, where sparsity factors are only applied to Emergency and Repair activities, but urbanity factors are applied far more widely; and
- from our review of the academic and regulatory literature on density models, we do not find consensus on the appropriate functional form for a density model. For example, Ofwat found a "U-shaped", quadratic relationship between density and costs at PR19[100]. However, the estimated relationship between costs and density might differ for gas distribution networks, which are – unlike water networks – not universally rolled out in the most rural areas of the country, resulting in a different cost structure. Studies from the German gas and electricity distribution sectors and the Slovenian electricity distribution sector only use linear density models, without changes in the relationship between costs and density at different levels of density[101].

Having applied the criteria above, we find that **network density makes the most intuitive sense to include in the Totex regression model** as it relates specifically to the number of customers which each GDN must serve per km of network length it operates. Other metrics which measure population density, as opposed to customer density, do not account for the differing proportion of the populations connected to GDNs. Our statistical testing also found the models including network density exhibit better statistical performance than the other density measures (most notably, higher explanatory power)[102]. GDNs cannot inflate this measure of network density, so it is an exogenous driver.

The results of including network density in two different Totex models are shown below. Each model includes the Totex CSV, with the first weighted as per Ofgem's GD2 methodology, and the second using our improved method. In each of these models we do not include any additional regional or company-specific pre-modelling adjustments, except for the Labour Costs Factor.

[99] Ofgem (2023) "RIIO-3 Sector Specific Methodology Consultation GD Annex", P. 77. See here: RIIO-3 Sector Specific Methodology Consultation – GD Annex (ofgem.gov.uk) Accessed 19/04/2024.

[100] Ofwat (2019) "Supplementary technical appendix: econometric approach", see here: Equifax (ofwat.gov.uk) Accessed: 14/02/24.

[101] Schweter and Wetzel (2017), "Scale and scope of economies of German electricity and gas distribution networks", ENERGIO Working Paper, Nr. 9, Table 4. ; Filippini, Hrovatin and Zoric (2004), "Efficiency and regulation of the Slovenian electricity distribution companies", Energy Policy 32 (2004), P. 335-344.

[102] We have not included this analysis to limit the page count of this appendix, but we would be happy to provide more details of our regression diagnostic tests if Ofgem would find this useful.

	Update of GD2 Model with Outturn Data	Network Density Model	Model with Improved Method to Weight the Totex CSV	Network Density Model with Improved CSV Weighting Methodology
Constant	-0.686*	-3.068***	5.509***	3.468***
Totex CSV	0.866***	0.895***	0.903***	0.928***
Network Density		0.496***		0.466***
Adjusted R-squared	0.904	0.934	0.914	0.940
RESET	PASS	FAIL	PASS	FAIL
No. observations	104	104	104	104

Note: Time trends as per RIIO-GD2 approach were included in the regression but results not reported for brevity.
** Indicates significant at the 10% significance level, ** 5% significance level, *** 1% significance level.*

Table 47: Density Model Results (source: Cadent analysis)

As shown above the network density cost driver is statistically significant in both models. Further, **both density models yield a higher adjusted R-squared than the updated GD2 model, meaning the models have higher explanatory power**. We include network density as a linear driver only, because we did not find a statistically significant quadratic relationship between Totex and network density. As shown below, the quadratic fitted relationship between Totex and network density is virtually linear over the estimation sample.

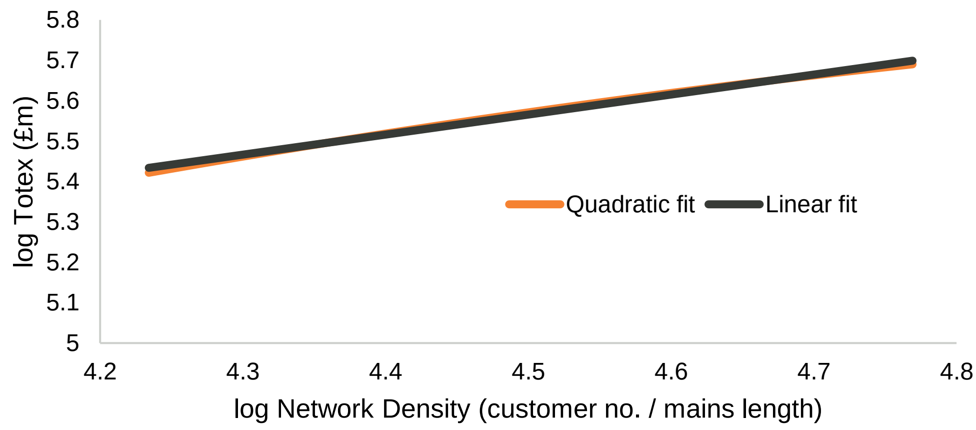

Figure 27: Relationship between Totex and network density in a quadratic model[103] (source: Cadent analysis)

Although some of the density models do not pass the RESET test, we do not dismiss the models based on this, consistent with Ofgem's approach as GD2, in which it stated that the RESET test "is not a critical measure for complex regression models and in context of other statistical measures of model performance is not a reason in its own right to question the robustness of the modelling outcomes from an academic perspective"[104]. The density models pass the other diagnostic tests performed[105].

Based on the statistical performance of the density models tested above, and the economic logic that efficient cost depends on the density of the GDNs' regions, we believe the inclusion of a density measure is an alternative and robust way to account for regional differences between the GDNs and should be used alongside a model with pre-modelling adjustments.

As a final step to verify this, and to check whether overfitting is a relevant concern, we have undertaken three alternative tests:

- Firstly, we have estimated the density models in table 47 with the London GDN excluded from the sample. We find the coefficient on the Network Density variable to be stable at 0.483 (compared to 0.496 when the London GDN is included in the sample). Similarly, with the improved CSV weighting methodology model, the coefficient on density in the model that excludes the London GDN is 0.495,

[103] The fitted lines shown in the chart are based on regressions of Totex on the Totex CSV and network density, evaluated at the sample average Totex CSV.
[104] Ofgem, (February 2021), RIIO-GD2 Final Determination – GD annex, para 3.108
[105] We perform tests for heteroskedasticity and pooling, in line with the tests performed by Ofgem at RIIO-GD2.

compared to 0.466 when the London GDN is included. This indicates that the estimated relationship between cost and density is stable, regardless of the inclusion of the London GDN, and hence suggests overfitting is not a concern for these models.

- Next, we estimated the two density models (with the GD2 method of weighting the CSV and the improved method to weight the CSV) with a dummy variable which is equal to 1 for all London GDN observations, and 0 for all others. In the model with GD2 CSV weighting, we find the coefficient on network density to be stable at 0.483 (compared to 0.496 in the model without the "London dummy"). Similarly, in the model with improved CSV weighting, the coefficient on density when we include a "London dummy" is 0.496 (compared to 0.466 without the "London dummy"). These results suggest the density driver is not simply acting as a "London dummy", and again, suggest overfitting is not a concern for these models.
- Lastly, we assessed whether there is evidence of any potentially influential individual observations, specifically amongst the London GDN observations (as opposed to all London GDN observations, as tested above), which could lead to overfitting. We do so by (i) seeking to identify the presence of these potentially influential observations and (ii) testing the impact of their removal from the sample:
  - We first assessed whether there is evidence that any London GDN observations could be considered potentially influential[106]. The presence of influential observations would mean that, in the absence of those observations, the relationship between cost and density would be materially different (i.e. they collectively have a disproportionate impact on the estimated relationship compared to other observations)[107]. We assessed each London GDN observation individually, identifying any which could be considered potentially influential.
  - Following this, we removed the identified potentially influential observations from the sample[108] and re-estimated the Totex models (i.e. with different approaches to weighting the CSV). We find that under both CSV compositions the coefficient on density remains statistically significant, and the value of the coefficient remains broadly stable (remaining unchanged to two decimal places in the model with the improved CSV weighting, for example). Again, this suggests overfitting is not a concern.

Therefore, we conclude that **the London GDN's observations do not have a disproportionately large impact on the estimated relationship between cost and density and they do not lead to overfitting**.

