Ofgem's TOTEX assessment approach at the RIIO-ET2 draft determinations: a review

Prepared for
Freshfields on behalf of SHE Transmission

3 September 2020

Final

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Contents

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Figures and tables

Executive summary

Scottish Hydro Electric Transmission plc (SHE-T) has asked Oxera to provide an assessment of Ofgem's approach to assessing its business plan total expenditure (TOTEX) as part of the RIIO-T2 Draft Determinations.[1]

Ofgem's sector annex sets out some of the challenges it faces in undertaking cost assessment in the electricity transmission sector,[2] including the limited availability of domestic comparators, their differences in terms of scale and region-specific characteristics, and lack of comparability to other regulatory regimes/international comparators.[3]

Given such challenges, a robust cost assessment framework for electricity transmission must carefully take into account the following factors.

- **The comparability of different benchmarks**—including but not limited to the differences (e.g. in terms of outlook, activity mix) between RIIO-T1 and RIIO-T2; differences in regional factors affecting companies' efficient cost relative to other comparators; differences in regional factors affecting a specific project's efficient cost relative to internal or external benchmarks.
- **The potential for cost allocation/reporting inconsistencies**[4] or **cost synergies** to affect the cost assessment framework and comparability of different benchmarks.
- **The scope for modelling error**—noting that unit cost analyses are models in the same way that econometric models are and can be highly susceptible to modelling error—and whether the regulatory framework leads to the impact of such error being biased either upwards (leading to higher TOTEX allowances, to the detriment of consumer welfare) or downwards (leading to lower TOTEX allowances, to the detriment of the ability of the company to finance its functions).

In this report, we outline how Ofgem's process, modelling principles and methods for determining allowed TOTEX do not address those challenges in a robust manner through a combination of: (i) a cost assessment framework that makes little allowance for the potential for error; and (ii) benchmarking models that overlook important normalisation factors or cost drivers due to limited data and therefore subject to significant modelling noise. These issues result in an inappropriately large challenge to SHE-T's submitted business plan expenditure.

In particular, Ofgem's cost assessment framework is not balanced as it *removes* the impact of potential positive modelling errors on companies' TOTEX allowance by capping funding at the business plan level, but *retains* the impact of negative modelling errors by applying the most stringent benchmark in several cases.[5] Such downward bias cannot be considered an appropriate aspect of a reasonable top-down cost-modelling approach.

[1] Ofgem (2020), 'RIIO-2 Draft Determinations – Core Document', 9 July.
[2] Ofgem (2020), 'RIIO-2 Draft Determinations – Electricity Transmission Annex', 9 July, para. 3.11.
[3] As a result, Ofgem's approach focuses on comparisons between the three domestic transmission operators (TOs) and inter-company comparisons within each TO using a combination of top-down and bottom-up benchmarking tools.
[4] Including differences in reporting data and definitions across and within companies.
[5] In principle, every modelling approach can be affected by modelling errors (or 'biases'), in particular in the presence of measurement errors in the variables used or model specifications omitting important cost drivers. Such biases can affect the estimates both upward and downward, depending on the direction of the impact on the estimated allowance.

By capping funding, Ofgem's approach also *weakens* the incentives for companies to reveal efficiencies through outperformance over RIIO-T2 and submit stretching plans for RIIO-T3 and beyond. This is a key feature of incentive regulation which offers companies the possibility to outperform the regulatory decisions and pass these on to consumers in the form of lower prices at future price controls. Given the simplicity of the modelling approach which could manifest in negative errors, Ofgem should assess whether a cap is warranted in the first place and, if so, whether it should be applied leaving no headroom for companies and the longer-term impact of its application. When considered in combination with the low incentive rate available in cost areas with low confidence (15%), the net effect of Ofgem's approach is to substantially reduce the incentives for companies to make future efficiency savings or submit challenging future business plan forecasts. This decision places too much weight on short-term price cuts at the expense of the longer term benefits available from adequately incentivising efficiency improvements in the future—ultimately at the expense of future generations of customers.

Assuming a cap is deemed appropriate at all—for example, where the modelling allowance is significantly above that requested by a company[6]—considering capping at the TOTEX level or at the aggregate cost level[7] could constitute a reasonable base case. Even this latter approach is not without risks as there could be cost synergies or reporting inconsistencies between closely associated indirect expenditure and load-related and non-load-related expenditure (LRE and NLRE) projects.

Ofgem's preference to use a sole benchmark to determine allowances—in particular, the most stringent one regardless of robustness—is inconsistent with regulatory best practice that seeks to consider multiple evidence bases (including the companies' proposals) to improve the overall robustness of the assessment. For example, in RIIO-GD1 and RIIO-ED1, where Ofgem has access to more comparator data, it used multiple evidence bases, and triangulated its view with the companies' (in the ratio 75:25) to reflect modelling limitations and informational imperfections.[8]

Making use of multiple benchmarks/evidence bases appropriately can reduce some of the uncertainty associated with modelling costs in the transmission sector. Two approaches have been used in regulatory contexts:

- giving companies the 'benefit of the doubt', as the truth is unknown and inappropriate outcomes may be driven by the assumptions underpinning a particular approach;[9]
- triangulating results across multiple evidence bases using a simple mean or other measure (such as weighting by evidence quality), which *can* lead to a more robust outcome as statistical noise and other drivers of uncertainty can offset each other to the extent that triangulation is undertaken over

[6] An example of this would be Ofwat's application of a 10% cap for Portsmouth Water as the TOTEX allowance from Ofwat's cost models was more than 10% of that requested by the company. See Ofwat (2010), 'PR19 final determinations: Portsmouth Water final determination', December.
[7] That is, indirect operating expenditure, network operating costs, LRE, NLRE and non-operational CAPEX.
[8] Ofgem (2014), 'RIIO-ED1: Final determinations for the slowtrack electricity distribution companies', November.
[9] For example, the German Energy regulator, Bundesnetzagentur, uses the maximum efficiency value from four approaches (two different methodological approaches with two different definitions of TOTEX for each approach) as the efficiency challenge for gas and energy distribution networks, in accordance with the requirements set out in the German regulatory Ordinance. Efficiency values are also capped with a lower bound of 60%. See: §12 (3), Anreizregulierungsverordnung.

robust evidence bases.[10] In this regard, the impact of noise on the estimated benchmarks needs examining—for example, by considering the distribution of unit costs or model predictions or other measures of information quality—to determine an appropriate approach for triangulation.

The cumulative effect of an overly narrow evidence base (relative to that available) and the selection of the minimum of several benchmarks exacerbates the potential for any modelling error to lead to windfall (i.e. unrelated to efficiency) gains or losses to company allowances. Capping outperformance at the lower of company submission or benchmark removes potential for any gains while retaining the reductions associated with a loss in place. Therefore, Ofgem's cost assessment framework is highly reliant on the accuracy of its cost assessment models.

However, there are a number of issues with the cost assessment models developed for the RIIO-T2 Draft Determinations that result in an inappropriately low cost allowance for SHE-T, including:

- double counting of a cost reduction in the modelling of closely associated indirect (CAI) and business support costs (BSC) by applying ex post adjustments;[11]
- stringent benchmarks resulting from an implausibly large amount of unexplained variation, which is highly unlikely to be solely attributable to inefficiency. For example, the large variation in unit costs is seen for most LRE and NLRE lead projects;
- use of a benchmark based on historical data without accounting for differences arising from changes in the mix and/or volume of activity;[12]
- the use of models that do not contain all relevant operational drivers (e.g. scale of projects, asset location) for the cost activity being modelled.

The table below summarises our assessment of the robustness of Ofgem's top-down models used to assess SHE-T's expenditure along with our recommendations for the key cost categories that were considered in our review.

It is widely acknowledged that all top-down models that are used to assess the efficiency of companies' expenditure are simplifications of highly complex operations. Even in the presence of a large number of comparators and where the models are correctly specified and all the underlying assumptions are met, there is always uncertainty surrounding the resulting predictions. In other words, top-down models cannot provide precise point estimates of the required costs (even if the uncertainty can be assessed empirically). While the application of top-down approaches can be relatively more challenging in the transmission sector, Ofgem's methodology does not fully recognise the high degree of noise and error involved in the process and places the entire risk of a

[10] For example, Ofgem's RIIO-GD1 approach to expenditure in the gas distribution sector averages the result from across four approaches to determine the baseline costs of gas distribution networks. Similarly, Ofgem's RIIO-ED1 approach used a weighted average of the top-down TOTEX model (25%), bottom-up TOTEX model (25%) and disaggregate models (50%). Ofgem suggests a similar approach for RIIO-ED2. At RIIO-GD1 and ED1 Ofgem also recognised that it did not have perfect information and considered the IQI interpolation, and triangulated its view with the companies' (in the ratio 75:25). Ofwat's approach to benchmarking enhancement expenditure at PR19 also averaged the results across different models.
[11] Ex post workload and outperformance adjustments and their application are presented in section 5.2.
[12] For example, SHE-T experienced a material shift in the location and type of underground cable work being delivered between T1 and T2, as documented in SHE-T's response to question 6 and question 7 of Ofgem's consultation on its company-specific annex—i.e. SHETQ6 and SHETQ7.

large scope for (negative) error entirely on the transmission companies—and in so doing failing to ensure operators are able to finance their functions.[13]

Moreover, Ofgem's published material on cost assessment lacks a clear and comprehensive description of the methodology and analysis undertaken. Specifically, the approach chosen and analysis undertaken must be presented in a way that enables easy comprehension and validation. There are several instances in which Ofgem's published material provided inadequate transparency. For example, Ofgem does not provide details on its methodology or calculations for stripping out SHE-T's ongoing efficiency assumption from its business plan, which is, as result, difficult to replicate.

Unless the issues set out in this report are adequately addressed at the Final Determinations, SHE-T's cost allowances will be understated.

[13] Ofgem (2013), 'Our Powers and duties', 19 July.

Assessment of Ofgem's top-down benchmarking models

Category	SHE-T BP (£m)	Ofgem allowance (£m)	Issues with Ofgem's approach	Suggested amendments	Indicative impact (£m)[2]
Indirect operating costs	360.3	265.7	• the benchmark to CAI costs is based on an erroneous combination of the workload and outperformance adjustments[1] • the econometric models are not aligned with operational expectations	• apply an outperformance adjustment post-workload adjustment, if at all • re-examine the econometric models to ensure they are robust to data changes and consistent with operational intuition	62–69
Direct LRE costs[3]	839.8	717.3	• the unit cost model has a high level of uncertainty and does not control for relevant factors such as scope of works and geographical factors • Ofgem selectively applies the minimum benchmarks from several different views • allowances are capped at the disaggregate level exacerbating the impact of uncertainty	• consider a balanced approach to set the benchmark, e.g. by triangulating across multiple evidence • review the need to cap funding and its application	82
Direct NLRE costs[3]	824.2	540.5			68
Network operating costs (NOCs)	207.8	90.2	• the benchmark applied to repairs and maintenance is not consistent with other areas of NOCs	• apply a consistent benchmark to repairs and maintenance	25–39
Volume uncertainty model	n/a[4]	n/a[4]	• the volume uncertainty mechanism model is not able to predict efficient costs in a robust way • the conventional measure of fit used by Ofgem is not appropriate in developing a predictive model, i.e. a model that is not intended to explain the known costs, but rather forecast future proposed connections	• consider a model that is consistent with operational intuition using appropriate metrics or use a bottom-up benchmark that can be tailored to the specific projects	n/a[4]

Notes: [1] Workload and outperformance adjustments and their application are presented in section 5.2. [2] Further details on the approach followed to estimate these cost impacts are provided in section 5. [3] As set out in section 1, only direct costs relating to LRE and NLRE projects are assessed through top-down benchmarking. While the cost gap between SHE-T's business plan submission and Ofgem's bottom-up allowances are not addressed within this paper, this reflects the scope of this review rather than the appropriateness or otherwise of Ofgem's bottom-up approach. [4] This is an uncertainty mechanism and deals with projects that are yet to be proposed, as such there is no quantifiable impact.

Source: Oxera analysis.

1 Introduction

Scottish Hydro Electric Transmission plc (SHE-T) has asked Oxera to provide an assessment of Ofgem's approach to assessing total expenditure (TOTEX) as part of its Draft Determinations for the RIIO-T2 price review.

The scope of this review includes:

- Ofgem's process, principles and framework for determining allowed TOTEX;
- Ofgem's application of top-down cost benchmarking tools to determine an efficient allowance for SHE-T, including an assessment of model quality and robustness.

A non-exhaustive list of aspects of Ofgem's TOTEX assessment framework outside the scope of this review includes:

- the use of engineering assessments to determine project need, volumes or cost efficiency;
- therefore, only LRE and NLRE expenditure relating to direct costs assessed through the PAM model (unit cost analysis) is considered within the scope of this paper—excluding preconstruction, civils, risk and contingency expenditure;
- network operating costs benchmarking, beyond the conceptual underpinning of the approach and the specific repairs & maintenance sub-category;
- Ofgem's application of an ongoing efficiency challenge, which is addressed in another annex—critique of RIIO-2 ongoing efficiency analysis;[14]
- the TOTEX incentive mechanism.

The rest of this report is structured as follows:

- section 2 sets out a high-level description of Ofgem's approach to TOTEX assessment at the RIIO-T2 Draft Determinations, for context;
- section 3 provides an overview of two related aspects of Ofgem's cost assessment methodology that contribute towards an inappropriately large challenge to transmission operator's submitted business plan expenditure: (i) Ofgem's imbalanced cost assessment framework and (ii) the high degree of uncertainty associated with the benchmarking models used by Ofgem;
- section 4 examines issue (i): the lack of robustness of Ofgem's cost assessment framework and the imbalanced impact of modelling errors on company outcomes;
- section 5 describes issue (ii): the high degree of uncertainty associated with the benchmarking models used by Ofgem.

[14] Oxera (2020), 'Critique of RIIO-2 ongoing efficiency analysis', August.

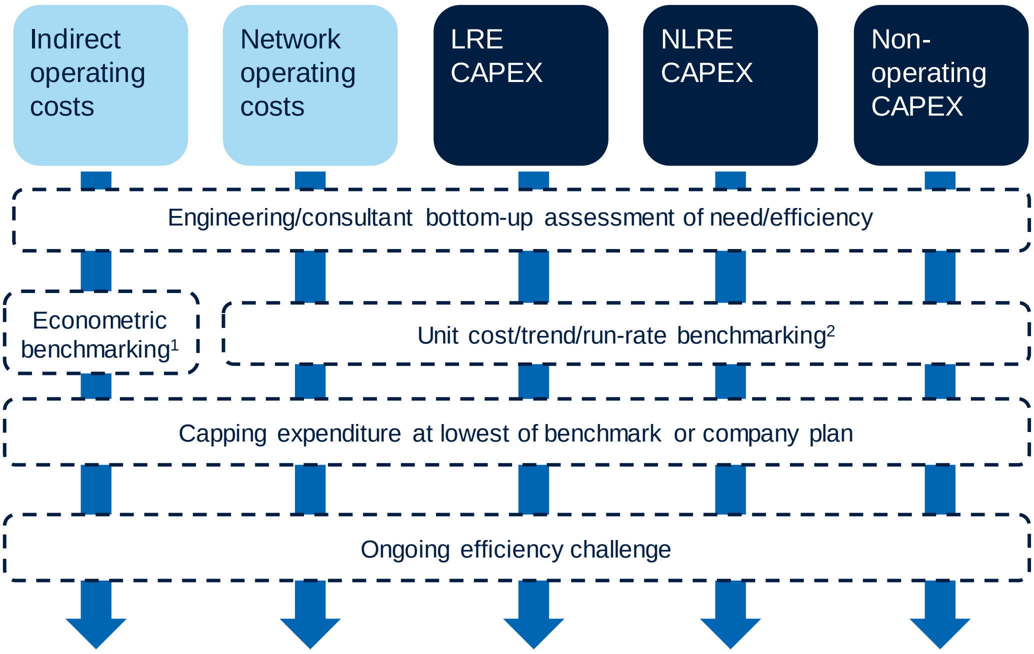
2 Ofgem's approach to TOTEX assessment

Key messages

- Ofgem's approach to TOTEX assessment is based on a combination of top-down and bottom-up cost benchmarking tools.
- Indirect operating costs are mostly assessed at an aggregate level through econometric modelling. NOCs are assessed through a combination of (i) unit cost comparisons, (ii) annualised RIIO-T1 costs with a 50% uplift, and (iii) bottom-up assessment of need, depending on the cost category.
- LRE and NLRE are assessed at the project level. Each area is first assessed for need by Ofgem's engineers. Direct lead and non-lead costs for each project are benchmarked in turn across network operators against both historical RIIO-T1 expenditure and forecast RIIO-T2 expenditure. As set out in section 1, other cost categories are assessed entirely though bottom-up assessment and fall outside the scope of this paper.
- Ofgem also considers a volume uncertainty model that is used to provide network operators with ex ante allowances for the provision of customer-driven generation and demand connections.

The diagram below sets out how Ofgem assesses the five elements of SHE-T's expenditure, with operating expenditure in light blue and capital expenditure (CAPEX) in dark blue.

Figure 2.1 Ofgem's electricity transmission sector cost assessment framework



Note: [1] While the majority of indirect operating cost expenditure is assessed through econometric benchmarking, bottom-up assessments in other areas inform the workload adjustment applied to CAI expenditure and £10.8m of closely associated indirect operating costs over RIIO-T2 (4% of the total) is separately assessed through a bottom-up assessment. [2] Only direct costs relating to LRE and NLRE CAPEX are assessed using top-down unit cost approaches, with other cost categories assessed exclusively through bottom-up approaches.

