Establishing an appropriate efficiency challenge

Prepared for
Scottish and Southern Electricity plc

29 November 2021

Final

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Executive Summary

As part of its evidence base for its business plan for RIIO-ED2, SSE commissioned Oxera to provide recommendations on the appropriate efficiency challenge for its two networks, SSES and SSEH. This report provides an assessment of: (i) SSEH's and SSES's relative efficiency and whether a catch-up efficiency challenge is appropriate; and (ii) ongoing efficiencies that can be expected over ED2.

We find that, after excluding subsea cables (a highly atypical area of spend for SSEH) and adapting Ofgem's modelling to be better aligned with operational insight, SSEH is efficient relative to the upper quartile (UQ), while SSES is 2.0% less efficient than the UQ.[1]

We consider that an ongoing efficiency assumption of 0.4% p.a. is appropriate over ED2, with a range of 0.1–0.6% p.a. based on a range of approaches and sensitivities. We understand that SSE has included an ongoing efficiency challenge of 0.7% p.a. in its business plan, which is a stretching target based on the evidence presented in this report.

These results are summarised in Table 1 below.

Table 1 Estimated relative inefficiency and estimated annual ongoing efficiency benchmark for SSEH and SSES

Area	Main findings
SSEH gap to UQ	0% (SSEH is efficient relative to the UQ)
SSES gap to UQ	2.0%
Ongoing efficiency improvements for SSEH and SSES per annum	0.4% (0.1–0.6%) p.a.

Source: Oxera analysis.

Catch-up challenge

Our approach to assessing SSES's and SSEH's relative efficiency is based on Ofgem's cost assessment approach at ED1. It consists of two aggregated (TOTEX) models and a number of disaggregated cost models (which model the various cost areas individually).[2] We weight the results from the aggregated and disaggregated approaches equally, following Ofgem's approach at ED1. However, we will re-examine what the appropriate weights should be when further data is shared.

Our assessment is based on the latest available data (covering the period until 2021), and therefore excludes forecast data over ED2.[3] When further data is

[1] We have used a UQ as the benchmark, based on the precedent form ED1. We have not examined the appropriateness of this choice, but will do so when further data becomes available. See section 2.4 for further details.
[2] Our disaggregated modelling includes ten cost models covering various activities with cost drivers specific to each activity. These models account for 88% and 90% of SSES's and SSEH's costs respectively over the 2016–20 period (the period within ED1 for which we have data).
[3] This paper carries out TOTEX modelling using data until 2021, but only data up until 2020 for disaggregated modelling. This is because the disaggregated models consider each cost area individually, and is reliant on selecting the right activity drivers that reflect the costs for that area. However, there is significant uncertainty around ED2, including the consistency of scenarios and cost definitions used by different DNOs and the activities that need to take place. Therefore, at this stage, it is not possible to determine and assess in detail what the appropriate disaggregated models should be. We have therefore not updated the disaggregated models to the latest available data, given the significant model development that may still be needed. See Oxera (2021), 'Potential effects of uncertainty in ED2 and fast-tracking WPD in ED1 on the benchmark in ED2', 28 October, for further details on the effects and potential solutions to tackling uncertainty over ED2.

shared and Ofgem publishes details on its proposed approach, we will update our modelling.

Critically, distribution networks will face significant challenges in the future arising from the electrification of heat and the impact of low carbon technologies (LCTs), such as distributed energy generation, and electric vehicles (EV) charging. Therefore, changes to Ofgem's modelling framework will be needed to accurately assess the efficient costs of meeting these challenges. However, without forecast data across the distribution network operators (DNOs), we are unable to examine these issues in this report.

Furthermore, there are inconsistencies in the forecast data submitted by DNOs, driven by inconsistent scenarios, cost definitions and potential anticipatory spending. These inconsistencies will need to be resolved and the modelling framework adopted should be robust to any remaining issues. [4]

During this analysis, we have identified a number of areas of concern in updating Ofgem's aggregated modelling with the latest data due to their inconsistency with the operational environment of DNOs generally and SSEH in particular. In particular, we note the following.

- There is no accounting for the atypical nature of subsea cables, the assets and costs of which are not comparable to those of other DNOs. This issue has become more significant since ED1.
- The weighting of scale drivers in the top-down model now places a 24% weight on customers (compared to 12% in ED1). This is excessive when compared to operational insight, which identifies that the proportion of activity directly associated with customers is only c. 8%.
- The regional wage adjustments systematically underestimate the efficient cost of labour by DNOs operating in Scotland.