5.3. Establishing the efficiency of our costs

To benchmark the efficiency of our cost base, we have relied on two Totex models which apply the modelling approaches discussed above. Both of these models have all our proposed cost exclusions applied and use our improved method of weighting the CSV. However, they differ in their approach to capturing exogenous impacts on costs resulting from GDNs operating in different environments as follows:

- The first model applies pre-modelling adjustments in line with our regional and company-specific factor proposals set out in the previous section above (Model 1); and
- The second model applies the Labour Cost factor and uses a network density driver (Model 2).

Ofgem should also consider these model specifications in the development of the RIIO-GD3 cost assessment approach, given their improved econometric performance compared to the RIIO-GD2 Totex regression model.

The results of estimating these models over the RIIO-GD1 and RIIO-GD2 periods (using actual data where possible, and forecast data for the last two years of RIIO-GD2) show that both models perform significantly better in terms of explanatory power than the updated RIIO-GD2 model, as shown in the table below.

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[106] To test for potentially influential observations we use the Standardised DFBETA test (Ramzi W. Nahhas (13 October 2024), Introduction for Regression Methods for Public Health Using R, Section 5.22). This test estimates the regression with and without each London GDN observation and standardises the difference in coefficients by the standard error of the full-sample model. We compare the standardised DFBETA values to a cutoff of 0.2 (Harrel 2015, P.504). An observation with an absolute DFBETA value below this cut off is considered not to be a potentially influential observation.

[107] It is important to note that finding the presence of potentially influential observations in the sample per se, does not indicate overfitting by itself. The presence of potentially influential observations indicates that particular observations have a larger effect on the relationship in question than others in the sample. Overfitting, by contrast, requires a relationship to not be present in the underlying data when an observation, or set of observations, is excluded from the sample.

[108] We removed 3/13 observations in the model utilising Ofgem's CSV weighting and 4/14 for our improved CSV weighting approach

	Update of GD2 Model with Outturn Data	Model 1: Improved Method to Weight the Totex CSV, Updated Regional Factors, and Updated Exclusions	Model 2: Improved Method to Weight the Totex CSV, Updated Exclusions, and Network Density Cost Driver
Constant	-0.686*	5.504***	3.416***
Totex CSV	0.866***	0.890***	0.917***
Network Density			0.477***
Time Trend 1	0.003	-0.004	-0.004
Time Trend 2	0.023	0.031*	0.031*
Adjusted R-squared	0.904	0.920	0.939
No. observations	104	104	104
*Note: * Indicates significant at the 10% significance level, ** 5% significance level, *** 1% significance level.*			

Table 48: Combination of Model Improvements – Pre-Modelling Adjustments Approach and Within Model Approach to Accounting for Density (source: Cadent analysis)

Using these models to assess GDNs' efficiency over the RIIO-GD2 period, our GDNs rank 2nd, 3rd, 6th, and 7th in Model 1, which utilises pre-modelling adjustments, and 1st, 3rd, 4th, and 6th in Model 2 which utilises a network density driver. However, to establish the efficiency of Cadent's cost base, we have aggregated results and benchmarked ourselves against other gas distribution ownership groups. Whilst we have utilised the comparative regression analysis at the network-level (above) to inform this, as we own multiple networks, we consider the most appropriate comparison is relative to other ownership groups. We have therefore compared our group-level efficiency position relative to SGN and CKI (who are the common owners of both NGN and Wales and the West Utilities). As shown below we rank 2nd and 1st respectively under each of the two models, and when averaged, **Cadent are the most efficient ownership group**[109].

	Model with Improved Method to Weight the Totex CSV, Updated Regional Factors, and Updated Exclusions		Model with Improved Method to Weight the Totex CSV, Updated Exclusions, and Network Density Cost Driver		Average	
	Efficiency Score	**Rank**	**Efficiency Score**	**Rank**	**Efficiency score**	**Rank**
Cadent	0.99	2	0.97	1	0.98	1
CKI	0.97	1	1.01	3	0.99	2
SGN	1.00	3	1.01	2	1.00	3

Table 49: Group Level Efficiency Scores for RIIO-2 Efficiency Performance (source: Cadent analysis)

To develop our RIIO-3 cost forecasts, we have estimated the cost of undertaking the workload, which we plan to complete in the upcoming period, based on the assumption that we will continue to operate as we have been over the RIIO-2 period. As a result, based on the finding that we are operating efficiently in RIIO-GD2, this implies our cost forecasts moving into RIIO-GD3 are also efficient.

5.4. Cross-checking our regional and company-specific factors

As well as evidencing the efficiency of our costs, we have also used out updated modelling suite to assess the conservativeness of our regional and company-specific factor claims set out above in section 4 above.

Given that some of our GDNs, and in particular the North London GDN, obtain a higher efficiency score in the model which uses a density driver to account for regional and company-specific factors, our pre-modelling proposals for regional and company-specific factors are likely to be conservative. The improvement in ranking for the London GDN in the model with a density driver likely arises due to the difficulty in quantifying all factors which influence how GDNs' efficient costs rise in dense, urban environments, and the interactions between those factors, solely via pre-modelling adjustments.

[109] We have grouped the Scotland and Southern networks as SGN owns both these networks, and the Wales and West Utilities and Northern Gas Networks as CKI, as CKI owns both of these networks.

To confirm this, we have also combined the inclusion of a network density driver (i.e. Model 2 above in section 5.3, table 48) with all of our proposed regional and company-specific factor pre-modelling adjustments (i.e. Model 1 above in section 5.3, table 48) into a single model. The results of this 'cross-check model' are shown below, with the coefficient on the network density driver now being smaller than in the results above but remaining statistically significant. This shows that the updated regional factors capture some of the impact of operating in a dense operating environment on incurred cost (as the coefficient on density gets smaller), but not all (as the coefficient on density is still statistically significant). As a result this **provides clear evidence that our pre-modelling factor claims are conservative** as there are potentially other unaccounted factors driven by cost differences due to density that we have not quantified in our proposed pre-modelling adjustments.

	Model with Improved Method to Weight the Totex CSV, Updated Regional Factors, and Updated Exclusions and a Network Density Driver
Constant	4.346***
Totex CSV	0.907***
Network Density	0.262***
Time Trend 1	-0.004
Time Trend 2	0.031*
Adjusted R-squared	0.935
No. observations	104

*Note: * Indicates significant at the 10% significance level, ** 5% significance level, *** 1% significance level.*

Table 50: Regression Results of Regional Factor Cross-Check (source: Cadent analysis)

5.5. How we have delivered the efficient benchmark in RIIO-2

As noted within our main RIIO-3 business plan document[110], for RIIO-2 we set an ambitious plan for the period, embedding £500m of efficiency savings (in 2018/19 prices, c.£620m in 2023/24 prices) which then had a further stretch applied by Ofgem of £450m (23/24 prices) on top of this (following the CMA appeals process).

In RIIO-GD2, we have been operating in a very different environment than that experienced and envisaged when developing our business plan, with a myriad of cost pressures leading us now to forecast an overspend of £420m over the period. However, our benchmarking above shows that, in spite of these pressures and the overspend we forecast, we are delivering most efficiently in the face of this challenging economic environment.

To deliver the efficient benchmark of costs within RIIO-2 we have transformed our business, changing the ways we work and improving output delivery for our customers. Specifically, we have:

- finalised our organisational transformation to a depot-centric operating model, which was a key feature of our RIIO-2 plan. Our previous centralised structure was found to have led to diseconomies of scale in the business through a more complex operational and decision-making structure. Across each network, we now have Investment Planning Offices (IPOs) that have full visibility and control over investment programmes and their delivery approach. We also have implemented a new 'Customer Operations Area' structure within each network, aligning our teams to the different customers they serve and providing them with full accountability for all customer outcomes and delivery of investment processes. These changes have driven down costs and brought day-to-day decision making closer to our customers and their needs, improving the value they derive from our service (as shown in the step change in our Main Business Plan[111]).
- transformed our delivery model for replacement works. Previously, we utilised large strategic partners to deliver key elements of our investment programme such as mains replacement. Whilst these delivered benefits from operating at scale, we found they did not deliver the customer service standards we require. From the start of RIIO-2 we have driven cost efficiency and enhanced customer service by encouraging greater competition at a local level. We now utilise a model whereby we have Contract Management Organisations in each of our networks who competitively procure packages of replacement works from a wide range of independent smaller LDPs.
- leveraged our capabilities and use of cross-network benchmarking and sharing of best practice. We now have a centralised Commercial team within the business whose objectives are to produce and optimise the use of up-to-date MI about output, quality and cost performance which we use to drive improvements across and within our networks at a granular 'patch' level. This also allows us to understand where there

[110] System Efficiency and Long-term value for money, pages 67-68
[111] Figure 8, page 19

are drivers of variances that are beyond our control (i.e. regional factors). We use all of this to foster healthy competitive tension across our networks, and also across our suppliers.
- adopted new and innovative technologies. As set out in our RIIO-2 business plan, we want to create a culture of continuous improvement through entrepreneurship. To deliver this, and ensure we are innovating to better serve the diverse needs of our customer groups, we devolved our innovation team, similar to our operational model – aligning staff to each network. This has proven to be a success, with localised solutions being developed to tackle the most pressing issues, which can then be rolled out if successful and delivering benefit. An example of this has been innovation we have developed to reduce interruptions to our MOBs customers, allowing us to keep supplies running while we undertake repair activities by utilising Nu Flow pipe lining technology.