Source: Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', 9 July; and Ofgem (2020), 'RIIO-2 Draft Determinations - Scottish Hydro Electric Transmission', 9 July.

In this section, we summarise Ofgem's approach by cost area, for reference. A review of this approach and Ofgem's execution of this methodology is set out from section 3.

2.1 Indirect operating costs

Indirect operating costs comprise two separate areas: CAI expenditure, and BSC expenditure. CAI expenditure relates to back-office functions directly involved in the construction and operation of network assets, while BSC expenditure relates to more general back-office functions, such as corporate governance.[15] Although CAI and BSC expenditure each comprise a number of sub-categories—set out in Figure 2.3 and Figure 2.3—the majority of expenditure is assessed at an aggregate level through econometric modelling.

Figure 2.2 CAI expenditure: SHE-T's business plan against Ofgem's allowance (£m)

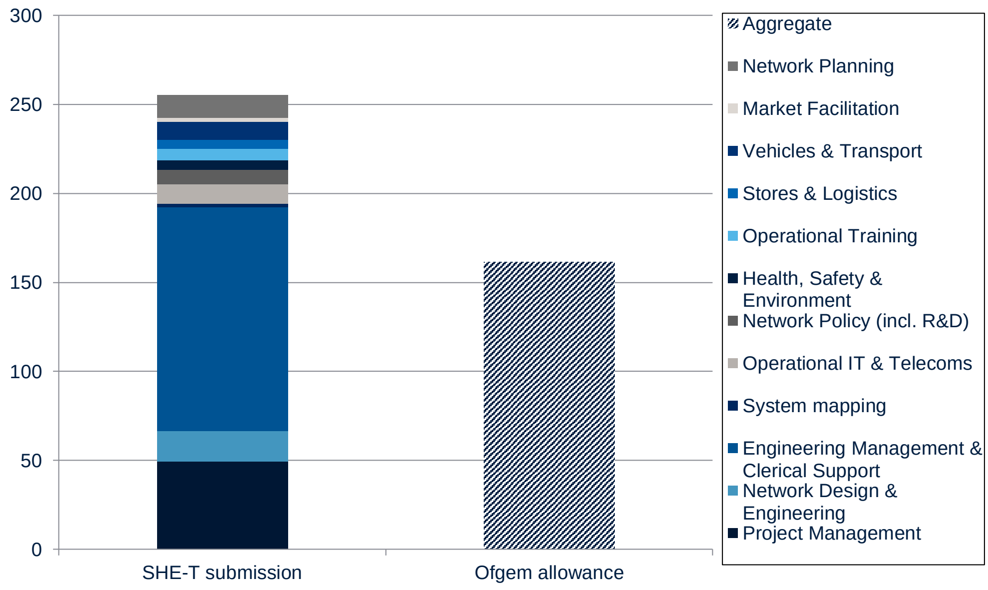
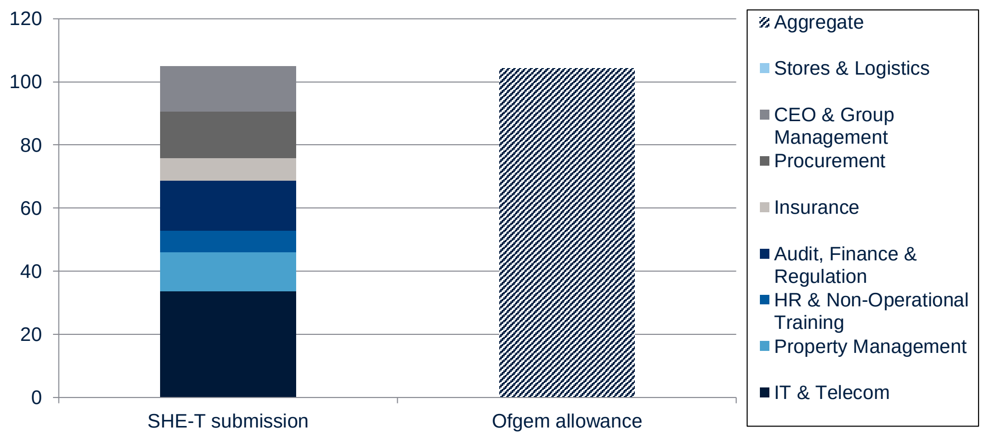


Figure 2.3 BSC expenditure: SHE-T's business plan against Ofgem's allowance (£m)



[15] Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', 9 July, para. 3.6.

Source: Oxera analysis of modelling file received from Ofgem: 'Allowances_File_DD_Network Share'.

Ofgem and Economic Consulting Associates (ECA) have developed separate econometric models for benchmarking expenditure in these two areas using historical RIIO-T1 data for the three electricity transmission networks and single gas transmission network operating in Great Britain. Modern equivalent asset value (MEAV) and CAPEX[16] are used as drivers of CAI expenditure, while MEAV and a composite scale variable (CSV)[17] are used as drivers of BSC expenditure.

Ofgem uses the results of these models to assess companies' expenditure, adjusting the model allowance to account for revisions in other parts of the cost assessment framework and estimated outperformance. A detailed review of how these adjustments are applied is set out in section 5.2.1.

We note that the model applied by Ofgem to set company expenditure is not the same as that presented in the ECA paper. As well as giving different coefficients, the models used by Ofgem perform less well in some of ECA's statistical tests.[18]

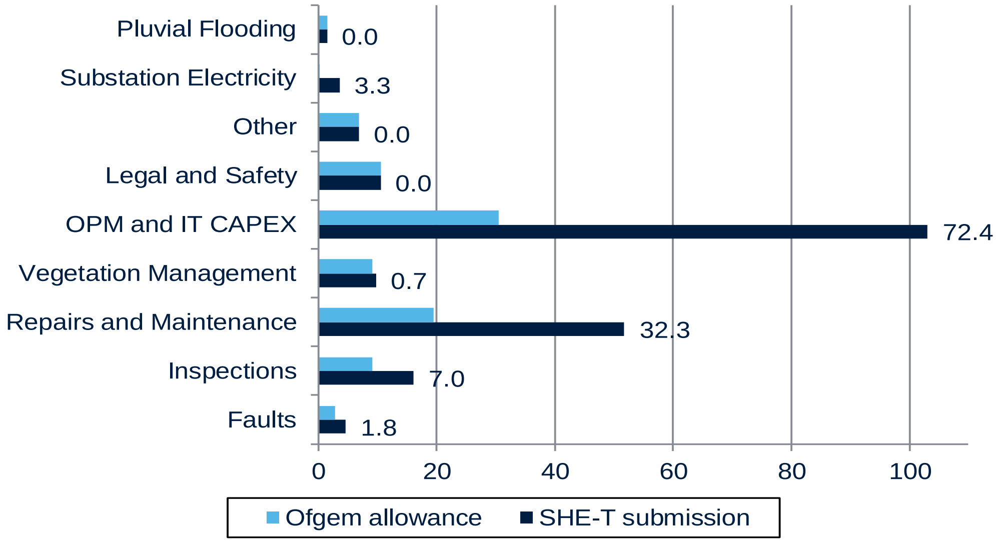
Ofgem notes that operating expenditure relating to information technology and telecoms (IT&T) assets was reviewed separately by Atkins Consultancy, on the basis of the quality of companies' bottom-up justification instead of being assessed econometrically.[19]

2.2 Network operating costs

NOCs are costs incurred in the day-to-day running of the network and are assessed across 11 areas.[20] Figure 2.4 sets out SHE-T's business plan against Ofgem's Draft Determinations allowance. The gap between SHE-T's submission and Ofgem's allowance is labelled.

[16] Excluding non-operating CAPEX.
[17] Derived by applying weights to three measures of company scale: MEAV, TOTEX and full-time equivalents (FTEs).
[18] In particular, the stability of model results to inclusion of a time trend.
[19] Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', 9 July, para. 3.37.
[20] Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', 9 July, para. 3.6; and Modelling file received from Ofgem: 'RIIO-ET2_SHET_NOCs_Model_DD.xlsx'.

Figure 2.4 NOCs, SHE-T's business plan against Ofgem's allowance (£m)



Note: The cost categories Visual Amenity and Fluvial and Coastal Flooding have been omitted from the diagram above as SHE-T did not submit expenditure in these areas.

Source: Oxera analysis of modelling file received from Ofgem: 'RIIO-ET2_SHET_NOCs_Model_DD.xlsx'.

Ofgem's preferred methodology for assessing expenditure in this area is by comparing submitted unit costs over RIIO-T2 with historical unit costs attained over RIIO-T1 (excluding the last two years of RIIO-T1, 2020–21). This is used to set SHE-T's expenditure within the Faults, Inspections,[21] and Vegetation Management sub-areas.

To assess Repairs & Maintenance expenditure Ofgem instead sets these at annualised RIIO-T1 costs with a 50% uplift. From its methodology and analysis files it makes clear that its preference is to move to a unit cost approach in this area for the draft determinations. This is on the basis of:

- its sector methodology,[22] in which it states 'we applied this [annualised] approach where a network company failed[23] to provide in its BPDTs volumes…'
- the relevant analysis file,[24] in which it states 'we will seek the volumes data to accurately quantify the increase in costs.'

As SHE-T provided this data in early May, Ofgem has the information required to implement a unit cost approach, as we set out in section 5.4.1. We understand from discussions between SHE-T and Ofgem that Ofgem intends to apply a unit cost approach to Repairs & Maintenance expenditure for the Final Determination.

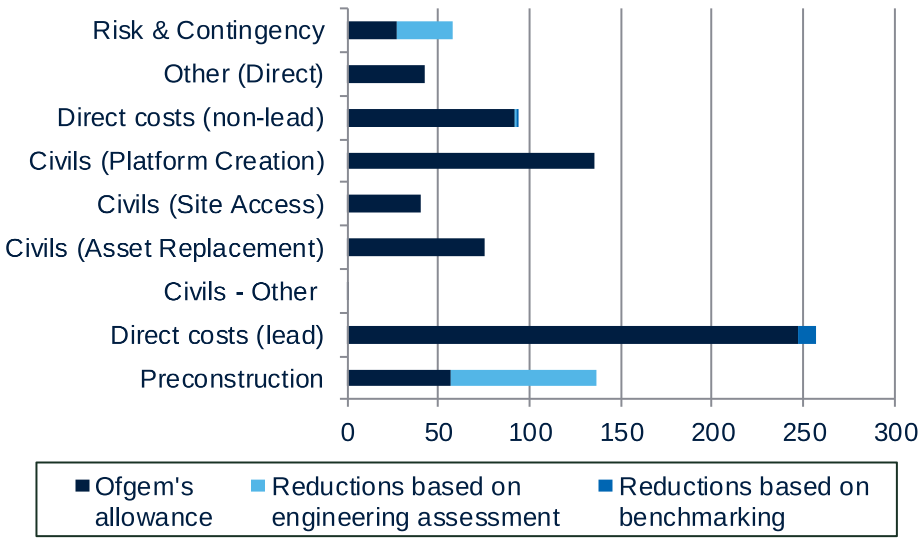
Finally, the Legal and Safety and Operational Protection Measures (OPM) and IT CAPEX sub-areas are assessed through a bottom-up assessment of need.

[21] Ofgem makes an exception for HVDC costs in this sub-area, although it makes no corresponding exception for HVDC costs in the Faults and Repairs & Maintenance sub-areas.
[22] Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', 9 July, para.
[23] We note that SHE-T provided the relevant data to Ofgem through SQ responses in early May, around two months in advance of publication of the Draft Determinations.
[24] RIIO-ET2_SHET-NOCs_Model_DD, sheet 'SHET_Repair_&_Maintenance'.

2.3 Load-related CAPEX

LRE is composed of 27 discrete projects (plus 15 individual pre-construction schemes), assessed by Ofgem across nine categories of expenditure. Figure 2.5 sets out LRE by cost category allowed by Ofgem (dark blue bar) highlighting the cost reductions resulting from the engineering and benchmarking assessments (lighter blue bars). The sum of Ofgem's allowance and such reductions corresponds to the cost submitted in SHE-T's business plan.

Figure 2.5 LRE: SHE-T's business plan against Ofgem's allowance, by category (£m)



Source: Oxera analysis of Ofgem data.

Ofgem carries out cost assessment at the project level, across the 27 LRE projects with associated direct costs that SHE-T submitted in its RIIO-T2 business plan. For each project, each area is assessed for need by Ofgem's engineers and then passed to the cost assessment team. As noted above, this aspect of Ofgem's assessment falls outside of Oxera's review.

Subsequently, direct lead[25] and non-lead[26] costs for each project are benchmarked across transmission operators (TOs) against both historical RIIO-T1 expenditure and (separately) forecast RIIO-T2 expenditure. Expenditure is benchmarked at the asset-voltage level (e.g. 400 kV transformers), relative to the (weighted) mean unit costs for that asset type.[27]

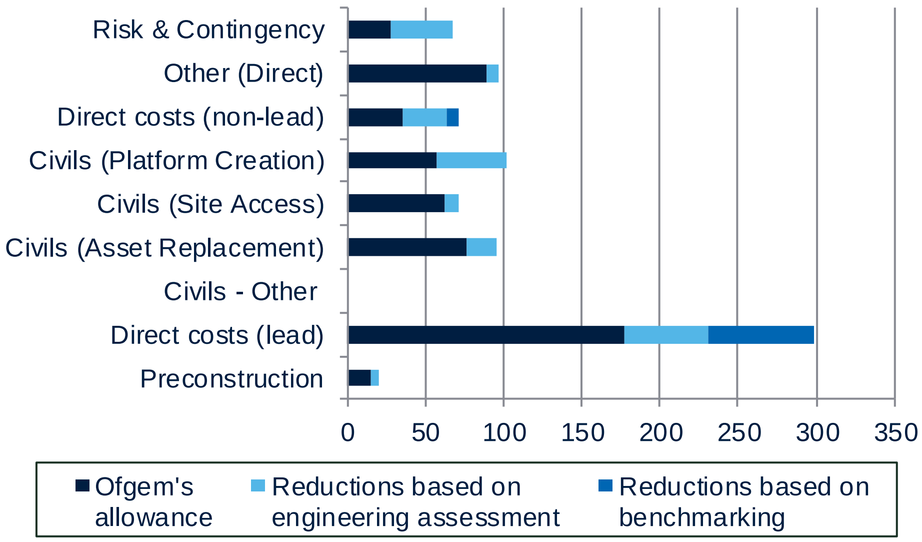
Allowed expenditure for a given project–asset combination is capped at the lower of the RIIO-T1 benchmark (where available), the RIIO-T2 benchmark (where available) and company submitted cost.

[25] Lead costs are defined as the main assets comprising the transmission network that are required for the safe and reliable transfer of electricity from one point on the network to the other—Ofgem (2017), 'RIIO-ET1 Annual Report 2015–16', 24 February, pp. 59–60.
[26] Non-lead costs refer to other direct expenditure, including monitoring, telecommunications, protection equipment (except for switchgear), assets below 132kV and cost incurred to maintain or improve weather related resilience—Ofgem (2017), 'RIIO-ET1 Annual Report 2015–16', 24 February, pp. 59–60.
[27] It is our understanding that the weighting of asset unit cost occurred based on the amount of units constructed as part of a scheme.

2.4 Non-load-related CAPEX

Analogous to LRE expenditure, NLRE is composed of 28 discrete projects (plus 15 pre-construction, spares or black start projects without a scheme reference code), assessed by Ofgem across nine categories of expenditure. Figure 2.6 sets out NLRE by cost category allowed by Ofgem (dark blue bar) highlighting the cost reductions resulting from the engineering and benchmarking assessments (lighter blue bars). The sum of Ofgem's allowance and such reductions corresponds to the cost submitted in SHE-T's business plan.

Figure 2.6 NLRE: SHE-T's business plan against Ofgem's allowance, by category (£m)



Source: Oxera analysis of Ofgem data.

Ofgem's process for assessing efficient NLRE is the same as for LRE. The same unit cost benchmarks are applied for asset types common across LRE and NLRE projects. We therefore set out our critique of its assessment of LRE and NLRE together.

2.5 Non-operational CAPEX

There are four categories of non-operational CAPEX—relating to assets not directly connected to the network, but in support of general functions—assessed by Ofgem, as follows:

- **property**—Ofgem assesses historical run rate analysis and the ratio of property costs to MEAV and CAPEX. Non-operational funding requests are assessed specifically;
- **small tools, equipment, plant and machinery (STEPM)**—Ofgem assesses historical run rate analysis and the ratio of STEPM costs to MEAV and CAPEX;
- **vehicles and transport**—vehicles are subject to historical trend analysis. For electric vehicles, Ofgem also considers the unit costs of electric vehicles;

- **IT&T—**these costs are assessed against robustness of justification, credibility of planning, understanding and deliverability of resource definition, and efficiency and certainty in costing by external consultants.[28]

The two major cost challenges to SHE-T's expenditure in this area come from bottom-up assessments of operational need and therefore fall outside the scope of this report.

2.6 The volume uncertainty model

Ofgem proposes four types of uncertainty mechanism for electricity transmission, including volume drivers, re-openers, pass-through and indexation mechanisms.[29] Here, we focus on the approach used to determine ex ante allowances for the provision of customer-driven generation and demand connections.

Ofgem uses the same approach for LRE and NLRE to derive an estimate of efficient costs for each of the generation and demand projects provided by the TSOs in their submissions. It then performs a series of regression analyses of the estimated efficient costs against a number of potential cost drivers, to determine which combinations have the best 'predictive power' according to Ofgem's metrics. Ofgem suggests this is done against each network company's baseline projects, the combination of baselines and uncertain projects, and also across all network company projects pooled together. In practice, however, Ofgem excludes a number of projects challenging the extent to which the remaining projects can be considered to constitute a network company's 'baseline'. Based on this modelling exercise, Ofgem concludes that:[30]

- the combination of the capacity of the new generation (MW) or demand (MVA) in conjunction with the linear assets (km of overhead line, km of underground cable) give the closest predictions of modelled efficient cost;
- models based on individual network company project portfolios give better predictions than those based on the pooled sample of all projects;
- multivariate models give better predictions than the single rate models used during RIIO-ET1.