We address these issues by:

- excluding subsea assets and costs from the data in the econometric modelling for all DNOs;
- weighting scale drivers in the top-down model based on operational insights from SSE;
- grouping Scotland's cost of labour with the South East, which, according to ONS data, it is aligned more closely to, instead of the rest of the UK.[5,6]

These adjustments are based on operational insight, the uniqueness of SSEH's subsea cables activity and insights from external data. In addition, we

[4] See Oxera (2021), 'Potential effects of uncertainty in ED2 and fast-tracking WPD in ED1 on the benchmark in ED2', 28 October, for further details on the effects and potential solutions to tackling uncertainty over ED2.
[5] We note that the underlying economic drivers for high wages in Scotland may be very different to those in the south East, which may mean that wages may develop differently in the future, which would then require an amendment to the grouping of regions (e.g. treating Scotland as its own region). However, based on the data available, an amended three-region approach with Scotland and the South East is currently appropriate (see section 2.2.4).
[6] The results when adopting this amended three-region approach are similar to those when treating all 11 regions separately. The gap to the UQ with the 11-region approach is 7.2% better than the benchmark for SSEH and 0.5% less efficient than the UQ for SSES. In comparison, the gaps to the UQ for SSEH and SSES using the amended three-region scenario are 6.7% better than the benchmark and 0.9% less efficient than the benchmark respectively.

note that our amended models have a similar statistical performance to Ofgem's original approach.[7]

Our analysis of the disaggregated modelling has also identified issues with updating Ofgem's previous approach with the latest data. Some of these issues are similar to the issues raised under the aggregated model. For instance, accounting for subsea cables is also inadequate in the disaggregated models. In addition, we identify issues of stability of the tree-cutting model and inconsistent results from the trouble-call model. These findings are not exhaustive. For example, there are potential distortions to the disaggregated modelling due to cost allocation issues or different approaches to carrying out activities (e.g. a greater reliance on contractors), which may need to be accounted for in future modelling. We recommend that further model development and data collation of additional drivers is undertaken to accurately assess tree cutting costs and capture additional drivers of trouble-call costs.

Combining the estimated efficiencies from the aggregated and the disaggregated models, excluding subsea cable costs and assets, and accounting for all the other adjustments above, results in SSEH being estimated as an efficient company, 5.2% better than the benchmark, and SSES being estimated as 2.0% less efficient than the UQ.

Ongoing efficiency

Ongoing efficiency (OE) captures the degree to which an efficient firm can reduce costs due to technological change. OE is part of the change in efficient costs (or frontier shift)—the rest (i.e. input price changes) will be reflected by indexing TOTEX allowances to inflation (CPIH) and by applying Real Price Effects (RPEs).

For the assessment of the scope for ongoing efficiency improvements for SSE over RIIO-ED2, we consider a growth-accounting approach using EU KLEMS data. Our approach to assessing OE broadly follows the framework set out in our April 2016 report for the Dutch regulator (Authority for Consumers & Markets, ACM).[8]

We determine that ongoing efficiency improvements should be calculated based on GO-TFP growth in industries that correspond to DNO activities over full business cycles.

- With support from SSE, we identify construction, repair and installation of machinery and equipment, transport and storage, and manufacturing of electrical equipment as comparator sectors for CAPEX activities.
- With support from SSE, we identify transport and storage, professional, scientific, technical, administrative and support service activities, telecoms, and IT and other information services as comparator sectors for OPEX.
- For the purposes of this report, we weight each of the comparator sectors equally within the expenditure category. However, this may not be aligned with DNO activities. Going forward, we may re-examine the weighting of sectors depending on available data.

[7] As measured by the R-squared, which is a statistic measuring the percentage of variation in the data that is explained by the model. Performance across other model diagnostics and statistical tests, such as the RESET test and the Chow test, are likewise broadly similar.
[8] Oxera (2016), 'Study on the ongoing efficiency for Dutch gas and electricity TSOs', January.

- We identify one complete business cycle in the EU KLEMS database, 2007–16.

In addition to our analysis of EU KLEMS data, we also considered direct approaches of estimating historical ongoing efficiency in the electricity distribution sector. We have done this based on analysing the annual reductions in unit costs achieved by the benchmark and frontier DNOs as well as applying stochastic frontier analysis (SFA) to decompose cost changes over time into catch-up and ongoing efficiencies. This allows us to use multiple different methods to estimate the likely scope for ongoing efficiencies over ED2 to improve the robustness of our estimates.

We determine the scope of likely ongoing efficiency improvements over RIIO-ED2 to be 0.4% p.a based on the EU KLEMS data, with a range of 0.1–0.6% p.a. based on a number of sensitivities and the range of approaches we have adopted. We note that this is consistent with the findings of the report by NERA commissioned by the ENA, which concluded that 0.3% p.a. was an appropriate benchmark for ongoing efficiency for the DNOs.[9] Given the available evidence, SSE's ongoing efficiency assumption of 0.7% p.a. is therefore relatively challenging.