Despite the challenging economic environment, we have proactively taken measures to mitigate cost pressures. A notable example of our efforts has been our new internal ‘Fit for the Future’ programme where we have continued to refine and optimise our new organisational structure and further leverage native competition across our networks through improved data and analytics. This, and other initiatives, has enabled us to drive the efficiency benchmark.

6. Frontier shift

Our analysis above establishes the efficiency of our costs, based on information available today. This underpins our forecasts. However, in the future, as a result of either further productivity (i.e. Ongoing Efficiency (OE)) improvements or changes in input prices above or below the level of indexation provided by Consumer Prices Index including owner occupiers' housing costs (CPIH) (i.e. RPEs), it is likely the actual costs we incur in the RIIO-3 period will differ from those forecast in our BPDTs. This section sets out our views on what we believe is an achievable level of OE improvement for gas distribution in the RIIO-3 period and how this will be delivered within the upcoming period as well as how the RPE framework should evolve to ensure we are remunerated accurately, taking into account of variations in input prices not captured via indexation.

6.1. Ongoing Efficiency

OE improvement represents the delivery of a set of outputs for a reduced level of inputs over time, or, for a fixed level of input, the delivery of a greater set of outputs. These are gains that even the most efficient GDN should be able to achieve. Taking account of the outcome of CMA appeals, the RIIO-2 price control set a stretching 1% per annum OE challenge for all GDNs, predominantly based on benchmarking of productivity improvements from comparator industries. At the time, this figure was largely determined based on data from before the financial crisis, despite the long period of very low (near-zero) productivity growth within the UK economy observed since 2008 (often referred to as the ‘productivity puzzle’), which was already visible at the time the control was set. Ofgem and its advisors justified reliance on pre-crisis data by suggesting potential for productivity growth to return its higher, pre-crisis levels[112]. However, new data published since the RIIO-GD2 decision shows this has not been the case, with productivity remaining stagnant. Figure 28 below shows that RIIO-GD2, like other regulatory decisions on OE in recent years, are significantly detached from the real productivity growth achieved in the UK economy as a whole (see below).

[112] EI (2024) “Further Evidence on OE for Gas Networks at RIO-3 – Supplementary report”, P. 7

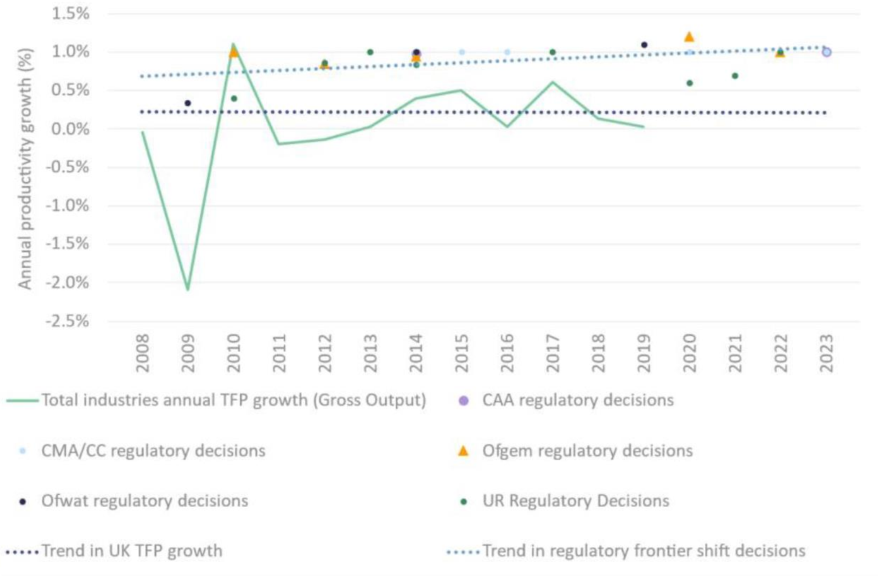

Figure 28: Annual UK productivity growth post 2008 and Network Regulation OE Targets (source: EI (2024) "Ongoing efficiency for gas networks at RIIO-3", P.8)

As shown, the productivity growth since 2008 has continued to be positive but very low, and clearly below 0.5% per annum. In contrast, however, sector regulators have increased OE targets over the same period, typically to around 1%. This practice implies utilities should be able to outperform the UK economy's productivity growth. In fact, as the chart shows, the assumption of 'productivity reversion' has not materialised. It is therefore unsurprising that the outlook for GDN cost performance for RIIO-2 is completely different to that at RIIO-1, with all ownership groups expecting to overspend allowances, despite additional expected re-opener allowances.

RIIO Totex performance	Cadent	CKI	SGN
% Out(under)performance – RIIO-GD1	5%	18%	16%
% Out(under)performance – RIIO-GD2 (2023/24 RRP forecasts)	-6%	-1%	-6%

Table 51: GD Ownership Group Actual and expected allowance performance[113,114] (source: Cadent analysis, Ofgem, GDNs)

Whilst it is difficult to attribute all Totex underperformance to exaggerated OE targets, as it is intrinsically very difficult to separate OE from catch-up gains and GDNs may under or outperform price controls for a variety of reasons, we believe this shows that the RIIO-GD2 price control was too stretching.

These observations together call into serious doubt the underpinning assumptions used to set previous OE challenges. Therefore, new analysis for RIIO-3 is needed, firmly rooted in up-to-date economic data.

6.1.1. Identifying the range of Ongoing Efficiency potential for RIIO-3

To identify the range of potential OE for RIIO-3, with other gas networks, we have commissioned EI to undertake an independent, principles-based benchmarking analysis (presented in two reports, May 2024 and October 2024 – collectively referred to here as the 'EI Reports' hereafter and included as Annexes to this appendix – Annex 3a and Annex 3b specifically).

To benchmark the potential for OE, the approach taken in the EI Reports is to assess productivity growth for comparator sectors over varying, historical time periods. These sectors are chosen to mimic the characteristics of gas networks, with the time period chosen so it is relevant to the RIIO-3 period. The next sections summarise and justify the methodological decisions made when developing the analysis, followed by its results, which we have used to anchor our proposed level of OE for the RIIO-3 period.

113 Data sourced from Ofgem (2022) "Regulatory Financial Annex to RIIO-1 Annual Reports 2020-21", see here: Regulatory Financial Performance annex to RIIO-1 Annual Reports 2020-21 | Ofgem and consolidated Network Company Strategic Performance Overview Documents of RRP 2023/24

114 Note underperformance for non-Cadent networks in reality is larger than shown in the table as RIIO-GD2 CMA remedies were not applied to non-Cadent networks (which would have lowered non-Cadent networks' allowances) and so are not reported against

Choice of productivity measure

OE is an economic concept that is not directly observable from economic data. However, it is typically estimated using changes in Total Factor Productivity growth (TFP) as a proxy. TFP is a residual and measures the change in economic output not explained through changes in factor inputs (e.g., capital, labour, other).

At RIIO-ED2 Ofgem chose to use a TFP-based measure of productivity to benchmark OE for Totex and at RIIO-GD2 for Capex and Repex. However, for GD2 Ofgem placed a degree of weight on a specific measure of labour productivity for Opex. Having reviewed this, the EI Reports set out that use of a single TFP based assumption is more appropriate for RIIO-3 for all spend areas. In particular, as conceptually, when measuring TFP from a set of comparators, this is calculated on a Totex basis and so, should be applied on a Totex basis. Furthermore, each comparator benchmarked would have chosen their mix of labour and other inputs optimally to deliver their output(s). As such, utilising a general TFP measure for some elements of the expenditure base and a more specific measure for others is inconsistent with the underlying comparator-based benchmarking approach used. In addition, the use of a specific, labour-based productivity measure assumes that Opex incurred by GDNs relates to 100% labour expenditure. Analysis set out in the EI Reports shows this is simply not the case[115].