Our critique of this approach is set out in Section 5.5 below.

[28] Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', 9 July, paras 3.34–3.37.
[29] Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', 9 July, para. 4.3.
[30] Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', 9 July, para. 4.14.

3 Overview of Ofgem's cost assessment framework

Key messages

- There are many factors that make cost benchmarking for the electricity transmission sector challenging, including the limited number of domestic comparators and their differences in scale and region-specific characteristics. In such a setting, a robust modelling approach must take into account the comparability of different benchmarks, the potential for cost allocation/reporting issues and the scope for modelling error.

- Our assessment of Ofgem's cost assessment methodology is that it does not address these challenges in a robust manner through a combination of: (i) a cost assessment framework that makes little allowance for the potential for error; and (ii) benchmarking models that overlook important normalisation factors or cost drivers due to limited data and are, therefore, subject to significant modelling noise. These issues result in an inappropriately large challenge to SHE-T's submitted business plan expenditure.

- In particular, Ofgem's cost assessment framework is not balanced as it *removes* the impact of potential positive modelling errors on companies' TOTEX allowance by capping funding at the business plan level but *retains* the impact of negative modelling errors by applying the most stringent benchmark. Specifically, instead of triangulating across multiple robust views in a way that improves the robustness of the benchmark, Ofgem tends to apply the *minimum* of several views. This produces a negative bias for TOTEX allowances in the transmission sector. This downward bias is not justified within Ofgem's sector methodology. This imbalance is inconsistent with best practice cost assessment and Ofgem's duties to ensure companies' business plans are financeable.

- This approach also weakens incentives to outperform in the future and submit efficient business plans—at the expense of future consumer welfare. The key feature of incentive regulation is that companies are offered the possibility to outperform the regulatory decision. By capping funding, Ofgem is removing such high-powered incentives to achieve future efficiency gains, which are designed to lead to benefits to consumers in the form of lower prices at future price controls.

- Overall, while accurately determining efficient TOTEX is an inherently challenging exercise, the application of top-down benchmarking approaches can be particularly difficult in the transmission sector and any approach will necessarily involve some degree of noise and error, Ofgem's methodology places the entire risk of a large scope for (negative) error entirely on transmission companies.

- Moreover, Ofgem's published material on cost assessment lacks a clear and comprehensive description of the methodology and analysis undertaken. In particular, Ofgem's outputs do not always contain information necessary to follow, replicate and validate its analysis without considerable effort, especially regarding the model selection and estimation of the econometric analysis. We note that Ofgem did not carry out a methodology consultation for the transmission sector and does not provide a separate cost assessment methodology document setting out the rationale for its overall approach

- Unless these issues are adequately addressed by Ofgem at the Final Determinations, SHE-T's cost allowances will be understated.

3.1 Introduction

Ofgem's annex[31] for the electricity transmission sector sets out some of the challenges it faces in undertaking cost assessment in the electricity transmission sector:

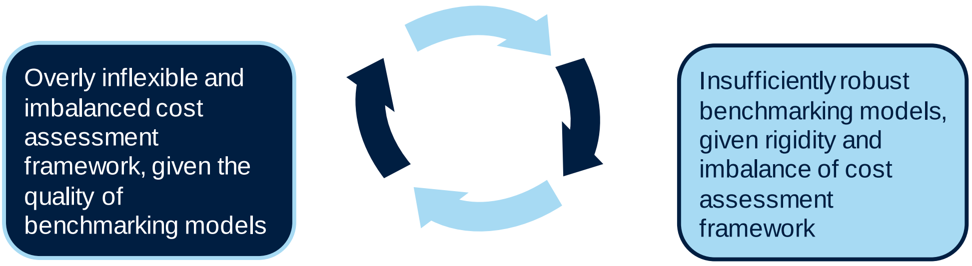
- there are relatively few domestic comparators—three TOs in Great Britain;
- these comparators vary in size and scale;
- there are a number of region-specific elements to their business plans;
- there is a lack of comparability to other regulatory regimes/international comparators.

Given such challenges, a robust cost assessment framework for electricity transmission must carefully take into account the following factors.

- **The comparability of different benchmarks**—including but not limited to the differences (e.g. in terms of outlook, activity mix) between RIIO-T1 and RIIO-T2; differences in regional factors affecting companies' efficient cost relative to other comparators; differences in regional factors affecting a specific project's efficient cost relative to internal or external benchmarks.
- **The potential for cost allocation/reporting inconsistencies**[32] or **cost synergies** to affect the cost assessment framework and comparability of different benchmarks.
- **The scope for modelling error**—noting that unit cost analyses are models in the same way that econometric models are and can be highly susceptible to modelling error—and whether the regulatory framework leads to the impact of such error being biased either upwards (leading to higher TOTEX allowances, to the detriment of consumer welfare) or downwards (leading to lower TOTEX allowances, to the detriment of the ability of the company to finance its functions).

Our assessment of Ofgem's cost assessment methodology is that it does not adequately address all of the above issues through its combination of: (i) a cost assessment framework that makes little allowance for the potential for error; and (ii) benchmarking models that ignore important normalisation factors or cost drivers due to limited data and are therefore subject to significant modelling noise, as illustrated in Figure 3.1.

Figure 3.1 Challenges with Ofgem's TOTEX assessment methodology



Source: Oxera.

[31] Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', 9 July, para. 3.11.
[32] Including differences in reporting data and definitions across and within companies.

3.2 Main features of Ofgem's cost assessment framework

The principal feature of Ofgem's cost assessment framework is that it *removes* the impact of potential positive modelling errors on companies' TOTEX allowance by capping funding at the business plan level but *retains* the impact of negative modelling errors by applying the most stringent benchmark in several cases.[33] Section 4.1 sets out in more detail how the specific mechanics of Ofgem's cost assessment framework lead to a downwards-biased TOTEX allowance overall. Such downward bias cannot be considered an appropriate aspect of a reasonable top-down cost-modelling approach and constitutes a departure from regulatory precedent in energy and other sectors.

A second feature is the way in which Ofgem uses multiple sources of evidence. If used appropriately, deriving multiple benchmarks to assess efficiency can reduce some of the uncertainty associated with modelling efficient costs in the transmission sector. Two approaches have been used in regulatory contexts (further details are provided in section 4):

- giving companies the 'benefit of the doubt', as the truth is unknown and inappropriate outcomes may be driven by the assumptions underpinning a particular approach;[34]
- triangulating results across multiple evidence bases using a simple mean or other measure (such as weighting by evidence quality), *can* lead to a more robust outcome than relying on a single method, as statistical noise and other drivers of uncertainty can offset each other.[35]

However, instead of triangulating across multiple robust views in a way that improves the robustness of the benchmark, in several cases Ofgem inappropriately applies the *minimum* of several views, for example applying the lower of RIIO-T1 and RIIO-T2 benchmarks in its assessment of network operating costs and LRE and NLRE for lead projects. Rather than reducing the potential for a downwards bias caused by model uncertainty, this approach increases the potential for downwards bias for TOTEX allowances in the transmission sector and therefore reduces the accuracy of the resulting benchmark. Section 4.2 sets out in more detail how multiple sources of evidence are combined in a way that reduces rather than increases the accuracy of Ofgem's TOTEX assessment.

This is both a rigid and skewed approach to cost assessment:

- rigid, as it requires the cost assessment models to be very accurate at identifying inefficiency to set an appropriate allowance;
- skewed, as error that increases the TOTEX allowance is removed, while error that decreases the TOTEX allowance is retained.

Even in an hypothetical scenario with very accurate cost assessment models, a framework with these two features is highly unlikely to set an appropriate cost allowance, as differences in model results can be driven by the different

[33] In principle, every modelling approach can be affected by modelling errors (or 'biases'), in particular in the presence of measurement errors in the variables used or model specifications omitting important cost drivers. Such biases can affect the estimates both upward and downward, depending on the direction of the impact on the estimated allowance.
[34] For example, this is the approach followed by the German energy regulator, as discussed in further detail in section 4.2.2.
[35] To the extent that triangulation is across a number of robust models. Triangulating across a robust model and a biased model will not produce a superior outcome, relative to only using the robust model.

assumptions underlying the alternative modelling approaches and it may be unknown which is the most appropriate.

Importantly, this approach also reduces incentives to outperform in the future and submit efficient business plans. The key feature of incentive regulation is that companies are offered the possibility to outperform the regulatory decision to earn higher returns. By capping funding, Ofgem is removing such high-powered incentives to achieve future efficiency gains, which are designed to lead to benefits to consumers in the form of lower prices at future price controls. This is exacerbated by the low incentive rate available for cost areas where it does not have confidence in underlying data (15%). This short term view of efficiency places too much weight on the benefits of short term reductions in prices at the cost of future technology improvement to benefit consumers across Great Britain.

Given the numerous difficulties associated with cost assessment in the transmission sector as outlined above, it is even less likely that such a framework could be appropriate.[36]

In addition, as set out in section 5, there are a number of issues with the cost assessment models developed for the RIIO-T2 draft determinations. Key examples of inappropriate aspects of Ofgem's approach to modelling at RIIO-T2 include:

- use of a benchmark based on historical data without accounting for differences arising from changes in the type or volume of activity, e.g. SHE-T experienced a material shift in the location and type of underground cable work being delivered between T1 and T2;[37]
- the use of models that do not contain all the relevant operational drivers (e.g. scale of projects, asset location) for the cost activity being modelled;
- double counting of a cost reduction in the CAI and BSC modelling;
- the application of direct cost benchmarks with an implausibly large amount of unexplained variation that cannot be solely attributable to inefficiency, as shown by the large variation in unit costs for most LRE and NLRE lead projects (section 5.3).[38]

While *some* models with *some* of these features could be used within a cost assessment framework, such a framework would need to mitigate these issues by carefully re-examining the modelling approach used and the appropriateness of a cap on funding as well as adopting a more balanced triangulation approach. By applying all of these features together, Ofgem generates substantial 'efficiency challenges' as a product of model noise, rather than genuine potential for efficiencies.

It is instructive to consider what the characteristics of a hypothetical efficient company plan would have to be in order for its TOTEX submission to be considered efficient within Ofgem's cost assessment framework at the Draft Determinations. A necessary, but not sufficient, set of characteristics would include the following.

[36] Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', 9 July, para. 3.11.
[37] As set out in documented in SHE-T's response to question 6 and question 7 of Ofgem's consultation on its company-specific annex—i.e. SHETQ6 and SHETQ7.
[38] We note that this does not include the potential impact of Ofgem's bottom-up assessment approach to assess other categories of expenditure relating to LRE and NLRE projects.

- Within **each** of its 27 LRE projects and 28 NLRE projects with associated direct costs, **every** unit cost across the 99 asset types (30 of which are subject to a benchmark) benchmarked by Ofgem would have to be lower than both historical RIIO-T1 *and* forecast RIIO-T2 weighted sector mean benchmarks for that asset type.
- Within **each** of the 11 areas within network operating costs, **every** sub-unit cost or annualised rate across up to 50 different sub-areas per area, would have to be lower than the RIIO-T1 benchmark.
- Any uncaptured[39] upwards cost pressure caused by regional factors, change in input mix, or noise[40] affecting the unit cost of **any** asset type or sub-area within **any** LRE project, NLRE projects or network operating cost category would have to be small enough to avoid pushing project cost above the benchmark.
- Any uncaptured[41] downwards cost pressure caused by regional factors or statistical noise affecting the unit cost of **any** asset type within **any** LRE project, NLRE project or network operating cost category that contributes to the sector or company[42] RIIO-T1 and RIIO-T2 benchmarks would have to be small enough to avoid these benchmarks becoming artificially[43] challenging for truly efficient projects.
- Any cost misallocation—which can result from unclear/ambiguous regulatory reporting guidelines as well as company error[44]—or synergies that affect the unit cost of **any** asset type within **any** LRE project, NLRE project or network operating cost category would have to be small enough to avoid pushing project cost above the benchmark.
- Any cost misallocation or synergies that affect the unit cost of **any** asset type within **any** LRE project, NLRE project or network operating cost category that contribute to the sector or company[45] RIIO-T1 and RIIO-T2 benchmarks would have to be small enough to avoid these benchmarks becoming artificially[46] challenging for truly efficient projects.
- Any cost differences driven by new outputs or requirements at RIIO-T2 affecting the unit cost of **any** asset type within **any** LRE project, NLRE project or network operating cost category would have to be small enough to avoid pushing project cost above the benchmark.
- The net impact of any statistical noise and model mis-specification on econometric models of CAI and BSC expenditure would either be upwards-biased or smaller in scale than company outperformance beyond the sector average benchmark.

[39] As only unit cost analysis is used, any regional factor that increases unit costs will not be captured.
[40] We note that, while noise is more commonly discussed in the context of econometric modelling, applying unit cost analysis just imposes a more restricted cost model. As such it is equally, if not more, prone to such issues.
[41] As only unit cost analysis is used, any regional factor that increases unit costs will not be captured.
[42] In benchmarking network operating costs, Ofgem uses a company-specific benchmark.
[43] i.e. impose a benchmark more stringent than the truly efficient cost.
[44] For example, TSOs are instructed to ensure the categorisation of each investment activity (replacement, refurb etc) is to be determined by the *primary* driver. This leads to expenditure on activities which do not generate new asset volume being included with new assets and therefore being cut because the expenditure is not supported by a corresponding volume.
[45] In benchmarking network operating costs, Ofgem uses a company-specific benchmark.
[46] I.e. impose a benchmark more stringent than the truly efficient cost.

- Not being subject to ***any*** workload adjustments affecting CAI or BSC expenditure, given the way Ofgem's cost assessment framework combines outperformance and workload adjustments (see section 5).

It is clear that there are many possible company business plans that could be objectively efficient but not meet each and every one of these criteria. On the other hand, meeting all of these criteria appears highly improbable. In short, Ofgem's cost-assessment framework will almost certainly determine *any* business plan to be inefficient *by design*. Further, by capping company expenditure at its submitted costs, Ofgem removes the possibility for any imperfections in its cost assessment framework to cancel out. As such, any imperfections will result in erroneous outcomes. Moreover, it is unclear how this approach is consistent with a TOTEX framework designed to avoid biasing companies to target particular solutions.[47] We set out these two complementary sets of issues: the framework and the models, in more detail in sections 4 and 5 respectively.

Overall, while accurately determining efficient TOTEX is an inherently challenging exercise, the application of top-down benchmarking approaches[48] can be particularly difficult in the transmission sector[49] and any approach will necessarily involve some degree of noise and error, Ofgem's methodology places the entire risk of a large scope for error entirely on transmission companies—to the detriment of the ability of the company to finance its functions.

Although some of the challenges mentioned above were recognised early on in the price review process, we understand from SHE-T that there was limited engagement from Ofgem on the cost assessment methodology and the selection of a relevant approach for the electricity transmission sector. We note, for example, that in its RIIO-2 cost assessment tools consultation, Ofgem explicitly states that:

> Further detail on other cost assessment tools that we more typically apply in the transmission sector are also provided (but for which **we do not seek explicit views**).[50] [Emphasis added]

Of the 24 questions consulted on:

- 2 related to ongoing efficiency/frontier shift in general;
- 2 to related to real price effects in general;
- 17 to TOTEX assessment in the gas distribution sector only; and
- 3 related to assessing business support costs across gas distribution, gas transmission and electricity transmission.

Not only does business support constitute a relatively small component of TOTEX in electricity transmission, but the questions themselves were relatively high level:

> Question 13: Should we assess business support costs at a group level in order to address cost allocations across companies within groups?

[47] Ofgem (2010), 'Handbook for implementing the RIIO model', October, p. 64.
[48] As set out in section 2, a review of bottom-up/engineering/operational assessments falls outside the scope of this report.
[49] Relative to sectors with more domestic comparators, such as water or gas distribution.
[50] Ofgem (2019), 'Consultation – RIIO-2 tools for cost assessment', 28 June para 1.3.

> Question 14: Which types of business support costs should be benchmarked, and how should they be benchmarked?
>
> Question 15: Which types of business support costs should be excluded from benchmarking?[51]

Ideally, efficiency targets should be set using a methodology that is predictable (in terms of the tools and sources of information used) and that has been consulted on and agreed with the industry. This has the positive effect of securing trust in the approach as well as facilitating replication and validation of the results from third parties.

In this respect, we note that Ofgem's published material on its approach to cost assessment lacks a clear and comprehensive description of the methodology and analysis undertaken, and the justification for the particular approach followed. In particular, Ofgem's outputs do not always contain necessary information to follow, replicate and validate its analysis without considerable effort, especially regarding the model selection and estimation of the econometric analysis. Although Ofgem has published the modelling codes used by its consultants, the codes contain information on BSC and CAI cost modelling only, from which Ofgem also partially deviates in its determination. Similarly, Ofgem has not provided details on its methodology or calculations for stripping out SHE-T's ongoing efficiency assumption from its business plan, which is, as result, difficult to replicate. Finally, we note that the information is available only to Ofgem and networks, in contrast to other regulators (such as Ofwat) which provide files to replicate determinations in the public domain.

In conclusion, unless these issues set out above (and in more detail below) are adequately addressed by Ofgem at the Final Determinations, SHE-T's cost allowances will be understated. Between the Draft and Final Determinations, transparency and close engagement with transmission operators (and other stakeholders) will be important in areas where Ofgem amends its approach to address the issues set out in this note.