Conclusion

The overall results from the TOTEX model and disaggregated modelling suggest that SSEH is more efficient than the UQ, while SSES is 2.0% less efficient than the UQ. In addition to SSES improving its efficiency by 2.0%, **both networks can improve their efficiency through ongoing efficiency improvements of 0.4% p.a., with a range of 0.1-0.6% p.a. (though this should be offset by any estimated real price effects)**. We understand that this represents one piece of evidence that SSE will use when determining its efficiency assumption for its Business Plan. For example, SSE has adopted a stretching ongoing efficiency assumption of 0.7% p.a. in its business plan.

[9] NERA (2021), 'Ongoing Efficiency Improvement at RIIO-ED2', 30 April.

1 Introduction

Scottish and Southern Energy (SSE) has commissioned Oxera to provide a benchmark against which the company's efficiency assumption can be compared to inform its business plan for RIIO-ED2. This is assessed for both of SSE's networks, SSEH and SSES.

There are three key elements that can help to inform SSE's efficiency assumption:

- **catch-up efficiency**, which represents the rate at which a company can improve its efficiency to catch up with the most efficient firm (see section 2);
- **ongoing efficiency (OE)**, which captures the degree to which an efficient firm can reduce costs due to technological change (see section 3);
- **input price changes**, which are reflected by indexing total expenditure (TOTEX) allowances to inflation (CPIH) and by applying Real Price Effects (RPEs).

In this report, we examine the first two components. With regards to RPEs, SSE, as part the ENA working group, have commissioned work from consultants, NERA, who will provide supporting analysis and a report to Ofgem for the RIIO-ED2 draft submission in July 2021.[10] These top-down assessments only provide part of the evidence base to support SSE's business plan; significant bottom-up and engineering evidence also supports SSE's assumptions.

We conclude in section 4 with our overall assessment of SSE's potential for efficiency improvements over ED2.

[10] NERA (2021), 'Price Effects for the RIIO-ED2 Price Control Review', 28 May, p. ix.

2 SSE's past performance

A key consideration for what is an appropriate rate of efficiency improvement for SSE is whether there is any scope for SSE to catch up to the efficiency frontier. If not, the efficiency challenge over ED2 (2023–28) would be informed mainly by SSE's potential to innovate (i.e. the frontier shift).

This section analyses SSE's cost performance and efficiency over the RIIO-ED1 regulatory period in order to provide insights into SSE's potential for catch-up efficiency improvements over ED2.

We use the latest available data on DNOs (up to 2021) and Ofgem's modelling approach at ED1, as the updated methodology on cost assessment for ED2 is yet to be published.[11] With the ED2 cost modelling methodology still to be developed and no forecast data across the DNOs available, this assessment of SSE's performance will need to be revised. Furthermore, in the light of significant changes to the demands on distribution networks from the electrification of heat, distributed energy generation and EV charging, we expect that further changes to the methodology will be required.

In particular, we note that there is a significant uncertainty over ED2, with inconsistencies in scenarios and cost definitions in the business plans submitted by each DNO over ED2. These inconsistencies should be resolved prior to carrying out the modelling. However, to reduce the risk of these issues distorting the results, it may be necessary for the appropriate methodology to rely on historical data where it is likely to provide a robust estimate of relative cost efficiency. For other cost areas, alternative approaches may be needed, e.g. estimating models over ED2 with appropriate activity drivers. We discuss these issues further and provide potential solutions in Oxera (2021), 'Potential effects of uncertainty in ED2 and fast-tracking WPD in ED1 on the benchmark in ED2'.[12]

In addition, we use the upper quartile (UQ) benchmark that Ofgem used in RIIO-ED1. As with the models used, we use this benchmark as it was the approach in ED1 and Ofgem's position for ED2 has yet to be developed. We discuss this assumption in section 2.4, but have not undertaken any detailed analysis on the appropriateness of a UQ benchmark as this will need to be examined when forecast data becomes available.

The main findings of our analysis of SSE's relative efficiency are summarised in the box below.

[11] This paper carries out TOTEX modelling using data until 2021, but only data up until 2020 for disaggregated modelling. This is because the disaggregated models consider each cost area individually, and is reliant on selecting the right activity drivers that reflect the costs for that area. However, there is significant uncertainty around ED2, including the consistency of scenarios and cost definitions used by different DNOs and the activities that need to take place. Therefore, at this stage, it is not possible to determine and assess in detail what the appropriate disaggregated models should be. We have therefore not updated the disaggregated models to the latest available data, given the significant model development that may still be needed. See Oxera (2021), 'Potential effects of uncertainty in ED2 and fast-tracking WPD in ED1 on the benchmark in ED2', 28 October, for further details on the effects and potential solutions to tackling uncertainty over ED2.