There are two approaches that could be used to estimate TFP: (i) Value-Added (VA), and (ii) Gross Output (GO) based calculations. These differ in their treatment of intermediate inputs – VA excludes them, GO explicitly takes them into account. EI concludes that GO is preferable as:

- the academic literature on productivity measurement explains “there are theoretical grounds for preferring the gross output approach, particularly at the industry level”
- removal of intermediate inputs using VA causes biased estimates of TFP – with EI finding that “the data is consistent with VA being systematically upwards biased” when used to estimate TFP; and
- this bias for VA-based TFP estimates is likely to be pronounced for “industries with a material utilisation of intermediate inputs”. Based on data from gas networks, EI concludes that intermediate inputs are likely to be important to GDNs, as they make up a significant portion of our controllable opex[116].

At the RIIO-GD2 Final Determination, Ofgem stated that it placed some weight on GO methods, following nine Draft Determination responses in favour of GO methods.

Dataset utilised

In all past RIIO controls, Ofgem has utilised productivity data from EU KLEMS. This has also been used by Ofwat and the CMA as part of setting and redetermining the PR19 price control. Given the widespread use of the dataset, it has also been used by EI. However, unlike at past controls, EI has now been able to use the recently updated ‘NACE II’ version of the dataset (released in February 2023, covering three additional years of data up until 2019), alongside the longer running ‘NACE I’ version. This is important because, as Ofgem’s former advisor CEPA set out in its report for Ofgem at RIIO-ED2, the benchmarking “should account for the most recently available evidence on UK productivity growth”[117].

Approach to comparator selection

Gas networks are not specifically identified in EU KLEMS, so EI selected comparators to estimate benchmark levels of TFP, in line with regulatory precedent. To determine the comparator set, EI used the following criteria:

- Similarity of activities undertaken – activities undertaken by comparators must be similar to gas networks so processes and technology are similar and resulting productivity estimates are relevant;
- Competitiveness of the industry –TFP can capture efficiencies achieved through ‘catch-up efficiency’ and OE. However, TFP in competitive industries will be less polluted by catch-up efficiencies, as the process of competition tends to incentivise efficiency and force inefficient operators out of the market.
- Extent of scale effects – TFP can also include productivity gains achieved through increasing economies of scale. Therefore, so that estimated TFP is reflective of the scope for energy networks to improve productivity, comparators should be chosen so they have the same potential for changes in scale economies as gas networks.

These criteria broadly align with the criteria deployed by CEPA for Ofgem at RIIO-GD2 in determining the comparator industries for the “targeted comparator set” approach.

115 EI Report, May 2024, P. 14-15

116 IBID, P. 17, 19, 21

117 CEPA (2022) “RIIO-ED2: Cost Assessment – Frontier Shift methodology paper”, P.11.

Following application of this criteria EI benchmarked productivity across the following comparators industries: manufacturing; chemicals; basic pharmaceutical products; manufacture of rubber and plastic products and other non-metallic mineral products; computer, electronic, optical products; electrical equipment; manufacture of machinery and equipment n.e.c.; manufacture of motor vehicles, trailers, semi-trailers and other transport equipment; manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment; construction; wholesale and retail trade; repair of motor vehicles and motorcycles; and transportation and storage[118].

Recognising there may subjectivity in these choices, EI also include 'All Industries' as a comparators so economy average productivity is reflected in the analysis. This also mitigates the risk that annual TFP rates from particular sectors are highly variable over time, which could distort results over certain periods. Further supporting information on comparator selection is set out in the EI Report (May 2024) section 2.

Time period of analysis

EI considered four factors to select the time period to benchmark TFP growth over in comparator industries:

- Consistency with the wider framework – productivity is correlated with other key elements of the price control (e.g., equity returns) necessitating a consistent period for any historical benchmarking so that parameters set do not overly punish or reward companies.
- Maximisation of data – utilising the most data available to reduce the impact of outliers.
- Capturing full 'Business Cycles' – productivity is pro-cyclical so the period assessed must include a full Business Cycle to capture an average level of productivity potential over a regulatory period.
- Structural breaks – structural breaks, resulting from fundamental changes in the pattern of economic activity and economic relationships, may cause a step change in the level of TFP, necessitating use of data only since any such structural breaks have occurred to avoid distorting results.

Of these factors we believe the one of most concern is the latter. Given the need to forecast the potential for OE in the RIIO-3 period, it is essential that any historical comparison is based on data with the same underlying relationships in the economy that will also apply in the future. This is best achieved by using current or recent data. As shown in Figure 29, there has clearly been a structural break in productivity since the financial crisis, meaning productivity gains achieved by all firms in the UK economy today are much lower than before 2008.

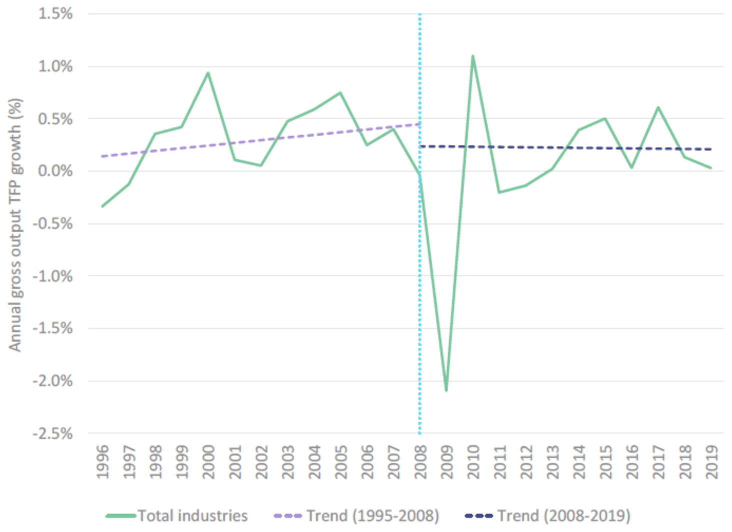

Figure 29: Average UK TFP growth pre and post financial crisis (source: EI (2024) "Ongoing Efficiency for Gas Networks At RIIO-3", P. 37)

At RIIO-GD2, Ofgem and its advisors placed significant weight on the pre-crisis period, suggesting there was potential for productivity growth post-2008 to revert. The chart above shows this has simply not occurred in the 16 years since the 2008 crisis. Whilst there is always some uncertainty about whether this will change, EI states "the latest available data and forecasts do not provide any strong basis to suppose that productivity growth will materially or rapidly improve in the short term"[119]. Its conclusion is based on:

[118] EI Report, May 2024, P. 33
[119] EI Report, October 2024, P.7

- The latest published forecasts from a number of organisations, such as HM Treasury, showing productivity expectations remain poor despite more optimistic economic growth forecasts in recent months; and
- The results of a separate, independent and recently published academic paper – "The UK productivity Puzzle: A survey of Literature and Expert Views"[120]. This surveys 26 of the UK's leading experts on productivity analysis and suggests the majority do not expect material changes in UK productivity performance over the next five year. Indeed, the majority of those providing views expect growth of 0-0.1% or lower over the next twelve months and below 0.5% over the next five to ten years[121].

Therefore, it would exaggerate the current potential for OE to assume a significant reversion in productivity to pre-crisis levels is likely. As a consequence, more weight must be placed on the post-2008 period in setting OE targets. Furthermore, the release since RIIO-2 of the NACE II data provides historical evidence up to 2019, so recent data for a full post-crisis business cycle can be used. EI has chosen to assess productivity for comparators over two periods to provide a view of OE potential for RIIO-3:

- 2010-2019 (using partial NACE II dataset only) – chosen to recognise the most recent evidence from a full business cycle since the financial crisis.
- Weighted average (by no. years) of 1995-2019 (full NACE II dataset) and 1970-2007 (full NACE I dataset) – chosen to look at data over the full time period available from EU KLEMS, and implicitly allowing for a relaxation of the assumption that there is no reversion to previous productivity trends.