[51] Ofgem (2019), 'Consultation – RIIO-2 tools for cost assessment', 28 June p. 45.

4 Ofgem's cost assessment framework

Key messages

Capping funding

- Ofgem's current approach of capping funding at a disaggregate level is inappropriate, not supported by regulatory precedents and risks diluting incentives for companies to reveal efficiencies through outperformance over RIIO-T2 and submit stretching plans for RIIO-T3 onwards—to the detriment of future consumers.
- We illustrate that, as uncertainty in the efficient cost allowance increases, Ofgem's approach is likely to impose a disproportionate reduction in companies' TOTEX allowance unrelated to considerations of efficiency.
- Ofgem should assess whether a cap is warranted in the first place and, if so, whether it should be applied leaving no headroom for companies and the longer-term impact of its application. Assuming a cap is deemed appropriate at all—for example, where the modelling allowance is significantly above that requested by a company—considering capping at the TOTEX level or at the aggregate cost category level could constitute a reasonable base case. Even this latter approach is not without risks as there could be cost synergies or reporting inconsistencies between closely associated indirect expenditure and related LRE or NLRE projects.

Using multiple sources

- Cost assessment should consider multiple sources of evidence and tools to inform a benchmark. This increases the amount of information available to determine an efficiency target, and pooling results across models can be used to mitigate the impact of individual model error.
- Where noise is substantial, as it is here, Ofgem's approach of selecting the minimum across two benchmarks can lead to a sizeable cost challenge which is unrelated to company efficiency. For this reason, regulators typically do not consider a minimum approach to combining results from different benchmarks but rather triangulate across multiple evidence base.
- Ofgem should assess the extent to which noise is likely to affect its estimated benchmarks—for example by considering the distribution of unit costs or model predictions—and use this information to inform an appropriate methodology for triangulating across multiple benchmarks. Ofgem should also consider developing models using different approaches or different levels of aggregation to validate the results from its current models.

4.1 Capping funding

As set out above, a key feature of Ofgem's cost assessment framework is that it removes the impact of upwards modelling error on companies' TOTEX allowance, but retains the impact of downwards modelling error. This mechanism is either explicit, for example in its BSC modelling file Ofgem labels an adjustment as 'Adjusting the allowed cost to lower of modelled vs submitted',[52] or implicit where Ofgem states that 'our proposed allowance for asset costs is based on the lower of the network company's proposed unit

[52] 'PostAnalysis_File_SHET.xlsx', sheet Cal_BSS, cell J37.

costs for the scheme and Ofgem's benchmark unit cost for all asset types'.[53] Hereafter, we refer to both cases as 'capping funding'.[54]

As noted above, even if combined with cost assessment models that perfectly predicted efficient expenditure at the relevant level of aggregation, Ofgem's approach would risk diluting incentives for companies to reveal efficiencies through outperformance over RIIO-T2 and submit stretching plans for RIIO-T3 onwards—to the detriment of future consumers.

As uncertainty in the efficient cost allowance increases, Ofgem's approach is highly likely to impose a disproportionate reduction in companies' TOTEX allowance unrelated to considerations of efficiency. In particular there are three main potential sources of model error that can lead to an inappropriate reduction in companies' allowed TOTEX:

- noise/unexplained factors—unexplained variation in the data used to develop benchmarking models that appears to be inefficiency but is in fact related to uncontrolled characteristics such as regional conditions or different output/input mix. It is important to note that unit cost approaches are equally susceptible to such error as more complex econometric approaches;
- cost allocation inconsistencies—allocation of direct or shared project costs in an inconsistent way between companies, in such a way that some projects appear artificially expensive and others correspondingly artificially inexpensive or appear without associated volumes;
- operational synergies—where carrying out a certain combination of projects together leads to cost reductions that would not necessarily be available for comparators carrying out some of the same projects in isolation.

4.1.1 Stylised example

Figure 4.1 sets out a stylised example of the potential impact of any of these issues on cost allowances across two hypothetical areas of expenditure within LRE.[55] Each chart sets out three bars—unit costs from the company business plan, a RIIO-T1 sector benchmark unit cost, and a RIIO-T2 sector benchmark unit cost. The implied benchmark is defined by the lower of the T1 or T2 benchmarks, and shown as a dashed line. The company submits the same cost in both cases.

The upper row of the panel sets out the 'true' picture of cost efficiency across two cost areas within LRE, area 1 on the left and area 2 on the right. In both areas, the 'true' cost position of the company is that it spends less (i.e. outperforms) the benchmark in both areas, and so receives an allowance equivalent to its full submission across the two areas.

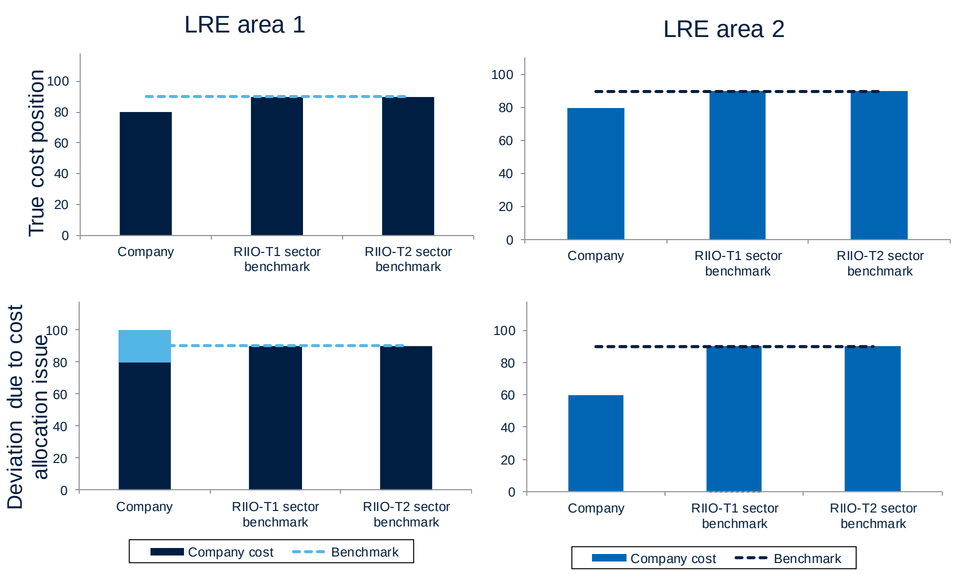
The lower row of the panel shows the impact of a deviation from the company's 'true' cost position, which could result from a cost allocation inconsistency.[56] As a result, costs in area 1 appear to be £20m greater than the true level, while costs in area 2 costs appear to be £20m lower. In both cases, the company

[53] Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', 9 July, para. 3.23.
[54] Note, strictly this is a cap on *ex ante* outperformance, as this relates to assessment of the company business plan.
[55] We note that the issue highlighted by this example is not specific to LRE expenditure, but applies to the entirety of Ofgem's TOTEX assessment, including but not limited to NLRE expenditure and network operating costs.
[56] This example could also represent the impact of regional factors that offset one another, with a disadvantageous factor increasing costs in area 1 and an advantageous factor decreasing costs in area 2.

thus submits total costs of £160m. The company therefore receives a reduced allowance in LRE area 1, because its submitted unit cost exceeds the benchmark. As there is a cap on funding in area 2, there is no corresponding increase available to counteract this. Therefore, despite being efficient, the company receives an allowance of only £150m instead of the £160m submitted.

Were the cap on funding applied at the aggregate level in this hypothetical example, the cost allowance would be unchanged from its submission, resulting in the correct outcome despite allocation/model error.

Figure 4.1 Impact of capping funding: stylised example 1 (£m)



Source: Oxera stylised example.

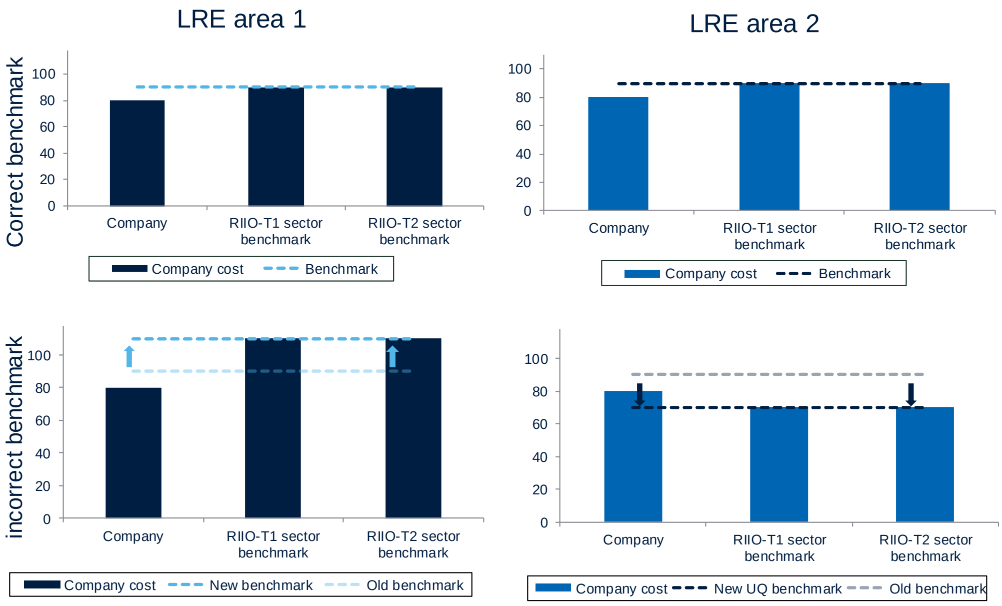
The nature of benchmarking to comparators is that, in order to achieve an appropriate outcome, it is not sufficient that a company's own costs are unaffected by model noise, allocation issues or synergies. *Any* observation that informs the benchmark can affect the allowance for a company, even where the mis-reporting or issue is associated with another company. Therefore (as in first example), despite being efficient, the company receives an allowance of only £150m instead of the £160m submitted.

Figure 4.2 sets out a similar stylised example, but focusing on the potential impact of errors in the benchmark on cost allowances in the context. As before, each chart sets out three bars—the company-submitted unit costs, a RIIO-T1 sector benchmark unit cost and a RIIO-T2 sector benchmark unit cost. The implied benchmark is defined by the lower of the T1 or T2 benchmark, and shown as a dashed line.

The upper row of the panel sets out the same 'true' cost efficiency position as in the previous example. However, in the lower row, rather than amending the company value, we instead show the impact of a deviation of the benchmark from its 'true' level. In this hypothetical example, a consistent unexplained factor leads to T1 and T2 models in area 1 consistently overpredicting expenditure (by £20m relative to the 'true' benchmark in the upper row), while models in area 2 consistently underpredict expenditure (by £20m relative to the 'true' benchmark in the upper row). This leads to a re-calculated benchmark marked by the opaque dashed line, with a transparent line overlaying the original benchmark, for reference.

We see in area 1 that the gap between company-submitted unit costs and benchmark (erroneously) increases substantially. However, as outperformance is capped, the company receives no corresponding increase in its allowance. In area 2, where the benchmark has (erroneously) decreased, the company faces a reduction in costs. Therefore (as in first example), despite being efficient, the company receives an allowance of only £150m instead of the £160m submitted.

Figure 4.2 Impact of capping funding: stylised example 2 (£m)



Source: Oxera stylised example.

4.1.2 Regulatory precedent

Reflecting the inherent issues in Ofgem's approach, we note that there is extensive regulatory precedent against capping funding at the granular level applied at the RIIO-T2 Draft Determinations for the reasons set out above. Some relevant examples include:

- Ofgem's RIIO-GD2 draft determinations—in which a top-down benchmarking model is used (and capping applied thereafter) on the basis of such a model's ability:

  > to better account for cost complementarities, trade-offs and potential reporting inconsistencies across GDNs[57]

- Ofwat's approach to enhancement expenditure relating to environmental obligations at the PR19 draft and final determinations, which moved from applying individual outperformance caps to each constituent element of the programme to applying an aggregate outperformance cap across the entirety of the programme, following push back from water companies.[58] Ofwat explains how and why its approach changed in this area as follows:

  > We are aware of the **limitations of cost models** and control for this in two ways […], for the draft determination stage **we take a programme level approach** to assessing efficient costs as set out below […][59] For benchmarked costs at the initial assessment of plans, we set efficient allowances by taking the

[57] Ofgem (2020), 'RIIO-2 Draft Determinations – Gas Distribution Annex', 9 July, para. 3.60.
[58] Oxera/Yorkshire Water (2019), 'Ofwat's enhancement modelling approaches at the IAP: a review', March.
[59] Ofwat (2019), 'PR19 draft determinations: securing cost efficiency technical appendix', July, p. 60.

> minimum of the company requested investment and our view of efficient costs in each enhancement area. For draft determinations we have changed our approach. **Rather than develop our view of efficient cost within each enhancement area, we develop our view of efficient costs at a programme level**, and set an allowance that is the minimum of our programme level view of efficient costs and the company requested costs.[60] [Emphasis added]

This latter change would be equivalent to Ofgem applying its funding cap to aggregate LRE direct costs, aggregate NLRE direct costs or aggregate network operating costs, rather than its current granular approach.

4.1.3 Suggested amendments

Ofgem should justify its framework decision based on an assessment of the scale of potential error induced by its selective approach, relative to alternatives, and assess whether a cap is warranted in the first place and, if so, whether it should be applied leaving no headroom for companies and the longer-term impact of its application.

Assuming a cap is deemed appropriate at all, funding at the TOTEX level (as Ofgem does in its approach to econometrically modelled costs in the gas distribution sector) would constitute a reasonable base case. An alternative would be capping or partially capping at the aggregate level within each of the five cost areas—indirect operating expenditure, network operating costs, LRE, NLRE and non-operational CAPEX. Even this latter approach is not without risks, for example there could be cost synergies or allocation inconsistencies between closely associated indirect expenditure and related LRE or NLRE projects.

4.2 Using multiple sources of evidence

Cost assessment should consider multiple sources of evidence and tools to inform a benchmark. This increases the amount of information available to determine an efficiency benchmark, and pooling results across models can be used to mitigate the impact of individual model error.

In considering how to combine multiple views of efficient costs, it is relevant to consider the distinction between noise and inefficiency. Any model, however complex or simple (including unit cost analysis), is subject to noise, representing the difference between the true cost prediction and the prediction estimated by the model. In the absence of persistent bias, such as that caused by omission of a key cost driver, model noise will be distributed approximately symmetrically—i.e. in some models the estimated prediction will be higher than the true value, while in others it will be lower with an approximately equal probability. By contrast, inefficiency is an inherently one-sided concept, as a company can be more or less inefficient, but can never have 'negative inefficiency'.

While some cost assessment modelling approaches, such as stochastic frontier analysis, aim to explicitly model inefficiency and model error separately, the approaches applied by Ofgem at RIIO-T2—unit cost analysis and ordinary least squares regression—do not make this distinction.

As a result, the difference between the prediction of any one of Ofgem's benchmarking models and a company's submission will always be a combination of noise and inefficiency. In determining the best way to combine

[60] Ofwat (2019), 'PR19 draft determinations: securing cost efficiency technical appendix', July, p. 61.

multiple sources of evidence on efficiency, a key consideration is whether the difference for each model is primarily inefficiency or noise.

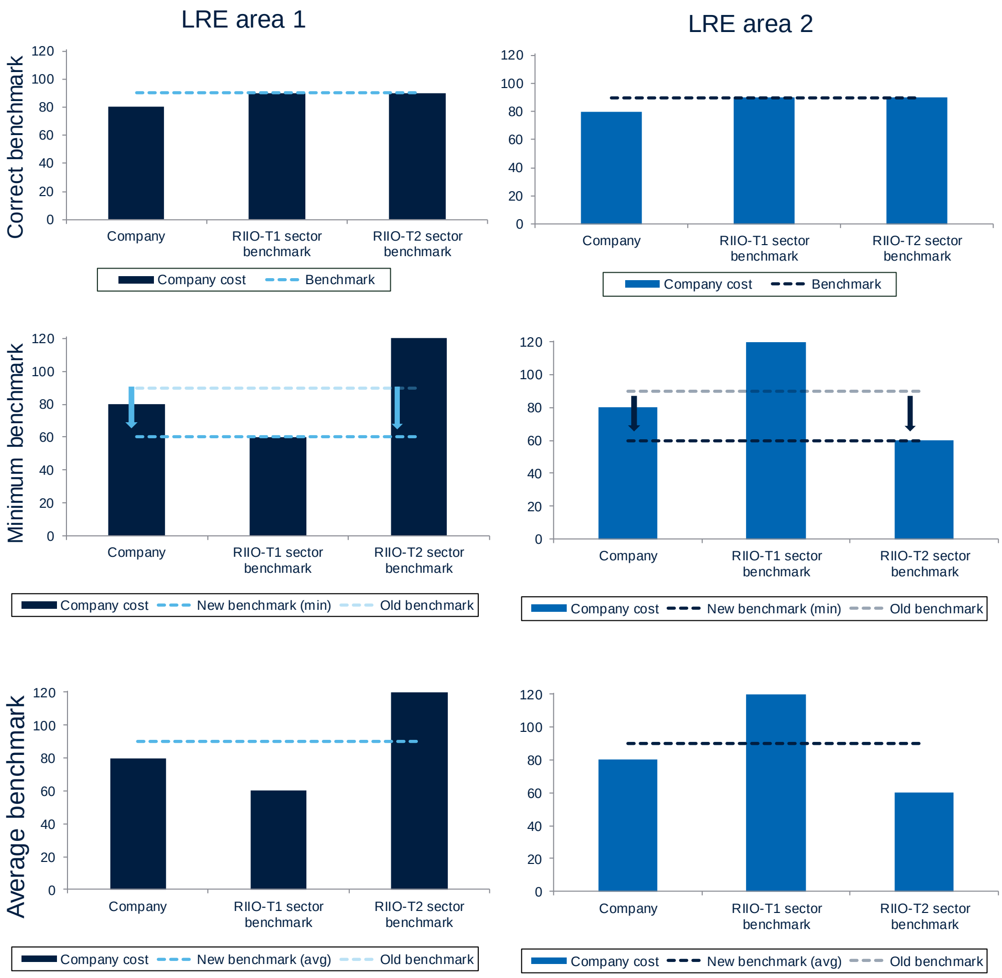
Consider, for example, a regulator that suggests the use of two different benchmarks based on two different approaches. As the scope for noise affecting the benchmarks increase, so too does the likelihood of either benchmark that is set primarily due to noise. Choosing the minimum of the two benchmarks may result in an unattainably stringent efficiency challenge, which could result in reduced levels of service from the company. Such a possibility is made more likely by the selection of the minimum benchmark.[61]

4.2.1 Stylised example

Figure 4.3 sets out a stylised example in which selecting a minimum benchmark can lead to an inappropriately stringent allowance. The first row of the panel sets out the same 'true' cost efficiency position as used in the two examples from section 4.1 (Figure 4.1 and Figure 4.2). The second panel shows the impact of applying a minimum benchmark where the impact of model noise reduces one benchmark by £20m and increases the other by £20m. Finally, the third row demonstrates the impact of moving to an average benchmark, which completely mitigates the effect of noise in this scenario.

[61] For example, in the Bristol Water price appeal inquiry, the Competition and Markets Authority (CMA) felt that econometric models based on high-level cost drivers were susceptible to modelling limitations and data errors, and that an upper quartile benchmark might be overly demanding. The CMA also noted that, for it to properly apply an upper quartile (or any another benchmark besides the average), it would be necessary to make adjustments for company-specific factors to account for idiosyncrasies prior to calculating the efficiency scores. See Competition and Markets Authority (2015), 'Bristol Water plc, A reference under section 12(3)(a) of the Water Industry Act 1991, Report', October, paras 4.217–4.225.

Figure 4.3 Impact of applying a minimum triangulation approach: stylised example (£m)



Source: Oxera stylised example.

As a result, where noise is substantial, selection of the minimum across two benchmarks can lead to a sizeable cost challenge that is unrelated to company efficiency and is therefore unreasonable. For this reason, regulators typically do not consider a minimum approach to combining results from different benchmarks.

4.2.2 Regulatory precedent

In regulated sectors, analyses typically use a greater number of comparators than available for Ofgem's electricity transmission sector benchmarking, control for a greater number of cost drivers than in Ofgem's electricity transmission sector methodology and use more sophisticated approaches than unit cost analysis. As such, the scope for noise may be even greater in the transmission sector (see section 3).

Relevant examples of using multiple sources of evidence to inform the benchmark in other regulated sectors include:

- Ofgem's RIIO-GD1 approach to expenditure in the gas distribution sector, which **averages** the result from across four approaches to determine the baseline costs of gas distribution networks;[62]
- Ofgem's RIIO-ED1 approach, which used a weighted average of the top-down TOTEX model (25%), bottom-up TOTEX model (25%) and disaggregate models (50%).[63] Ofgem suggests a similar approach for RIIO-ED2;[64]
- Ofgem's approach in both RIIO-GD1 and RIIO-ED1 was based on an upper-quartile (and not the most stringent) benchmark, and additionally triangulated its view with the companies' (in the ratio 75:25) to reflect modelling limitations and informational imperfections;[65]
- Ofwat's approach to benchmarking enhancement expenditure at PR19—Ofwat averaged the results across different models, justified on the following basis:

  > We are aware of the limitations of cost models [for assessing enhancement relating to environmental obligations] and control for this in two ways. Firstly we **frequently triangulate between multiple models** to maximise the number of the factors used in assessing modelled costs […][66] [Emphasis added]

- The German energy regulator, Bundesnetzagentur, uses the **maximum** efficiency value from four approaches (two different methodological approaches with two different definitions of TOTEX for each approach) as the efficiency challenge for gas and energy distribution networks, in accordance with the requirements set out in the German regulatory Ordinance.[67] Efficiency values are also capped with a lower bound of 60%.[68]

None of the above take a minimum approach. As regards the use of a minimum benchmark, Ofgem made the following remarks with regard to this in the context of gas distribution in its cost assessment methodology for RIIO-GD2:

> In setting efficiency benchmarks in RIIO-1, we were mindful **the level of the company with the lowest costs** may be unachievable and unrealistic. This was because our models did not account for all company differences or perfectly map costs with cost drivers…[69] [Emphasis added]

As noted above, and in more detail in section 5, it is inconsistent (and inappropriate) for Ofgem to consider its (relatively) more robust econometric modelling in gas distribution to be insufficient to select a minimum benchmark and yet impose the minimum of sectoral or company weighted mean unit costs for transmission operators.

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[62] Ofgem (2012),'RIIO-GD1: Final Proposals - Supporting document - Cost efficiency', p. 12.
[63] Ofgem (2014), 'RIIO-ED1: Final determinations for the slowtrack electricity distribution companies Business plan expenditure assessment', November, p. 30.
[64] Ofgem (2020),' RIIO-ED2 Sector Methodology Consultation: Annex 2 Keeping bills low for consumers', July, p. 20.
[65] Ofgem (2014), 'RIIO-ED1: Final determinations for the slowtrack electricity distribution companies', November.
[66] Ofwat (2019), 'PR19 draft determinations: securing cost efficiency technical appendix', July, p. 60.
[67]§12 (3), Anreizregulierungsverordnung.
[68]§12 (4), Anreizregulierungsverordnung.
[69] Ofgem (2019), 'Consultation – RIIO-2 tools for cost assessment', 28 June para. 8.2.

4.2.3 Suggested amendments

To develop its cost assessment framework for the Final Determinations, Ofgem should adequately address the issues set out above.

First, Ofgem should assess the extent to which noise is likely to affect its estimated benchmarks—for example, by considering the distribution of unit costs or model predictions—and use this information to inform an appropriate methodology for triangulating across multiple benchmarks.

Second, Ofgem should consider developing models using different approaches or different levels of aggregation to validate the results from its current models. Such models should only be used where the benchmark set from these models can be considered to be robust. Unless these issues are adequately controlled for at the Final Determinations, SHE-T's cost allowances would be unreasonably underestimated, as illustrated in section 5.2 below for indirect operating costs.

5 Robustness of benchmarking models

Key messages

Indirect operating costs

- Ofgem's benchmark to CAI costs is based on an erroneous combination of the workload and outperformance adjustments. This leads to an unreasonable cost challenge to SHE-T's expenditure that appears incongruous with Ofgem's initial finding that SHE-T's CAI expenditure is efficient.
- Even taking Ofgem's workload adjustment as given, a reasonable range for SHE-T's CAI allowance would be between £213m and £220m—excluding allowances for areas assessed through bottom-up assessment, namely IT&T, which under Ofgem's current methodology equate to an additional allowance of +£10.70m[70]—or a total range including bottom-up areas of £224m–£231m. The lower bound reflects Ofgem's estimation of the workload adjustment, while the upper bound reflects SHE-T's revised expectation of its CAI expenditure accommodating the workload adjustment imposed by Ofgem.
- The lower bound relies on assumptions from Ofgem's econometric model that do not align with the operational impact of the reduction in expenditure on CAI. Therefore, absent development of a model that (at a minimum) addresses these issues, the upper bound of £220m (£227m including bottom-up costs) represents the most appropriate allowance for SHE-T for CAI.

LRE and NLRE

- Ofgem's unit cost modelling approach is associated with a considerable level of uncertainty and variation across companies. As a result, we would recommend that Ofgem follow a balanced approach by giving companies the benefit of the doubt, i.e. applying the maximum between the T1 and T2 benchmarks, instead of a minimum. This is consistent with regulatory precedents elsewhere in Europe. Making this change in isolation would result in an additional allowance of £35m for SHE-T. Where subsequent modelling development leads to more accurate modelling, a more stringent triangulation could be considered, such as taking an average across the two.
- To address the impact of uncontrolled project characteristics, local factors and differences in cost allocation, we would recommend that Ofgem review the need to cap funding. If a cap is to be used we would recommend that it be applied at the LRE and NLRE level, rather than at the asset-project level. Implementing this recommendation in isolation would result in an additional allowance of £64m for SHE-T. Implementing both recommendations would give an additional allowance of £150m in RIIO-T2.

Network operating costs

- The benchmark applied to repairs and maintenance is not consistent with other areas of network operating costs. We understand that Ofgem intends to update its Draft Determinations approach with volume data it received from SHE-T in early May. Based on an application of the benchmark consistent with other cost areas of NOCs this would result in an additional allowance of £24.8m for SHE-T.
- The allowance for repairs and maintenance could increase by a further £13.4m if civils are allowed in full and funding is capped at the NOCs level.

Volume uncertainty model

[70] £2.14m p.a. additional expenditure for IT&T expenditure. We exclude the £4m (£0.8m p.a.) adjustment for disallowed non-operational CAPEX, as we understand this to represent a double count of the workload adjustment arising from disallowed expenditure in this area, see section 5.2.2.

- Ofgem's volume uncertainty mechanism model is not able to predict efficient costs in a robust way. We would recommend that Ofgem re-examine its modelling approach following robust model development procedures in line with the purpose of the model to forecast future, unknown costs of new connections.
- It may be appropriate to consider the use of a bottom-up benchmark that can be tailored to the specific projects if the development of a robust top-down predictive model proves too difficult.

5.1 Introduction

In this section we set out an assessment of the robustness of the top-down benchmarking models used to assess SHE-T's expenditure (as noted previously, bottom-up, operational and engineering approaches to cost assessment fall outside the scope of this report).

As noted in section 3, Ofgem has not provided details on its methodology or calculations for stripping out SHE-T's ongoing efficiency assumption from its business plan. As a result, we have not been able to review and replicate Ofgem's approach for doing so. If done incorrectly, it is possible that for all areas of expenditure aside from CAI/BSC expenditure—the allowance for which is based on historical data only—Ofgem may double count the scope for ongoing efficiency where it relies on a benchmark determined by SHE-T's business plan or a RIIO-T2 sector benchmark to determine SHE-T's allowance. (Ofgem's approach to setting an ongoing efficiency challenge is reviewed in Oxera 'Critique of RIIO-2 ongoing efficiency analysis').[71]

5.2 Indirect operating costs

In this section, we address Ofgem's approach to modelling CAI and BSC expenditure. SHE-T's initial business plan submission for both BSC and CAI is assessed as efficient by Ofgem's econometric modelling approach. However, following adjustments for Ofgem's revised view of CAPEX over RIIO-T2 and outperformance, SHE-T's business plan submission is assessed to have underperformed by £69m—primarily from a £58m difference between SHE-T's submitted business plan cost and the costs predicted by Ofgem's model.

We address three aspects of Ofgem's approach:

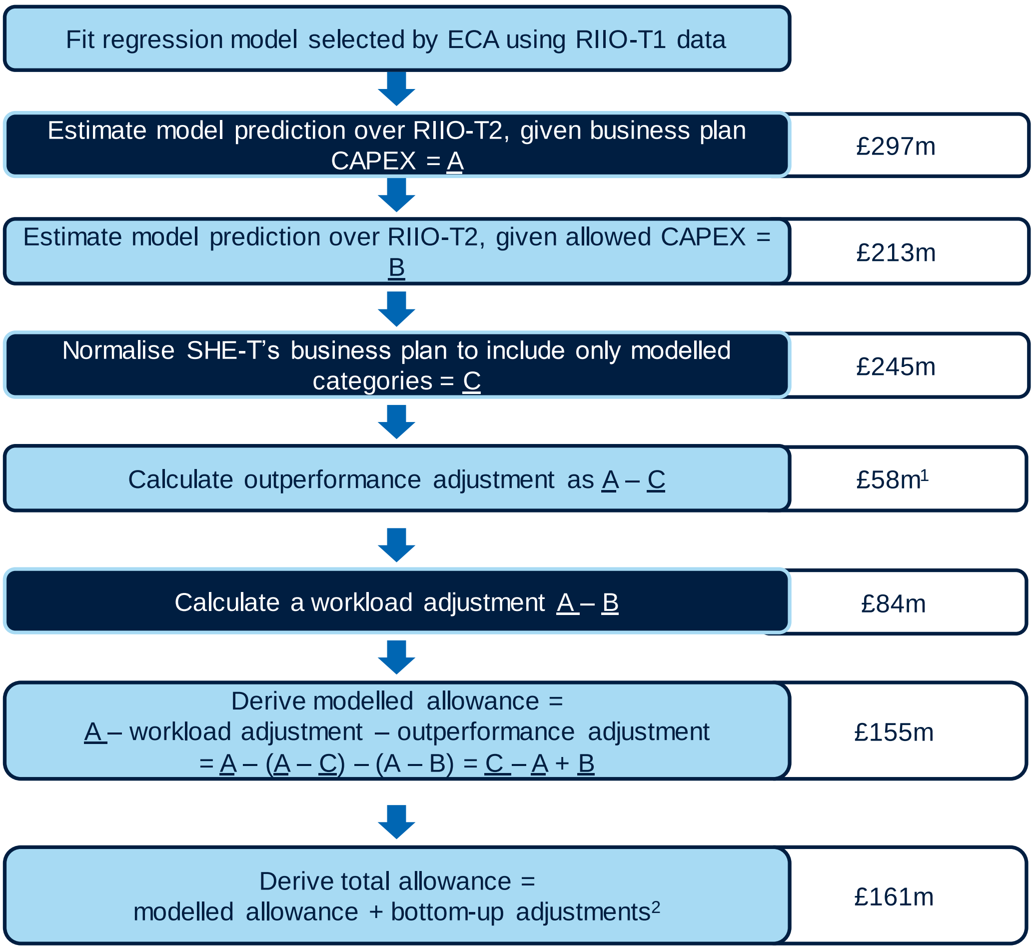
- Ofgem's calculation and application of its workload and outperformance adjustments, taking as given the econometric model;
- other issues with regard to the application of adjustments to Ofgem's econometric model;
- the technical and economic logic of the econometric models selected through this process (a key criterion for selecting econometric models, and identified as such within ECA/Ofgem's own modelling criteria).

5.2.1 The workload and outperformance adjustments

Ofgem uses the models developed by ECA to set CAI and BSC allowances for electricity and gas transmission operators. The following process is used to set CAI expenditure—the BSC approach is equivalent.

[71] Oxera (2020), 'Critique of RIIO-2 ongoing efficiency analysis', August.

Figure 5.1 Ofgem's framework for setting CAI expenditure, post analysis



Note: [1] This is larger than A-C=£53m as a £5m efficiency gap in 2026 is excluded from the calculation by Ofgem. [2] This consists of Ofgem's bottom-up assessment of CAI associated with IT&T expenditure and (+£10.7m) and an adjustment for CAI associated with disallowed non-operational CAPEX (-£4.0m) which we understand to represent a double count, see section 5.2.2.

Source: Oxera, based on 'PostAnalysis_File_SHET'.

The intention underlying the workload adjustment is to ensure that SHE-T is not receiving expenditure to meet closely associated indirect costs that are not required following Ofgem's engineering assessment. The intention underlying the outperformance adjustment is to ensure that SHE-T does not receive more expenditure than it has asked for.

However, combining adjustments in this way leads to a cost challenge to SHE-T's expenditure that appears incongruous with Ofgem's initial finding that SHE-T's CAI expenditure is efficient. While a similar process is followed in assessing BSC expenditure, as no workload adjustment is required, the same problem does not arise.

We first consider the two adjustments in isolation to illustrate the incongruity of Ofgem's approach.

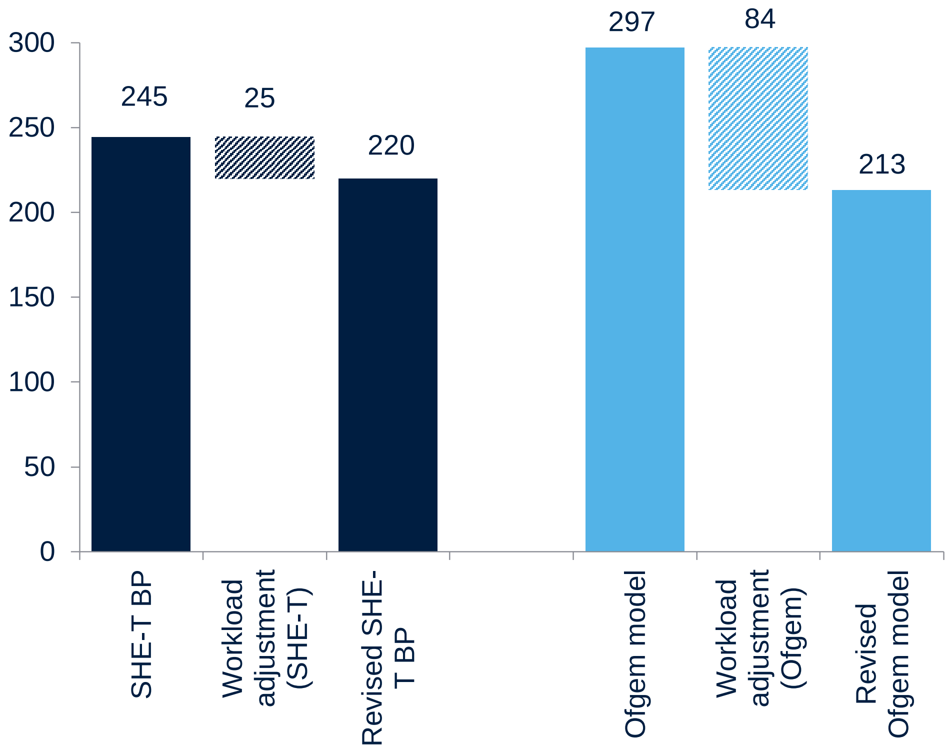
Workload adjustment without an outperformance adjustment

Figure 5.2 sets out how applying the workload adjustment without an outperformance adjustment would affect SHE-T's expenditure.