Results of benchmarking analysis

Based on the chosen TFP measure, comparators and two time periods, EI estimate a potential range of OE from **0.2%-0.8% per annum**. Alongside this EI has also 're-run' Ofgem/CEPA's analysis from RIIO-GD2 with the more up-to-date NACE II dataset. **Using the same comparators, productivity measure and updating the time period so this includes more recent years than those used by Ofgem/CEPA at RIIO-2, EI finds an upper bound estimate of 0.5% PA**, significantly lower compared to that at RIIO-GD2[122].

6.1.2. Other factors considered in determining our Ongoing Efficiency assumptions

Building on the EI Reports, we have also considered a range of other factors to determine an ambitious, but achievable, level of OE with reference to the benchmarked comparator range.

Whether gas networks are insulated from lower TFP growth potential due to the UK Productivity Puzzle

Regulators have previously suggested that regulated companies may be insulated from reductions in productivity in the wider economy (i.e. the productivity puzzle), as part of the justification for setting the OE target at the upper end of the benchmarked range. For example, Ofwat during PR19 appeals highlighted the insulation from demand reductions and reductions of investment. At RIIO-2, Ofgem also cited innovation funding as a factor insulating regulated companies from the productivity slowdown. In addition, the CMA argued during the PR19 and RIIO-2 appeals that the certainty of the regulatory regime may also insulate companies from the productivity slowdown. However, there has been no systematic and evidenced-based work to support these arguments. EI has sought to develop this, by reviewing the causes of the productivity slowdown to understand whether regulation mitigates their impact on network utilities. EI finds that the academic literature, and the independent survey of productivity experts (cited above), identifies the most pertinent factors causing the slowdown as:

- lack of public and private investment;
- lack of infrastructure quality; and
- quality of human capital stock (i.e. level of skilled workforce); and
- management quality.

It has been argued that the certainty of economically regulated sectors may mitigate the challenges associated with underinvestment in the regulated industries. However, this assumes returns are set at the correct level to incentivise capital inflow – or put another way, that controls are not set 'too tight'. To test this hypothesis EI examined aggregate UK investment levels, and specific energy sector investment levels compared to comparable economies[123]. This work shows clearly that the "UK economy has a longstanding underinvestment

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[120] Williams et al., (2024) "*The UK productivity Puzzle: A survey of Literature and Expert Views" – see here:* Full article: The UK Productivity Puzzle: A Survey of the Literature and Expert Views (tandfonline.com)

[121] Williams et al., (2024), quoted in EI Report (May 2024), P. 40

[122] EI Report, May 2024, P.5,101

[123] These include the G7 economies and Switzerland

problem" as it has and still is investing a much lower proportion of its GDP than other economies, which reduces the scope for productivity gains[124]. The pattern is also common when only considering energy sector investment. Both UK investment growth and energy sector investment growth have consistently dropped since the financial crisis, from an average of 3.7% and 7.8% per annum between 1998-2007 for the economy and energy sector respectively, to a much lower 2.3% and 1.2% per annum between 2010-2022[125]. This indicates that the lack of investment in the UK also affects the UK energy sector and, as a result, regulation does not provide the insulation as previously argued.

Regarding the quality of infrastructure, EI's review of the literature indicates that the quality of the UK's infrastructure is comparatively poor to other countries. Furthermore, as the quality of infrastructure is a key input to any company's, activities there is no reason to presuppose that the regulatory regime applied to gas networks would mitigate its impact. A similar conclusion is also reached in respect of human capital and management quality as the quality of labour and knowledge is all drawing from the same UK labour market.

Hence, there is no clear evidence that regulation protects companies from the impacts of the productivity slowdown, so we see no reason this argument justifies OE targets towards the upper part of the benchmarked range. This is also in line with other findings from the EI reports that: (i) the majority of independent productivity experts surveyed (in the aforementioned academic paper) expect the energy sector to see the same or lower productivity growth than the wider UK economy in future, and (ii) analysis from the Productivity Institute which shows "TFP growth of gas networks has reflected the structural break in productivity growth exhibited by the wider UK economy"[126].

Whether gas networks have higher or lower potential for productivity growth compared to other regulated sectors

Gas networks may face unique challenges in attracting future investment relative to other regulated sectors (e.g., water and electricity) moving forward. There is significant uncertainty regarding the future of gas networks. Whilst hydrogen will play a material role in the energy transition, under all credible scenarios, the gas networks will likely see declining future demand. Declining demand means productivity improvements can be difficult to achieve, as investments to improve efficiency may require a faster 'payback' than previously.

Whilst EI does not assess how the potential for productivity growth differs across gas vs. water and electricity, it is likely that gas networks have less scope for OE improvements.

Unlike gas networks, electricity networks are set to see large programmes of investment over the coming control periods to meet increased demand for network capacity. The same is also true to some extent in water, given the large investment programmes put forward at PR24, and recent government policy decisions to introduce more stringent drought resilience targets[127]. Hence, in addition to having longer payback periods for investments that improve OE and a faster pace of technological change, these investments that expand networks may help to achieve greater economies of scale, unlike the gas networks which are set to serve diminishing demand. Hence, when considering the range of benchmark evidence, these factors suggest the potential for OE could be lower for gas networks in RIIO-3 than in other regulated sectors.

Whether there are overlaps with TFP estimates and other features of the RIIO framework

We also considered overlaps between TFP benchmarking and the RIIO framework. These together suggest the true potential for OE is likely to lie below the top of the benchmarked EI range. Factors considered include:

- Catch-up efficiency – Productivity estimated via TFP trends in competitive industries will – as noted above – primarily reflect OE but may also include elements of catch-up. No industry is 'perfectly competitive', so the estimated benchmark range from EI is likely to have an element of 'catch-up efficiency' included, as well as OE. This means the true level of OE potential will be lower than the upper end of their benchmarked range.
- Outputs – OE can be driven through delivery of greater output quantity or quality for the same costs, rather than just through cost reductions. As such, where outputs become more stretching, the benchmarked TFP range will overstate the potential for OE to reduce Totex. Many of the outputs for the RIIO-GD3 price control (as with other price controls), will be re-baselined making commitments for the

[124] EI Report, October 2024, P.9
[125] EI Report, October 2024, P.9-14
[126] EI Report, May 2024, P.41, EI Report, October 2024, P.4
[127] UK Government, 14 April 2023, Water Resource Planning Guidelines

new control more stretching than the last. As a result, this would suggest that the OE challenge applied to costs should likely be somewhat lower than the upper end of the benchmarked range.

- Indexation – Price levels, as captured in measures of inflation, are in part driven by productivity changes, i.e. efficiency improvements can lower prices. This raises the potential for double counting efficiency gains that could be achieved by companies, as some OE is embedded in CPIH. Whilst we are unable to provide evidence on the extent of this overlap, the presence of this potential for double-counting also suggests that the true level of ongoing efficiency challenge may be below the upper end of the benchmarked range.
- Past innovation and efficiency gains in previous periods – Over RIIO-GD2, we delivered significant efficiency savings in line with our business plan through organisational transformation and 'BAU' innovation (i.e. that funded through Totex allowances). Where we have driven these savings within RIIO-GD2 and they have enduring impact, we have built these into our baseline Totex plan set out in BPDTs (i.e. exclusive of additional OE challenge) for the RIIO-GD3 price control. As such, there is no need to take account of the benefits of these innovations relative to the external benchmarked range of future OE potential.
- Past innovation funded through stimulus programmes – our innovation activities have been partly funded via the SIF, Network Innovation Allowance (NIA), and before it the Network Innovation Competition. Following our appeal of the RIIO-GD2 price control, the CMA found it was an error to uplift the benchmarked estimate of OE to account for the benefits of past innovation funding[128]. A key reason for coming to this decision was the fact that the vast majority of stimulus innovation funding at RIIO-GD1 was not directly targeted towards the ability to immediately reduce costs[129], but rather focused on longer-term environmental objectives. Moving into RIIO-3 the CMA's conclusion still holds, as none of the stimulus funds available to GDNs within RIIO-GD2 (and GD3) are targeted at reducing costs. The purpose of SIF is to fund projects that "support network innovation that contributes to the achievement of Net Zero" and the purpose of NIA is to fund "innovation relating to support for consumers in vulnerable situations and/or the energy system transition"[130]. Therefore, there is no need to account for the impact of innovation stimulus via adjustments to the benchmarked range, as supplementary analysis in the EI Report confirms.