The left-hand set of bars (in dark blue) shows SHE-T's estimate of the workload adjustment. The leftmost bar shows SHE-T's original business plan submission (£245m) and the righthand bar shows SHE-T's residual CAI expenditure following the workload adjustment (£220m). SHE-T's £25m workload adjustment, the middle dashed bar, is based on SHE-T's analysis of the amount of CAI expenditure associated with the specific CAPEX schemes disallowed by Ofgem.

The right-hand set of bars (in light blue) shows Ofgem's estimate of the workload adjustment. The leftmost bar shows the prediction from Ofgem's CAI model using the original workload in SHE-T's business plan (£297m) and the righthand bar shows the prediction from the econometric CAI model using the prediction from the econometric CAI model using the revised workload allowed by Ofgem (£213m). Ofgem's £84m estimate of the workload adjustment, the middle dashed bar, is based on the difference between its two model predictions.

Figure 5.2 CAI workload adjustment, SHE-T (left) against Ofgem (right) (£m over RIIO-T2)



Note: We note that bottom-up adjustments for disallowed non-operational costs could be considered to fall within the workload adjustment. However we understand this adjustment to represent a double count so it is omitted from the above chart, see section 5.2.2.

Source: Oxera analysis of 'PostAnalysis_File_SHET'.

As set out in section 5.2.3, the estimated cost relationship underlying the larger Ofgem workload adjustment represents a considerable departure from engineering/operational insight, and as a consequence, Ofgem's £84m is likely to be a considerable overstatement of the true workload adjustment.

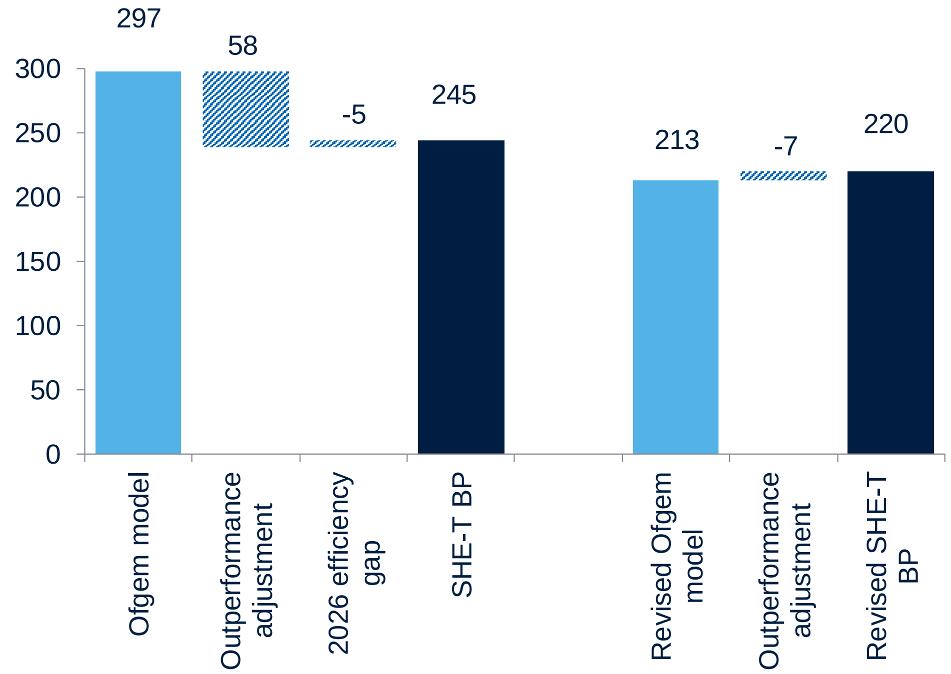
Outperformance adjustment without a separate workload adjustment

Figure 5.3 sets out how applying the outperformance adjustment *without* a separate workload adjustment would affect SHE-T's expenditure. The outperformance adjustment is defined as the difference between Ofgem's model prediction and SHE-T's business plan in every year. For clarity, a negative outperformance value suggests that SHE-T's business plan is higher than (underperforms) Ofgem's prediction.

The left-hand set of bars assumes the workload levels submitted by SHE-T in its business plan. The leftmost bar shows the prediction from Ofgem's econometric model given the workload level submitted in SHE-T's business plan (£297m), while the righthand bar shows SHE-T's original business plan submission (£245m). The £58m outperformance adjustment made by Ofgem, the second dashed bar, is based on the extent to which SHE-T's business plan is lower cost than (outperforms) Ofgem's prediction in 2022–25. This suggests an allowance of £239m. The remaining £5m gap to the SHE-T business plan is the amount by which SHE-T underperforms Ofgem's model in 2026.

The right-hand set of bars assumes the workload levels allowed by Ofgem at the RIIO-T2 draft determinations. The leftmost bar (£213m) shows the prediction from Ofgem's econometric model given the workload adjustment determined from CAPEX reductions at the draft determinations, while the righthand bar (£220m) shows SHE-T's estimate of its required expenditure given the workload adjustment determined at the draft determinations. The -£7m shown by the middle dashed bar is based on the difference between these two—i.e. the extent to which SHE-T's business plan is higher than (underperforms) Ofgem's prediction.

Figure 5.3 CAI outperformance adjustment (£m over RIIO-T2)



Note: We note that bottom-up adjustments for disallowed non-operational costs could be considered to fall within the workload adjustment. As this assessment was carried out on a bottom-up basis we omit these from the above chart. See section 5.2.2 for an assessment of how the timing bottom-up adjustments relates to the outperformance calculation.

Source: Oxera analysis of 'PostAnalysis_File_SHET'.

Considering these sets of adjustments in isolation indicates that, ensuring that allowances were capped at the company business plan and accounting for

Ofgem's required workload adjustment, **a reasonable modelled[72] CAI allowance for SHE-T would lie between £213m and £220m**.

The lower figure of £213m would be more appropriate if the econometric models used to estimate the workload adjustment were considered to be more accurate and robust than SHE-T's business planning adjustment. By contrast, if the econometric model were considered to be subject to uncertainty and error, and if it were considered that SHE-T's business planning adjustment were the more accurate figure, then its revised CAI expenditure of £220m should be allowed in full.

As set out in section 5.2.3 and above, Ofgem's estimate is likely to understate SHE-T's required allowance, given the disconnect between its econometric model specification and the operational/engineering relationship between cost and cost drivers.

Workload and outperformance adjustment

Ofgem imposes an unreasonable benchmark by using an erroneous combination of the adjustments set out above. In particular, it combines:

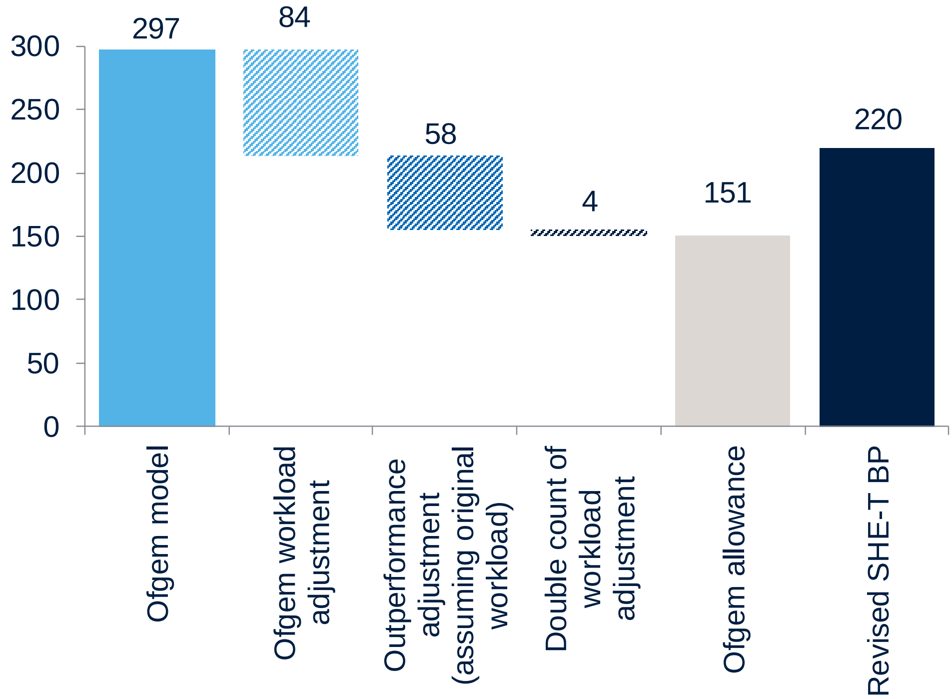
- the workload adjustment, derived by comparing the difference between the output of its econometric model with and without the CAPEX levels disallowed by Ofgem at the Draft Determinations; with
- an outperformance adjustment based on SHE-T's business planning data and Ofgem's econometric model **before** making any adjustment for workload.

Figure 5.4 shows how Ofgem's process compares with the adjustments set out above:

- Ofgem starts with the prediction from its econometric model assuming that SHE-T carries out the level of CAPEX set out in its business plan, £297m;
- next it subtracts £84m based on re-estimating its econometric model assuming that SHE-T carries out the level of CAPEX allowed by Ofgem at the Draft Determinations (as noted above and in section 5.2.1, this is likely to be an overestimate of the scale of the correct adjustment);
- next it subtracts £58m based on the difference between the results of its econometric model assuming that SHE-T carries out the level of CAPEX set out in its business plan in 2022–25 and SHE-T's original business plan submission for the same period;
- next, it subtracts £4m based on the spend associated with disallowed non-operational CAPEX schemes, which we understand to represent a double count, as the impact of these schemes is already accounted for within the £84m workload adjustment (we address this point in section 5.2.2);
- this gives a total allowance of £151m, relative to SHE-T's estimate of CAI expenditure required to deliver the amount of CAPEX allowed by Ofgem, £220m.

[72] Before the addition of £10.7m of separately assessed IT&T expenditure.

Figure 5.4 Ofgem's approach compared with adjusting for workload and outperformance (£m)



Note: This chart only covers modelled expenditure and does not include adjustments relating to Ofgem's bottom-up assessment of CAI associated with IT&T expenditure (£10.7m).

Source: Oxera analysis of 'PostAnalysis_File_SHET'.

The outcome of this is an efficiency gap to SHE-T's CAI expenditure programme of £69m[73]—31% relative to submitted CAI expenditure. Moreover, only £7m of this gap relates to the impact of the workload adjustment. A further £4m gap arises from the application of an additional adjustment to account for non-operational CAPEX being disallowed—we address the potential double count in section 5.2.2. The remaining £58m gap—27% of submitted CAI expenditure—is based on the outperformance that SHE-T's *would have achieved* had Ofgem *not* applied a workload adjustment. Given that Ofgem *does* apply a workload adjustment, it is unclear why SHE-T's allowance should be reduced by over one quarter on the basis of hypothetical outperformance in a scenario that is not relevant to the Draft Determination reached by Ofgem.

We understand from discussions between Ofgem and SHE-T following publication of the draft determinations that Ofgem intends to correct this approach for the Final Determination.

5.2.2 Application of outperformance caps following correction of Ofgem's approach

Based on the analysis set out in section 5.2.1, once the approach to workload and outperformance adjustments is corrected, it seems that the estimated model prediction for workload adjusted cost may not exceed the SHE-T's business plan submission. In addition, as set out in section 4.1, Ofgem may not consider it appropriate to apply any funding caps. However if the model prediction as used at the Final Determination *does* exceed SHE-T's business plan submission and if a cap is to be applied, it is important to address another

[73] i.e. £220m – £151m.

methodological issue with Ofgem's approach at the Draft Determination—the capping of any excess model allowance (over and above the company submission) on an annual rather than price control basis.

Any difference in allowance resulting from capping funding on an annual basis, relative to a price control basis, is likely to result from a number of factors unrelated to efficiency:

- any lags or leads with regard to the phasing of indirect expenditure with the driver of direct expenditure in the model (currently CAPEX)—for example, if some indirect expenditure relating to a project are incurred the year before or year after completion, then an annual approach may mistake such spend as inefficiency;
- model noise generated by the omission of relevant drivers of indirect expenditure from Ofgem's simple econometric model, which is more likely to cancel out over a 5 year price control period;
- model noise created by fixed elements of the cost base—unlike relatively discrete CAPEX projects, transmission operators cannot seamlessly remove large elements of closely associated indirect expenditure in a year with a low volume of CAPEX work and then restore it the next;
- the incentives created by this approach, namely that companies have to tailor their profile of expenditure to regulatory models in order to receive sufficient funding to finance their functions, which is inconsistent with a TOTEX framework designed to avoid biasing companies to target particular solutions.[74]

As such, the application of an additional efficiency challenge to SHE-T's expenditure on the basis of annual funding caps is likely to be driven by these factors and not efficiency. Unless Ofgem can demonstrate appropriate mitigations, such a challenge will be inappropriate.

Separately, Ofgem currently applies a £0.8m p.a. adjustment for its estimate of the impact of disallowed non-operational CAPEX *after* its outperformance adjustment. However, we understand that this may double-count the impact of these schemes being disallowed, as the workload adjustment calculation from the econometric model is based on the change in total CAPEX (including non-operational CAPEX). If this is the case, then this constitutes an inappropriate additional efficiency challenge, and should not be applied to SHE-T's TOTEX assessment at the Final Determination.

Finally, with regard to any legitimate model adjustments applied at the Final Determination, these should be applied *before* any adjustments to cap funding, rather than afterwards. As set out in section 4.1, funding caps/outperformance adjustments should be calculated across the total expenditure area, not by sub-category, consistent with other regulators and Ofgem's own approach to gas distribution.

5.2.3 Technical and economic logic of estimated coefficients and prediction

The assessment of the workload and outperformance adjustments in section 5.2.1 take as given the econometric model used by Ofgem to set CAI expenditure. However, for these models to be used to determine efficient cost allowances, it is important that the implied relationship between cost and cost

[74] Ofgem (2010), 'Handbook for implementing the RIIO model', October, p. 64.

drivers makes technical and economic sense. In particular, for a cost model to be applied it must:

- comprehensively capture relevant cost drivers, as far as possible (given limitations in data correction);
- where it is not possible to capture all relevant drivers of cost, appropriate adjustments should be considered before or after modelling to account for any omitted factors;
- the relationship between cost and cost drivers should align with the expected operational or engineering relationship.

While there are other aspects of model characteristics and model development that are also important for model assessment, an operationally reasonable relationship between costs and drivers is a necessary condition for a cost assessment model to be appropriate for use, regardless of other statistical properties of the model used or the appropriateness of the model. In its paper setting out the selected CAI and BSC models, ECA sets out among Ofgem's criteria for a 'good cost driver' that it should '**make economic and/or engineering sense**, so that it can be interpreted and understood as reasonable and relevant.'[75] This was made clear in Ofgem's methodology for model selection criteria, in which it states that:

> As a first step to building an appropriate econometric model, it is important to justify the variables (i.e. the cost drivers) that are assumed to explain given costs from a theoretical or engineering or business perspective. This guards against the possibility of 'data mining', whereby we are merely picking up spurious relationships between variables[76]

It is instructive to consider how ECA/Ofgem's selected CAI model performs against this criterion. The model selected, and indeed all models considered by ECA,[77] use a log-log specification. This means that, aside from the constant term, the model coefficients can be considered as 'weights' defining the impact of a change in one or other driver on cost. Table 5.1 sets out the implication of these coefficients in terms of the relationship between cost and driver.

Table 5.1 Coefficients and implied cost relationships, Ofgem's preferred CAI model

Cost driver	Coefficient value	Confidence interval (95%)	Cost impact of a 10% decrease[1]	Uncertainty range around this cost impact
MEAV	0.231	0.078 to 0.383	-2.31%	-0.78% to -3.83%
CAPEX	0.754	0.563 to 0.946	-7.54%	-5.62% to -9.45%

Note: [1] There would be a symmetric positive impact for a 10% *increase* in a driver.

Source: Oxera analysis, based on Ofgem's data pack.

This aligns with the scale of Ofgem's workload adjustment. Ofgem disallowed 35.4% of SHE-T's CAPEX expenditure. Using the central estimate of the relevant CAPEX coefficient given above (0.754) would imply a cost decrease of ~26.7% (£79.4m), close to the actual workload adjustment calculated by

[75] Economic Consulting Associates (2020), 'RIIO-GD2 and T2: BSC and CAI assessment methodology', Methodology Paper submitted to Ofgem, 7 May; and Ofgem (2019), 'RIIO-2 tools for cost assessment: Consultation', June, para 2.26–2.32.
[76] Ofgem (2019), 'Consultation – RIIO-2 tools for cost assessment', 28 June, para. 2.40.
[77] Economic Consulting Associates (2020), 'RIIO-GD2 and T2: BSC and CAI assessment methodology', Methodology Paper submitted to Ofgem, 7 May 2020, p. 34.

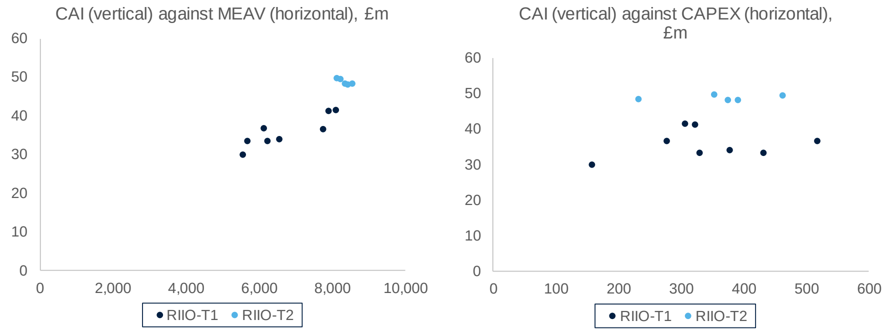
Ofgem of 28.3% (£84.3m).[78] Ofgem's model would predict that an equivalent percentage change to MEAV would have an effect three times smaller—around 8.3%.

These two effects are not consistent with the reality of SHE-T's CAI expenditure, which is driven more by its existing asset base (captured by the MEAV driver) than LRE and NLRE spend in a given year (captured by the CAPEX driver). Thus, the CAI of T2 will have to be larger than the one incurred in T1, as the asset base has grown significantly (by over 50% when measured by MEAV) since the beginning of T1.

This is reflected by SHE-T's estimation of the impact of accommodating Ofgem's volume challenge to its CAPEX programme. As set out in Figure 5.2, this estimate is around a third the magnitude of Ofgem's, at 9.8% (£25.1m).

Figure 5.5 shows two scatter plots, on the left, the relationship between SHE-T's CAI expenditure and its MEAV, and on the right, the relationship between SHE-T's CAI expenditure and CAPEX. Data from RIIO-T1 (outturn up to 2019) is marked in dark blue, while data from RIIO-T2 is marked in light blue. It can be seen that, while there is a strong correlation between MEAV and CAI, this relationship does not hold for CAPEX.

Figure 5.5 Relationship between CAI and MEAV (left) and CAPEX (right)



Source: Oxera analysis of 'BSCCAICostAssessment_File'.

There are three causes that could contribute to Ofgem's model attributing more weight to CAPEX, relative to MEAV than an operational understanding of SHE-T's cost function would suggest:

- the coefficients on CAPEX and MEAV may be very imprecisely estimated due to multicollinearity, whereby the statistical model is unable to distinguish between the impact of two cost drivers that are highly correlated (with a correlation of 0.82);
- errors in cost driver data provided by other companies;
- as the relationship is estimated across the electricity and gas transmission sectors, Ofgem's model could be capturing a cost relationship that holds for other transmission operators but is not relevant for SHE-T.

[78] It is important to note that the results from an econometric model, such as that estimated by Ofgem, should be considered to give a range of estimates rather than a single estimate. Ofgem's econometric model suggests that the workload adjustment is between £59.3m and £99.6m with a 95% probability.

5.2.4 Suggested amendments

As set out in section 5.2.1, even taking Ofgem's workload adjustment as given, a reasonable bound for SHE-T's CAI allowance of between £213m and £220m. The lower bound reflects Ofgem's estimation of the workload adjustment, while the upper bound reflects SHE-T's revised expectation of its CAI expenditure accommodating the workload adjustment imposed by Ofgem.

As set out in section 5.2.3, the lower bound relies on assumptions from Ofgem's econometric model that do not align with the operational impact of Ofgem's adjustments to SHE-T's CAPEX programme on its CAI expenditure. Therefore, absent development of a model that (at a minimum) addresses the issues set out in section 5.2.3, the upper bound of £220m represents the most appropriate allowance for SHE-T.

Ofgem's approach to bottom-up assessment of CAI expenditure relating to IT&T expenditure and its separate reduction for CAI associated with disallowed non-operational CAPEX projects (control centre warehousing) fall outside the scope of this assessment. Combining our model recommendation with Ofgem's assessments in these areas would give a total recommended allowance for SHE-T's CAI expenditure of £230m.

5.3 LRE and NLRE

In this section, we address Ofgem's top-down modelling approaches to determining efficient LRE and NLRE expenditure. We address these aspects of Ofgem's approach from the perspective of the framework concerns set out in section 4, in the context of the robustness and accuracy of the benchmarking approach that Ofgem uses to assess LRE and NLRE expenditure.

As noted in sections 2.3 and 2.4, the scope of this review addresses aspects of Ofgem's assessment of direct expenditure through the application of unit cost analysis.

5.3.1 Assessment of Ofgem's unit cost approach

Following its engineering assessment of project need, Ofgem uses sector weighted mean unit costs by asset type, voltage level and unit (or km) to assess proposed direct expenditure within LRE and NLRE. Ofgem applies the same unit cost benchmark for assets used across these two cost areas.

Unit cost models only consider one driver of costs—namely, the relevant volume measure used, for example km of line or number of units added—and assume constant returns to scale.[79] Therefore, unit cost models will not capture other relevant drivers of enhancement expenditure and should be viewed with an appropriate level of scrutiny and caution. They are unlikely to be appropriate to set allowances without additional evidence to validate these. Compared with more sophisticated top-down modelling approaches such as econometric models that can allow for hypothesis testing and other statistical analysis, setting an average unit cost benchmark is equivalent to setting an average benchmark from a restricted econometric model with a restricted functional form.[80] We note that, if the data available is insufficient to estimate an

[79] Constant returns to scale assume that the relationship between scale and cost is invariant to the amount of work done. This differs from increasing returns to scale (in which carrying out a greater volume of work implies declining unit costs) and decreasing returns to scale (in which carrying out a greater volume of work implies increasing unit costs).
[80] Assuming no constant and no flexibility for unit costs to change as the volume of work changes.

econometric model, it is unlikely to be appropriate to apply a benchmark based on such a restricted model.

In the context of electricity transmission, a simple unit cost model omits other factors that may affect the cost of assets other than scale. The factors not considered in a unit cost estimate include:

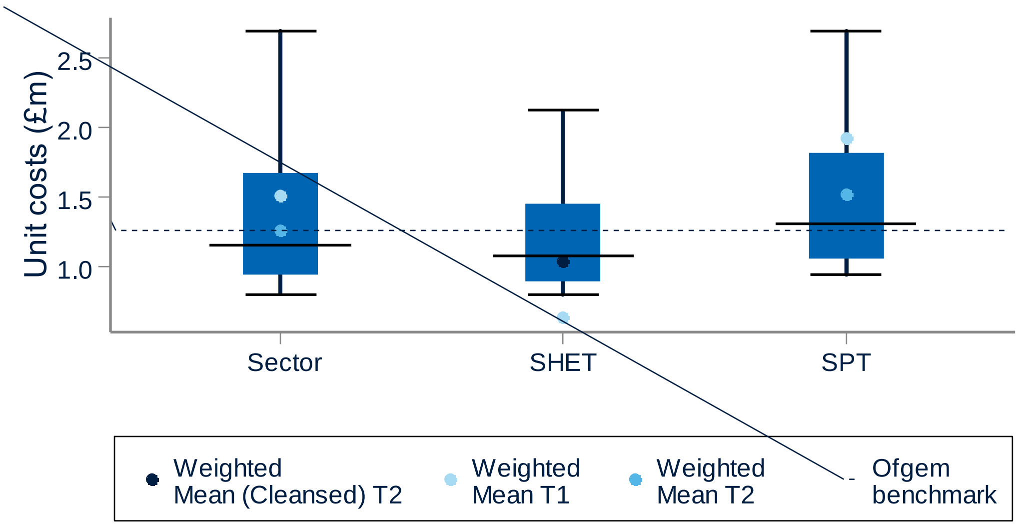
- asset location (e.g. ease of access, required resilience in harsh climates, closeness to the coast and thus susceptibility to corrosion);
- asset characteristics other than voltage (e.g. power rating of transformers, insulation required).

While some of these factors may have a greater impact on non-asset costs, (and therefore are even more relevant to other aspects of Ofgem's assessment), they will nevertheless contribute to differences in project (and thus asset) costs. By its nature, a unit cost comparison assumes that any of these legitimate differences that are not captured through the volume measure or using pre- or post-modelling normalisations are entirely due to differences in efficiency.

Compounding the issues set out above are the concerns that SHE-T has identified with the imbalanced weighting placed on high volume projects/years as a result of Ofgem's method for calculating weighted unit costs, as set out in its separate submission on this issue. In the presence of economies of scale, a prevalent feature of capital expenditure programmes, this approach is likely to fail to reflect more typical, lower volume schemes.

The effects of the simplification imposed by a unit cost model can be seen by considering the distribution of unit cost data available in the RIIO-T2 analysis files. For instance, Figure 5.6 shows the distribution of unit costs for 400kV circuit breakers with gas insulated busbars (ID) for the sector as a whole and each of the two transmission operators with expenditure in this area. Although Ofgem's benchmark is £1.26m (dotted line), which in this case corresponds to the weighted mean unit cost in T2, both TOs proposed both higher and lower unit costs of 400kV circuit breakers with gas insulated busbars in their RIIO-T2 business plans, depending on project and asset characteristics. For SHE-T the costs vary between £0.80m and £2.13m.

Figure 5.6 Range of unit costs 400kV circuit breakers with gas insulated busbars (ID) (£m/circuit breaker)



Note: We understand from Ofgem's analysis files that the weighted mean (cleansed) T2 equates to the weighted mean T2 with zero values removed; we note that there is no explanation of this process available in Ofgem's documentation. These two measures often coincide.

Source: Oxera visualisation of Ofgem data.

In this example—by setting direct costs associated with installation of the assets—not only does Ofgem apply a unit cost benchmark without considering further evidence, but it does so selectively, applying the more stringent benchmark from one of several sources, in particular:

- the RIIO-T2 (cleansed) sector mean, weighted by the volume of assets;
- the RIIO-T1 sector mean, weighted by the volume of assets;[81]
- and in some cases the RIIO-ED1 unit cost for the electricity *distribution* industry multiplied by a factor of 1.2.[82]

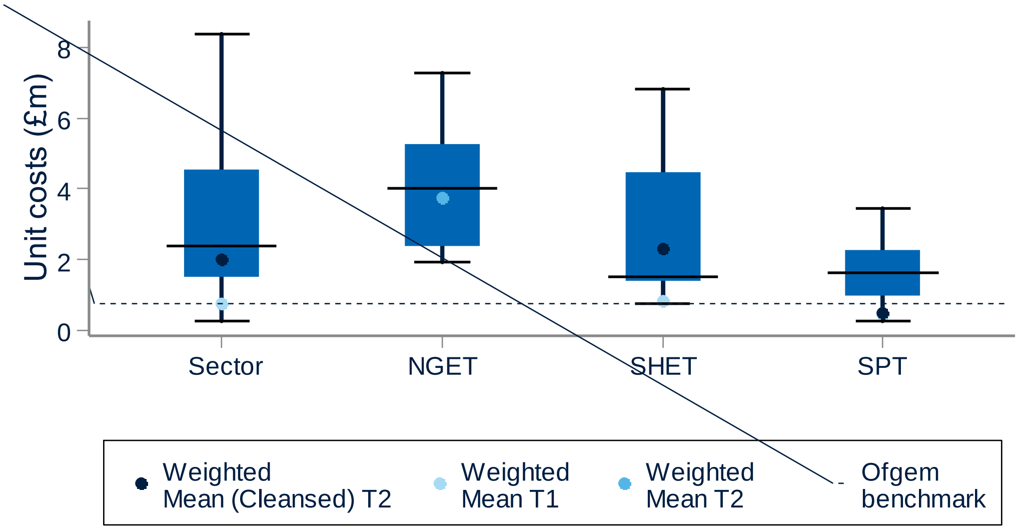
In some cases, this results in a large cost challenge to the industry, that seems unlikely to be solely driven by inefficiency.

For instance, as set out in Figure 5.7, the benchmark unit cost for 132kV non-pressurised underground cables—constituting 27% of SHE-T's proposed non-load CAPEX—is £0.74m/km. This is not only significantly less than the average unit cost proposed by SHE-T of £2.32m/km but is also less than half of the 25th percentile of the transmission industry.

SHE-T has previously argued that the spend on underground cables in T2 is not comparable with the spend on underground cables in T1, as the works differ significantly. While underground cables in T1 were mostly laid 'greenfield' and over long distances, the proposed spend in T2 is primarily driven by short-length cables to existing substations ('brownfield'). Ofgem does not explain why it is appropriate to use this benchmark, which is not comparable to the spend in T2 and which no TSO suggests is feasible in RIIO- T2. By contrast, in some other cases Ofgem has accepted certain expenditure as atypical and passed through the company's proposed expenditure in full.[83]

[81] Note that the calculation of this weighted mean appears to have changed slightly between T1 and T2 as in T1 the volume was reported by year, while in T2 the volume was reported by project.
[82] This only affects 2 asset types and we are not aware of data on the underlying distribution, so we have not reviewed these areas or made a recommendation on these direct costs.
[83] For SHE-T, this occurred in the case of the Phase Shifting Transformers (PSTs) in SHT2008 and SHT20010 and the Overhead Pole Line in SHNLT2028.

Figure 5.7 Range of unit costs—132 kV UG cables (non-pressurised) (£m/km)



Note: We understand from Ofgem's analysis files that the weighted mean (cleansed) T2 equates to the weighted mean T2 with zero values removed; we note that there is no explanation of this process available in Ofgem's documentation. These two measures often coincide. Note that the sector maximum is higher than the maxima of the three TSOs. This is an issue that is present in the data provided by Ofgem.

Source: Oxera visualisation of Ofgem data.

CAPEX projects in a particular asset category within the same company are generally subject to the same planning constraints and processes, and would often be managed within the same team. It therefore seems unlikely that the wide range of estimated unit costs within asset categories is solely the effect of inefficiency between different projects.

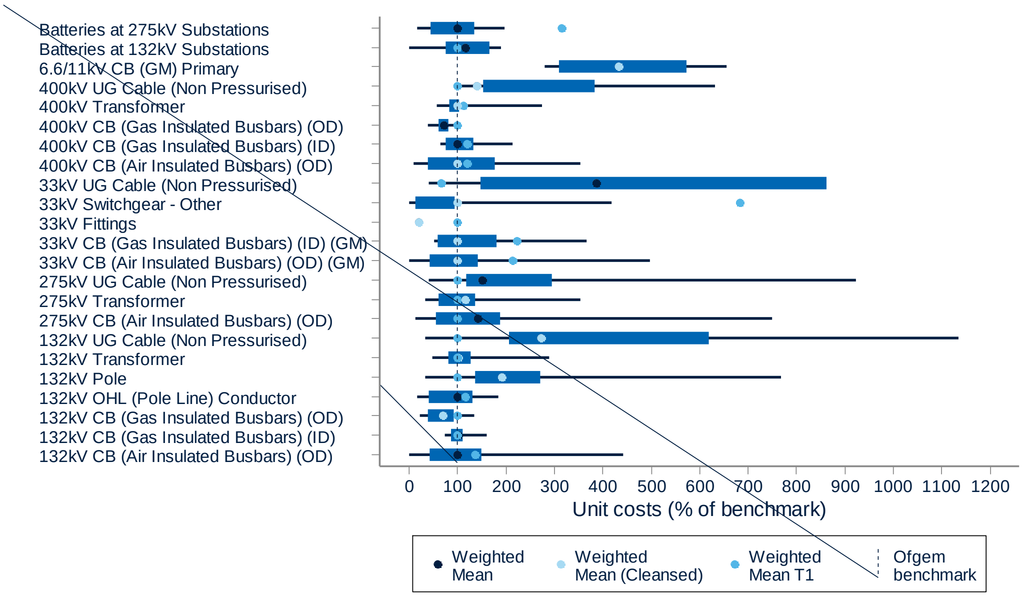
Rather, it is likely that part of the variation is driven by the omission of some of the relevant drivers of expenditure for this asset type. For instance, compare two transformers: one installed in a coastal area, requiring full insulation due to corrosion risks, with high access costs; and the other installed further inland near a major motorway with low access costs. SHE-T has submitted a breakdown of many such atypical geographical and regional factors that affect each project's efficient costs as part of its business plan.[84] Ofgem's simple model, considering cost per transformer, will not be able to control for these factors. While taking a weighted average unit cost across the sector will help to mitigate the impact of low-unit cost extremes on the benchmark, it will equally fail to represent high cost extremes.

If Ofgem's approach was only based on a company benchmark, given that its framework caps outperformance at the project-asset level, it would asymmetrically apply a cost challenge to projects with assets more expensive than the benchmark, without giving a balancing outperformance allowance for projects with assets below the benchmark. See section 4 for a more detailed assessment of the limitations of Ofgem's framework in the context of a modelling approach that omits important cost factors. By using a sector benchmark, Ofgem compounds this by assuming that *each* TO in *every* time period has a comparable mix of local factors within a particular asset category.

[84] SHE-T (2019), 'Efficient Capital Investment: Benchmarking and Cost Metric', December, p. 63.

The figure below shows the variation of unit costs for each asset type with respect to the benchmark, i.e. unit costs are shown as a percentage of the benchmark. The two correspond at the value of 100 on the horizontal axis (dotted line). The large variation in unit costs shows the high degree of noise and the deviation from the 100 line demonstrates the stringency of Ofgem's selected benchmark—with some unit costs more than 10 times larger than the benchmark.

Figure 5.8 Sector unit costs by asset type



Note: We understand from Ofgem's analysis files that the weighted mean (cleansed) T2 equates to the weighted mean T2 with zero values removed; we note that there is no explanation of this process available in Ofgem's documentation. These two measures often coincide.

Source: Oxera visualisation of Ofgem data.