Whether other economic factors impact the estimate range of TFP growth

EI also assessed the extent to which other economic factors need to be accounted for in the benchmarked OE range via 'ex-post adjustments'. The factors EI considered included:

- Embodied technical change – productivity gains brought about from use of new technology and assets;
- Disembodied technical change – productivity gains from the use of existing technology and assets; and
- Economies of scale.

Whilst it is clear in the academic literature that disembodied technical change is captured through TFP estimation exercises, there is a theoretical possibility that embodied technical change and gains from economies of scale may affect TFP estimates, making adjustments to the benchmarked range appropriate. However, EI's analysis shows that, due to comparator selection, the size and required direction of any adjustment is uncertain. Hence, EI recommends no adjustments to the benchmark range to account for these factors[131].

6.1.3. Our Ongoing Efficiency ambition for RIIO-3

Based on the analysis above and cost pressures we forecast for RIIO-3, **it is reasonable to set a target for ongoing efficiency for the GDNs at RIIO-3 towards the middle or lower end of EI's benchmark range**. None of the theoretical arguments surveyed above would justify a figure towards the upper end of the range, while some – in particular the overlaps with other elements of the RIIO framework and the unique challenges facing gas networks relative to other sectors – would justify a figure at the lower end. It would also be manifestly wrong and inconsistent with the underlying evidence to assume gas networks can consistently outperform UK productivity growth, as previous regulatory decisions have implied. Therefore, we believe the lower end of EI's range of 0.2-0.5% per annum represents a reasonable level of OE potential for gas networks at RIIO-3. This aligns with the result from EI's update of Ofgem/CEPAs RIIO-GD2 approach, and reflects surveyed experts'

128 CMA (2021) "Cadent Gas Limited, National Grid Electricity Transmission plc, National Grid Gas plc, Northern Gas Networks Limited, Scottish Hydro Electric Transmission plc, Southern Gas Networks plc and Scotland Gas Networks plc, SP Transmission plc, Wales & West Utilities Limited vs the Gas and Electricity Markets Authority – Final determination Volume 2B: Joined Grounds B, C and D", P. 273

129 NERA (2021), "Expert Report on Ofgem's Approach to Cost Assessment at RIIO-GD2"; P. 151-155

130 Ofgem (2020) "RIIO-2 Final Determinations – Core Document"; P. 99, 105

131 EI Report, May 2024, P.63-68

expectations for productivity growth. Only a very selective reading of the available economic evidence could justify a higher OE target for RIIO-3, e.g., at a level similar to the RIIO-2 OE target. However, reflecting our ambition to build on the significant reductions in costs within our business over RIIO-GD2, **our plan proposes an ambitious 0.5% PA ongoing efficiency assumption – which equates to almost £200m of reductions over the RIIO-3 period**. Consistent with Ofgem's guidance data, contained within our BPDTs is represented exclusive of the application of this assumption (i.e. 'pre OE'). Furthermore, consistent with EI's approach of deriving this figure from TFP trends, we propose that this is applied equally across our cost base[132].

6.1.4. How we will deliver our Ongoing Efficiency ambition within RIIO-3

To deliver our ongoing efficiency ambition of an additional £200m of cost reductions, we need to leverage new technology to deliver a more proactive approach to asset interventions to reduce unplanned emergency and repair work volumes.

We have laid the groundwork for this within the RIIO-2 period, by exploring use of new technology and ideas from outside the sector and across the world, to understand how our ambitions could be achieved. We have built partnerships with high-performing utilities and global tech-providers in the gas sectors, to share best practice and leverage learnings from other markets which we are then able to apply in the UK. We have shared our research through our two global technology events and showcased the new technologies we have brought into the UK such as: (i) Italgas's approach to advanced leakage detection as well as (ii) robotic technology such as CISBOT from the United States. These innovations have been generated through 'BAU innovation', rather than Ofgem's innovation stimulus programmes (discussed above).

Our broader programme of work to continue to transform our business by leveraging new technologies to both drive cost efficiency and better customer outcomes is called "Ops 4.0". Ops 4.0 contains five key groups of projects we will undertake throughout the RIIO-3 period:

- **The Smart Network –** initiatives to leverage data and technology to allow us to undertake proactive intervention and continuous refinement of our networks to reduce costs and deliver wider benefits.
- **The Connected Workplace –** we will be seeking to leverage technology (e.g., drones, wearable technology) and enhanced data collection and usage to improve business productivity.
- **The Performance Hub –** further leveraging data to allow for cross-network and geographically granular outcomes and performance management and provision of greater information for customers.
- **The Green Operation –** we are currently exploring and investing to further reduce our carbon footprint and become a greener, more sustainable business. For example, through supporting greater green gas injection into out networks, the deployment of zero-carbon construction sites and further efforts to support greater shrinkage reduction.
- **The Open Organisation –** championing a flexible and innovative employment proposition for our workforce, alongside our leading-edge training and support programme, to attract and retain people from a range of different backgrounds and experiences.

Further detail on Ops 4.0 and how the programme will drive efficiency and value for money for customers is contained within Appendix 8[133]

6.2. Real price effects

We remain supportive of the use of RPEs in setting regulatory cost allowances. We support the approach taken in RIIO-2, and our proposals outlined in this appendix aim to improve the accuracy in charge settings and more accurately match networks costs through refinements to the indices chosen and categories of spend. Our recommendations for actual and forecast indices are summarised in table 59 (see section 6.2.3).

[132] The application of our chosen Ongoing efficiency assumption in BPDTs (BPDT S1.02 specifically) has been assured by EI (in line with the other quantitative outputs of our cost assessment work)
[133] Innovation Strategy, sections 8.2 & 8.3, page 30-36

KPMG were commissioned, on behalf of the ENA, to review the current RPE framework and to raise recommendations to improve the current position. The executive summary of the KPMG "RPE framework at RIIO-3" paper is included in annex 3d. All references to KPMG in this section refer to this report.

6.2.1. Challenges with the current RPE approach applied in RIIO-2

Cost pressures over and above CPIH inflation experienced in RIIO-2 impacted more than just labour and materials

In RIIO-2, RPE's are applied to Labour and material costs only. Further cost categories were considered but discounted on the grounds of materiality.

As highlighted in KPMG's "RPE framework RIIO-3 Report", since 2022 machinery and equipment price index inflation has exhibited a large CPIH wedge (defined as costs higher than the CPIH index as measured by the ONS) and the aggregate GDN transport costs grew by 19.9% per annum in the first two years of RIIO-2. Thus, as there is no RPE for transport and plant, there has been a significant challenge to absorb these substantial increases. Whilst transport and plant costs were discounted in RIIO-2 on the grounds of materiality, as we have progressed through RIIO-2 our transport and plant costs have increased as a proportion of our Totex spend, due to a combination of the significant price increases and the increased use of vac-ex machines to support enhanced productivity, workforce safety benefits, smaller excavation sizes and enhanced consumer service.

The indices included within the RPE calculation should be reviewed to ensure they are reflective of a gas distribution networks expected spend profile in RIIO-3. The simplification applied in RIIO-2 of evenly weighting the impact of indices within expenditure categories has led to disproportionate volatility in RPE movements that are not reflective of costs

The intention of the RPE mechanism is to align allowances to network specific costs but some of the current indices are not reflective of spend.

For simplicity, in RIIO-2, indices are weighted evenly i.e. if there were 3 indices making up the materials component of spend, each would have a 33.3% weighting applied. However, as raised in our response to the RIIO-2 Draft Determination, there are disproportionate weightings applied to some indices relative to spend. As an example, the weighting of steel is 33% of the materials RPE indexation, but steel only makes up less than 1% of our materials spend and whilst we are increasing work on steel assets marginally in RIIO-3, an equal split with steel included is not rational. This disproportionate weighting has created significant volatility (ranging from -20% up to +50%) in the materials RPE due to the movements in the 3/S3 Structural Steelwork - Materials: Civil Engineering Work index, which we have very limited exposure to, creating volatility to consumers.

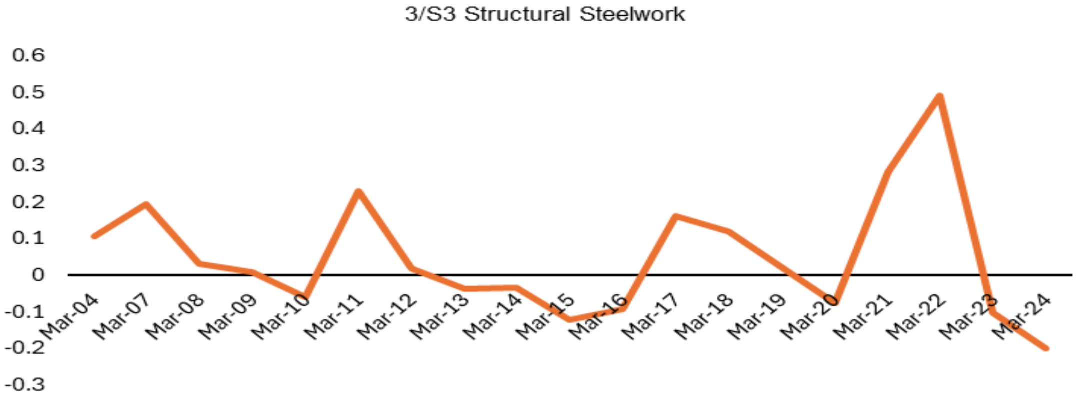

Figure 30: S3 Structural Steelwork - Materials: Civil Engineering Work index movements

Returning to long term forecasts has created further unintended volatility

In light of the recent unprecedented inflationary environment, the application of long term forecasts for materials has inadvertently created volatility in RPEs when setting forecasts. The graph below demonstrates the significant variance between the outturn of the three material indices relative to the long term forecast assumptions. Although there is a true-up mechanism, this is unhelpful for our consumers who experience a higher degree of fluctuation in their bill than is necessary.

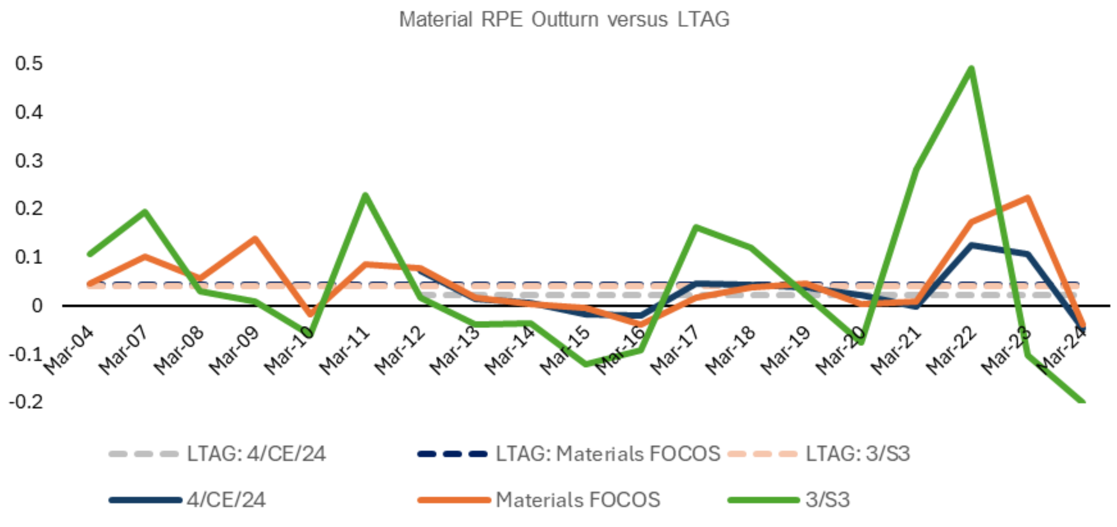

Figure 31: Materials RPE outturn vs long term assumptions

6.2.2. Potential RPE improvements in RIIO-3

Removal of materiality threshold

As mentioned in section 6.2.1 above, RPEs are only applied to labour and materials as other cost categories did not meet the 10% threshold. We agree with the KPMG's Report that the 10% materiality threshold should be removed as this is an arbitrary figure and was removed from the water industry's PR19. This would allow for RPEs to be applied to other significant cost categories which are reflective of our spend exposure.

RPEs should be applied to significant cost categories

For RIIO-3 our updated assessment of cost categories which we have considered for RPE indexation, as a proportion of controllable Totex, is summarised below, with the split between expenditure category within table S1.02 of the business planning data tables:

	Eastern	North London	North West	West Midlands	Cadent	Index
General labour	30.6%	30.9%	30.4%	30.8%	30.7%	Yes
Specialist labour	27.0%	27.0%	26.8%	27.1%	27.0%	Yes
Materials	15.4%	13.7%	16.0%	15.7%	15.1%	Yes
Plant & equipment	14.0%	14.4%	13.9%	13.0%	13.9%	Yes
Transport	5.2%	5.1%	4.2%	4.7%	4.9%	Yes
Other costs	7.8%	8.7%	8.7%	8.7%	8.4%	No

Table 52: RIIO-3 Cost category weightings

We support the continued application of RPEs to labour and materials given the significant spend in these areas, but would also like to see Ofgem include a transport & plant cost category given the increased proportion of spend in these areas, where we also note there has been volatility in costs relative to inflation as noted in section 6.2.1 above.

A comprehensive review of index selection

We agree with KPMG's recommendation to consider a longer list of indices for inclusion in the calculation of RPE's to provide more reflective input prices. In respect of how to choose a suitable index, as we stated in our RPEs business plan for RIIO-2, we still consider that it should be:

- Accurate – with activities that are comparable to those of GDNs;
- Independent – not dominated by GDNs or a concentration of buyers who dominate the index;
- Credible – produced by a reputable body;
- Continuous – with no jumps in the data and whether forecasts are available on the same basis;

- Excluding efficiency – otherwise RPEs and ongoing efficiency will be mixed;
- Transparent – being in the public domain; and
- Timely - Finalised on a timely basis.

We believe that the first five criteria are essential, and the last two desirable, in operating RPE indexation.

Labour

We reviewed KPMG's recommended longlist and considered the factors listed above, but did not find any indices which had a stronger correlation to our costs than the three labour indices currently applied to the labour RPE indexation, which have worked well during RIIO-2, so we would not advocate for any changes in the labour index.

We have reported a split of labour between general and specialist based on Ofgem's definition, but this exercise has only been carried out for our submission and is not how we assess costs within our workforce. If Ofgem consider splitting general and specialist labour RPE's, further indices should be reviewed or adjusting weighting across the current indices. We also note that the PAFI civil engineering (4/CE/01) index now has forecast data available.

Materials

As discussed in section 6.2.1, steel has a disproportionate weighting on the materials RPE so should be removed from the RPE calculation. Further, given the volatility in RPE forecasts created by the use of historic data compared to actuals, similar indices with forecasts could be considered as summarised in the table below. We also note that the BCIS Plastic Products (including pipes) (4/CE/24) index now has forecast data available. We include our recommended approach below:

Current Index	Proposed Index	Rationale
3/S3 Structural Steelwork - Materials: Civil Engineering Work (3/S3)	ONS's producer input prices index	As noted in section 10.2.2 our steel spend is not a significant component, so it would be more appropriate to include a general material index.
BCIS FOCOS Resource Cost Index of Infrastructure: Materials (7417)	BCIS Materials Cost Index (1171)	Indexation is broadly similar across these two indices, but the BCIS Material Cost index has the added benefit of forecast data.