5.3.2 Suggested amendments

As illustrated in section 5.3.1, there is potential for a considerable level of uncertainty to be associated with Ofgem's unit cost assessment. We set out the challenges of applying Ofgem's cost assessment framework in this context in section 4. We make two specific recommendations to address the deficiencies of Ofgem's framework, taking as given its cost assessment models.

First, we note that—in the context of substantial modelling uncertainty—it is appropriate to use a balanced approach, which can entail giving companies the benefit of the doubt when triangulating across several benchmarks. This is justified as companies' true position is unknown and poor outcomes may be driven by the assumptions underpinning a particular approach. As noted above, this is the approach taken by the Bundesnetzagentur, which, despite estimating more sophisticated models that take into account more factors than the simple unit cost models used by Ofgem, applies the maximum efficiency value from four approaches when setting the efficiency challenge.[85]

Given the large degree of modelling uncertainty and variation in company results, **we would recommend that Ofgem follow a similar 'benefit of the doubt' approach**, i.e. applying the maximum of the two benchmarks, instead

[85] Sumicsid, Swiss Economics and 4-Management (2019), 'Effizienzvergleich Verteilernetzbetreiber Strom der dritten Regulierungsperiode (EVS3)', April.

of a minimum. Making this change in isolation would result in an additional allowance of £35m for SHE-T. Were subsequent modelling development to lead to more accurate modelling, a more stringent triangulation could be considered, such as taking an average across benchmarks.

Second, in particular to address the impact of uncontrolled project characteristics, we would recommend that Ofgem review the need to **cap funding. If it is to be used, we recommend capping funding at the aggregate LRE and NLRE level, rather than at the asset-project level.** In this way, differences in unit costs due to allocation issues and local factors can potentially balance out across a company's profile of different projects. Implementing this recommendation in isolation would result in an additional allowance of £64m.

Implementing both recommendations would give an additional allowance of £150m in RIIO-T2.[86] The impact of Oxera's recommendations on SHE-T's direct expenditure is set out in Table 5.2.

Table 5.2 Impact of Oxera recommendations on SHE-T's allowance for lead and non-lead directs (£m)

	SHE-T business plan (£m)	Ofgem engineering assessment	Ofgem efficiency challenge	Ofgem allowance (£m)	Balanced approach[1] (£m)	Cap at the aggregate level (£m)	Recommendation: combined approach (£m)
LRE	342.5	0	-10.8	331.7	335.7	381.3	413.8
NLRE	369.0	-80.6	-75.2	213.2	244.6	227.6	280.7
Total	**711.5**	**-80.6**	**-86.0**	**544.9**	**580.3**	**608.9**	**694.5**

Note: This figure excludes the 'Protection-Memo' asset class for which no efficiency challenge was applied. [1] Applying the maximum (rather than minimum) of T1 and T2 benchmarks.

Source: Oxera analysis of Ofgem data.

This maps to SHE-T's total LRE and NLRE CAPEX, as set out in Table 5.3.

Table 5.3 Impact of Oxera recommendations on SHE-T's allowance for total LRE and NLRE (£m)

	SHE-T business plan (£m)	Ofgem engineering assessment	Ofgem efficiency challenge	Ofgem allowance (£m)	Balanced approach[1] (£m)	Cap at the aggregate level (£m)	Recommendation: combined approach (£m)
LRE	839.8	-79.9	-42.6	717.3	721.3	766.9	799.4
NLRE	824.2	-182.5	-101.2	540.5	571.9	554.9	608.0
Total	**1,664.0**	**-262.4**	**-143.8**	**1257.8**	**1,293.1**	**1,321.8**	**1,407.4**

Note: [1] Applying the maximum (rather than minimum) of T1 and T2 benchmarks.

Source: Oxera analysis of Ofgem data.

[86] The overall cost impact is £180m. According to Ofgem's view, £30m of this falls outside the T2 period.

In terms of extending its evidence base for assessing direct costs, one approach for Ofgem to consider would be to carry out aggregate econometric modelling at the project level. It could consider carrying out its analysis at the company or sector level, either of which would provide a relatively large dataset. Selection and collection of data on relevant drivers could be carried out through consultation with the industry. Such a model would provide a helpful cross-check for Ofgem's existing evidence base and, if relatively comprehensive and robust, could serve to alleviate some of the issues set out above.

We note that there is already some RIIO-T2 precedent for this approach, as this is the basis on which Ofgem defines its volume uncertainty model. While the specific model developed for volume uncertainty is unlikely to be appropriate, as set out in section 5.5, this should not rule out consideration of more robust approaches to aggregate modelling.

5.4 Network operating costs

Four cost categories within NOCs fall within the scope of this top-down review of Ofgem's methodology:

- inspections;
- faults;
- vegetation management;
- repairs and maintenance.

The first three cost categories are assessed using a unit cost approach similar to that applied in the LRE and NLRE cost areas. However, in this cost area, Ofgem applies RIIO-T1 and RIIO-T2 weighted means based on company rather than sector data. As the analysis is carried out at the category, rather than project level, Ofgem's RIIO-T2 benchmark equates to the company business plan submission. Given this more restricted approach, the lack of information on benchmark noise and the lower materiality of these areas, it may not be appropriate to apply the same recommendations to NOCs as set out for LRE and NLRE.

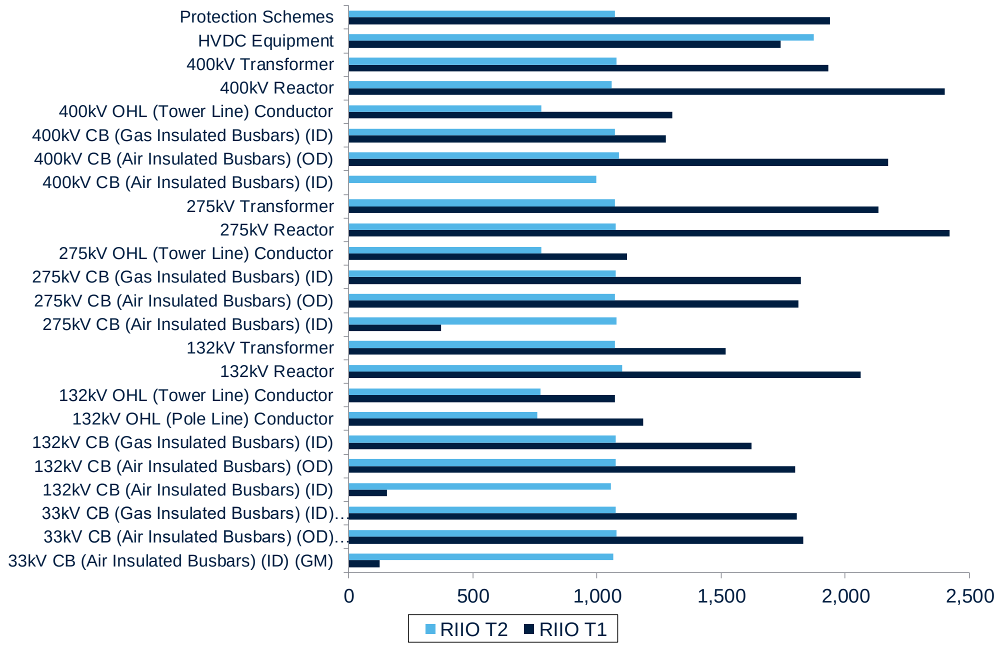
However, there are substantial issues with Ofgem's approach to repairs and maintenance as applied in the Draft Determinations. Ofgem currently proposes an allowance of £19.4m in this category, £32.3m less than the £51.8m requested by SHE-T. We understand that Ofgem intends to update its Draft Determinations approach with volume data provided by SHE-T. In section 5.4.1, we set out an assessment of how this data could be applied in a manner consistent with Ofgem's wider network operating costs methodology.

5.4.1 Repairs and maintenance

Ofgem's methodology for unit cost analysis in other areas of NOCs entails setting a benchmark at the lower of the RIIO-T1 and RIIO-T2 (i.e. business plan) unit costs for the company.

Figure 5.9 sets out a comparison of SHE-T's repairs and maintenance expenditure unit costs, by category, between RIIO-T1 (dark blue) and RIIO-T2 (light blue). It can be seen that RIIO-T2 repairs and maintenance costs are lower than the RIIO-T1 benchmark in all but five areas. Consistent with Ofgem's methodology in other areas, for such categories in which SHE-T's business plan submission is lower unit cost than the RIIO-T1 benchmark, its costs should be allowed in full.

Figure 5.9 Repairs and maintenance—RIIO-T1 against RIIO-T2 unit costs (£/volume)



Source: Oxera analysis of SHE-T data.

Of the five categories remaining, one—400kV CB (Air Insulated Busbars) (ID)—has no RIIO-T1 benchmark and, consistency with Ofgem's approach to HVDC Inspections, would suggest this are be allowed in full.

HVDC repairs and maintenance RIIO-T2 unit costs are around 8% higher than the level in RIIO-T1. However, SHE-T's costs in this area are set by a commercially negotiated contract, and, as such, already reflect the efficient market price for delivery of HVDC repairs and maintenance. Application of a challenge to this expenditure through a simple unit cost analysis—particularly given there are only three years of RIIO-T1 data available, compared to eight years for other areas—does not seem appropriate without also considering bottom-up evidence submitted by SHE-T, given the specific nature of HVDC costs.

In the remaining three cost areas, the RIIO-T1 unit cost benchmark is lower than SHE-T's business plan submission. These areas are:

- 33kV CB (Air Insulated Busbars) (ID) (GM);
- 132kV CB (Air Insulated Busbars) (ID);
- 275kV CB (Air Insulated Busbars) (ID).

Applying a RIIO-T1 benchmark implies a total cost reduction across these areas of £0.17m compared with the £25m proposed by Ofgem.

The analysis above excludes the civil works category within repairs maintenance, as these do not have an attached volume driver. SHE-T submitted £18.5m of expenditure in this area for RIIO-T2. Applying Ofgem's Draft Determinations methodology of allowing 150% of the RIIO-T1 annualised costs in this area would give an allowance of £11.1m, and a total cost challenge of £7.4m. However, it is likely that these costs are affected by the overall increase of repairs volume at RIIO-T2, relative to RIIO-T1. Accounting for this increase is likely to explain some to all of the cost gap between SHE-T's submission and the allowance given by Ofgem's approach.

5.4.2 Suggested amendments

Across the entire repairs and maintenance cost category (excl. civils), Ofgem should revise its assessment to allow the company submission of £33.3m for repairs and maintenance, less £0.17m to account for application of a RIIO-T1 cost benchmark to be consistent with its approach in other cost categories within NOCs.

Including civils, our analysis suggests a minimum appropriate allowance of £44.2m, which is £24.8m higher than Ofgem's current allowance. This is based on an allowance of £33.1m, which results from capping at the category level and adding Ofgem's allowance for civils of £11.1m. The allowance for repairs and maintenance could increase by a further £13.4m if civils are allowed in full and funding is capped at the NOCs area.

5.5 Volume uncertainty model

Ofgem uses the volume uncertainty model to provide network operators with ex ante allowances for the provision of customer-driven generation and demand connections. The model is thus *not* intended to explain the known costs, but rather serves as an out-of-sample forecast for future proposed connections.

5.5.1 The metric(s) used for model selection

While the exact measure and process used is not described in the outputs published by Ofgem, it notes that the approach was undertaken as it 'gave the closest predictions to modelled efficient cost'.[87] Ofgem's Excel files suggest that conventional R-squared-type measures have been used as the *only* metric to assess the closeness of predictions, as these are the only measures of fit calculated in these files.[88] Focusing on a single measure of fit is an overly simplistic and inappropriate approach to model development. For instance, it does not consider the operational intuition of the model, the appropriateness in terms of sign and magnitude of the coefficients or the ability of the model to predict out-of-sample projects. In fact, conventional in-sample measures of fit are generally not the appropriate measures to assess models which are intended to predict out-of-sample costs.

A simple validation exercise can demonstrate why the conventional measure of fit used by Ofgem is not sufficient or even appropriate in developing a forecasting model. In its estimation of the volume drivers, Ofgem chooses to suppress (i.e. exclude) the intercept. As can be seen in Table 5.4, this suppression of the intercept increases the R-squared in-sample by 0.325 (i.e. 0.763 less 0.438).

[87] Ofgem (2020), 'RIIO-2 Draft Determinations - Electricity Transmission Annex', p. 66.
[88] Further steps are also not clearly explained, e.g. it is not evident whether Ofgem considered company specific models after making the decision to model each TSOs data separately.

Table 5.4 Coefficients of estimated models

	Ofgem	With intercept
Intercept	-	4.848***
Sum of output cable	0.774**	0.454
Sum of output OHL	0.101**	0.094**
Sum of Electrical Output Count (#)	0.061***	0.028**
R-squared	0.763	0.438
Out-of-sample mean squared error	149.7	98.1

Note: Out of sample MSE is calculated by splitting up the dataset of 30 observations into a 'training dataset' of 25 observations on which the regression is estimated. The coefficients are then used to predict the efficient costs of the five remaining projects. This is repeated 10,000 times.

Source: Oxera analysis.

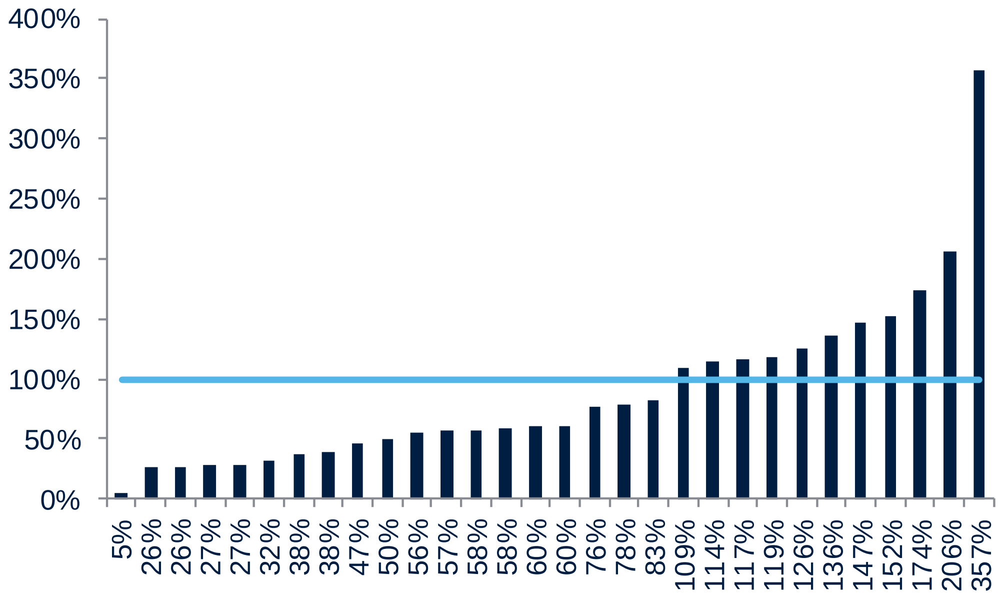
Importantly, when estimating the out-of-sample performance of the models we observe that a model including the intercept generally gives more accurate predictions of efficient costs, outperforming the model without the intercept in roughly 80% of cases.[89]

Note that we do not advocate the use of Ofgem's model with the addition of an intercept for the uncertainty mechanism either. This illustration simply serves to demonstrate how Ofgem's approach to model selection focused on limited metrics.

5.5.2 The model's in-sample performance

Even when disregarding the inappropriateness of in-sample metrics to evaluate a forecasting model, Ofgem's model does not perform sufficiently in-sample as well.

Figure 5.10 Estimated 'efficiency' of in-sample projects



Source: Oxera analysis.

[89] This is calculated by splitting up the dataset of 30 observations into a 'training dataset' of 25 observations on which the regression is estimated. The coefficients are then used to predict the efficient costs of the five remaining projects.

As can be seen in Figure 5.10, the model predicts a wide range of costs relative to the costs assessed as efficient by Ofgem itself. For some projects, as little as 5% of the allowed cost would have been funded through the uncertainty mechanism, for others, this cost would be as high as 350% of the spend assessed as efficient by Ofgem. This occurs despite these costs being previously assessed to be efficient by Ofgem. This suggests that the very simple top-down model used by Ofgem does not capture the bespoke nature of these new connections. There is therefore a large potential scope for underfunding generation and demand connections by TOs.

5.5.3 Suggested amendments

As outlined in this section, Ofgem's volume uncertainty mechanism model is not able to predict efficient costs in a robust way. This necessitates a re-examination of the modelling approach following robust model development procedures. Such development should incorporate the revisions to Ofgem's approach to assessing the efficiency of LRE and NLRE expenditure set out previously in this report, to ensure that the input data is not biased by regulatory error in other areas of the cost assessment framework.

If an econometric model is used, its appropriateness needs to be evaluated with respect to operational consistency (including whether it captures all of the important cost drivers and local factors, their sign and the magnitude of their impact), as well as statistical measures such as out-of-sample performance in addition to conventional methods of model fit.

The volume driver model at RIIO-T2, now on its third iteration[90], cannot yet be considered to have gone through these steps. We understand from SHE-T that it has highlighted the following issues with previous and current volume driver models:

- original versions of the model contained input errors;
- the process by which projects are included or excluded from the modelling risk;
- the model is too simplistic to capture the complexities of cost in this area;
- alternative company-developed models offer a superior fit to the data but have not been pursued by Ofgem for application to RIIO-T2.

As the nature of the projects differs widely, a robust top-down econometric model may not be feasible and lead to inappropriate funding in RIIO-T2. It may be more appropriate to consider the use of a bottom-up benchmark that can be tailored to specific project characteristics, either solely or in tandem with appropriate top-down models.

[90] Based on discussions with SHE-T.

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