Table 53: Proposed material indices

Index	Accurate	Independent	Credible	Continuous	Exc efficiency	Transparent	Timely
ONS's producer input prices index	Comparable to cost base	Not dominated by GDNs	Yes – produced by ONS	Historical data, but no forecast data	Exc efficiency	Publicly available	Monthly
BCIS Materials Cost Index (1171)	Comparable to cost base	Not dominated by GDNs	Yes – produced by BCIS	Historical data & forecast available	Exc efficiency	Behind pay wall	Monthly

Table 54: Materials index assessment

Transport & plant

Given the significant increased proportion of spend in transport & plant costs in RIIO-2 (which is expected to continue into RIIO-3), we have assessed potential indices for inclusion below:

Index	Accurate	Independent	Credible	Continuous	Exc efficiency	Transparent	Timely
BCIS PAFI plant and road vehicles (90/2)	Comparable to cost base	Not dominated by GDNs	Yes – produced by BCIS	Historical data, but no forecast data	Exc efficiency	Behind pay wall	Monthly
ONS Machinery & Equipment for domestic market (G6VG)	Comparable to cost base	Not dominated by GDNs	Yes – produced by ONS	Historical data, but no forecast data	Exc efficiency	Publicly available	Monthly

BCIS Purchased Plant Including depreciation and maintenance 4/CE/04	Comparable to cost base	Not dominated by GDNs	Yes – produced by BCIS	Historical data & forecast available	Exc efficiency	Behind pay wall	Monthly
BCIS Plant and Road Vehicles: Providing and Maintaining	Comparable to cost base	Not dominated by GDNs	Yes – produced by BCIS	Historical data, but no forecast data	Exc efficiency	Behind pay wall	Monthly

Table 55: Transport & plant index assessment

In addition, three of these indices are already applied in other regulated sectors:

Index	Price control
BCIS PAFI plant and road vehicles (90/2)	ED-2 / NIE
ONS Machinery & Equipment n.e.c. for domestic market (G6VG)	NIE
BCIS Plant and Road Vehicles: Providing and Maintaining 1702/(70/2)	SHET

Table 56: Indices adopted in other sectors

Given that all indices meet to a strong extent our criteria for assessment, we believe it is appropriate to include them all (with an equal proportion applied) within the RIIO-3 mechanism as discussed below.

Weightings of indices should be reflective of proportion of spend rather than applying a simplistic approach where there is data to support this

We understand the difficulty in applying weightings to indices when spend across the sector can vary, but there are some indices we believe should have stronger weighting than others, with indicative weightings summarised below:

Cost category	Index	Weighting	Comments
Labour	AWE: Private Sector Index: Seasonally Adjusted Total Pay Excluding Arrears (K54V)	50%	A significant proportion of GDN activities are related to construction & engineering, so a 50% weighting across these 2 indices is applied.
	AWE: Construction Index: Seasonally Adjusted Total Pay Excluding Arrears (K553)	25%	
	PAFI civil engineering (4/CE/01)	25%	
		100%	
Materials	BCIS Plastic Products (including pipes) (4/CE/24)	50%	PE pipe represents a significant proportion of our materials costs so a higher weighting has been placed on this comparative to general material price indices.
	BCIS Materials Cost Index (1171)	25%	
	ONS's producer input prices index	25%	
		100%	
Transport & Plant	BCIS PAFI plant and road vehicles (90/2)	25%	Transport & plant costs feature across all of these indices, so an even weighting has been proposed.
	ONS Machinery & Equipment n.e.c. for domestic market (G6VG)	25%	
	BCIS Purchased Plant Including depreciation and maintenance (4/CE/04)	25%	
	BCIS Plant and Road Vehicles: Providing and Maintaining (1702)/(70/2)	25%	
		100%	

Table 57: Proposed index weightings

Latest forecasts should be applied to all elements of RPEs, rather than labour alone, and should not be based on long term historical averages where possible given the high level of volatility experienced during RIIO-2

We understand the challenges around obtaining credible forecasts, however, BCIS also provide forecast data for a number of the indices we have proposed (including existing indices used in the current RPE methodology), so consideration should be given to whether those forecasts would be appropriate given the consistency with actual outturn data, rather than relying on long term historical averages.

In section 6.2.2 (a comprehensive review of index selection) for each of the proposed indices, we summarised whether forecasts are available on a consistent basis. For those which do not have forecasts, we have included some suggestions on possible alternative forecasts below:

Cost category	Index	Comments
Labour	AWE: Private Sector Index: Seasonally Adjusted Total Pay Excluding Arrears (K54V)	OBR Average Earnings Forecast
	AWE: Construction Index: Seasonally Adjusted Total Pay Excluding Arrears (K553)	HMT Average Earnings Forecast
Materials	ONS's producer input prices index	Lack of forecasts available, so use of historical averages may be more appropriate
Transport & Plant	BCIS PAFI plant and road vehicles (90/2)	Lack of forecasts available, so use of historical averages may be more appropriate
	ONS Machinery & Equipment n.e.c. for domestic market (G6VG)	
	BCIS Plant and Road Vehicles: Providing and Maintaining 1702/(70/2)	

Table 58: Proposed Indices where forecasts are not available

For forecast years, the weightings applied should mirror those applied to actual outturn data.

Changes to the profiling of the RPE true-up mechanism

The annual RPE true-up approach introduced in RIIO-2 should be continued but could be refined to alleviate fluctuations in bills for consumers. As suggested by KPMG, following periods of volatile inflation, the true-up profile could be reviewed to lessen short term impacts on consumers.

6.2.3. RPE summary

We remain supportive of the use of RPEs in setting regulatory cost allowances, but believe improvements could be made to the indices used to calculate RPEs as summarised below:

Cost category	Index	Weighting	Forecast source
Labour	AWE: Private Sector Index: Seasonally Adjusted Total Pay Excluding Arrears (K54V)	50%	OBR Average Earnings Forecast and/or HMT Average Earnings Forecast
	AWE: Construction Index: Seasonally Adjusted Total Pay Excluding Arrears (K553)	25%	
	PAFI civil engineering (4/CE/01)	25%	Same as actual
Materials	BCIS Plastic Products (including pipes) (4/CE/24)	50%	Same as actual
	BCIS Materials Cost Index (1171)	25%	Same as actual
	ONS's producer input prices index	25%	Historical averages
Transport & Plant	BCIS PAFI plant and road vehicles (90/2)	25%	Historical averages
	ONS Machinery & Equipment n.e.c. for domestic market (G6VG)	25%	Historical averages
	BCIS Purchased Plant Including depreciation and maintenance (4/CE/04)	25%	Same as actual
	BCIS Plant and Road Vehicles: Providing and Maintaining (1702)/(70/2)	25%	Historical averages

Table 599: Summary of RPE proposals

7. Glossary

Term	Definition
ALD	Advanced leakage detection
ASHE	Annual Survey of Hours and Earnings
BAU	Business as Usual
BPDT	Business plan data table
Capex	Capital expenditure
CMA	Competition and Markets Authority
CO	Carbon monoxide
CPIH	Consumer Prices Index including owner occupiers' housing costs
CSV	Composite scale variable
DESNZ	Department of Energy Security and Net Zero
DfT	Department for Transport
DNOs	Distribution network operators
DPLA	Digital Platform for Leakage Analytics
EAP	Environmental action plan
eCAF	Enhanced cyber assessment framework
ECC	Energy control centre
ECSV	Emergency CSV
EOL	End-of-life
ESOS.	Emergency Standards of Service
FCOs	First call operatives
FES	Future energy scenario
FSM	Field service management
FWACV	Flow weighted average calorific value metering systems
GD	Gas distribution
GDNs	Gas distribution networks
GO	Gross output
HD	High density
HSE	Health & safety executive
IMRRP	Iron mains risk reduction programme
ITL	International territorial level
LAs	Local authorities
LDP	Local delivery partners
LEZ	Low emission zone
LTS	Local transmission system
MEAV	Modern equivalent asset value
MOB	Multi-occupancy building
NARM	Network asset risk metric
NESO	National energy system operator
NI	National insurance
NIA	Network innovation allowance
NZARD	Net Zero and Re-opener Development
ODA	Other direct activities
OE	Ongoing efficiency
Opex	Operational expenditure
OT	Operational technology
PCD	Price control deliverable
PE	Polyethylene

PRE	Publicly reported escapes
PSUP	Physical security
Repex	Replacement expenditure
RESP	Regional energy system planners
RPEs	Real price effects
RRP	Regulatory reporting process
SCADA	Supervisory Control and Data Acquisition
SIF	Strategic innovation fund
SLM	Shrinkage leakage model
SOC	Standard occupational classification
SSMC	Sector specific methodology consultation
SSMD	Sector specific methodology decision
SSR	Standard statistical region
TfL	Transport for London
TFP	Total Factor Productivity growth
Totex	Total expenditure
UBLE	Understanding the Baseline Level of Efficiency in London
UIOLI	Use it or lose it
ULEZ	Ultra low emission zone
VA	Value-added
VCMA	Vulnerability and Carbon Monoxide Allowance
VOA	Valuation office agency
WAD	Weighted average density