[12] Oxera (2021), 'Potential effects of uncertainty in ED2 and fast-tracking WPD in ED1 on the benchmark in ED2'.

Box 2.1 Past performance of SSE

- Under the TOTEX model, SSEH and SSES are ranked first and fifth respectively, with UQ gaps of -6.7% and 0.9% respectively.
- Under the disaggregated modelling, SSEH and SSES are ranked second and 11th respectively, with UQ gaps of -1.8% and 5.2% respectively.
- Overall, the combined results from the TOTEX model and the disaggregated modelling rank SSEH and SSES as first and sixth respectively, with UQ gaps of -5.2% and 2.0% respectively.

2.1 Ofgem's approach to assessing relative efficiency at ED1

In ED1, Ofgem used a range of cost assessment models to assess the efficiency of the DNOs' July 2013 business plans. The core models that it used were two TOTEX econometric models (a 'top-down' model and a 'bottom-up' model), alongside a suite of disaggregated models. In combination, these were used to determine whether DNOs' plans were efficient.[13]

Ofgem makes a number of adjustments before modelling to account for factors that may impact DNO expenditure, such as sparsity and regional wage differences. It also excludes some asset and cost categories where these are atypical.[14]

Ofgem then used ordinary least squares regressions to predict the TOTEX of each DNO based on its characteristics, which Ofgem captured through two Composite Scale Variables (CSVs) and a time trend. The top-down CSV was a weighted average of DNOs' MEAV and customer numbers, while the bottom-up CSV was a weighted average of seven different cost drivers.[15]

In addition, Ofgem used a disaggregated modelling approach, where it modelled each of 30 cost areas that make up the DNOs' total cost. For three of these cost areas—tree-cutting, trouble call and CAI—Ofgem used regression models to assess the DNOs' costs. For the other areas, Ofgem uses ratio analysis, trend analysis and technical assessments to determine efficient costs.[16]

Finally, Ofgem aggregated the results from the different methods and ranked DNOs by comparing their outturn expenditure to the expenditure predicted. A benchmark was then chosen at the UQ. DNOs that incur costs below the UQ are considered efficient and those above the UQ inefficient. The latter DNOs were then set a cost allowance based on the UQ cost prediction.[17]

[13] Ofgem (2014), 'RIIO-ED1: Final determinations for the slow-track electricity distribution companies – Business plan expenditures assessment', 28 November, pp. 27–30.
[14] Ofgem (2014), 'RIIO-ED1: Final determinations for the slow-track electricity distribution companies – Business plan expenditures assessment', 28 November, p. 41.
[15] Ibid., pp. 58–59.
[16] Ibid., p. 29.
[17] Ibid. In ED1, Ofgem determined allowed costs using the Information Quality Incentive (IQI). This involved interpolation, where allowed costs were based on 75% of Ofgem's view of efficient TOTEX and 25% of the DNO's view. See Ofgem (2014), 'RIIO-ED1: Final determinations for the slow-track electricity distribution companies', para. 2.1. We do not consider the IQI further as this report focuses on catch-up and ongoing efficiencies.

2.2 TOTEX modelling

2.2.1 SSE's relative efficiency using Ofgem's models at RIIO-ED1

Ofgem's approach to TOTEX modelling at RIIO-ED1 consisted of two models: 'top-down' and 'bottom-up'.[18]

We start with these models given that they were used at ED1, but we note that, partly due to the impact of more recent data, there are several issues with using these models (such as not accounting for the impact of subsea cables, the now highly counterintuitive weighting placed on customer numbers in the top-down TOTEX model and the potentially distorting impacts of regional wage differences on expenditures). These, and other issues, are discussed and accounted for in subsequent sections. In addition, further issues, such as ensuring the benchmarking approach is robust to uncertainty over ED2, as set out in section 2 above, are considered in Oxera (2021).[19]

We expect that updates will be required to our analysis and approach after Ofgem shares more data (and, in particular, forecast data), and when Ofgem publishes further detail regarding its modelling approach for RIIO-ED2.

Top-down model

The driver of the top-down model is a composite scale variable (CSV), consisting of MEAV and the number of customers. At ED1, Ofgem used a statistical procedure to determine the weights on MEAV and the number of customers.[20] This was found to be 88% and 12% respectively.

Using the most up-to-date data, correcting for an error in SPWM's MEAV variable[21] and following Ofgem's ED1 modelling approach, the weight on the number of customers has increased to 24%, while the weight on MEAV has fallen to 76%.[22,23,24] **This weighting is counterintuitive when compared to operational insights, and therefore is not appropriate for constructing the CSV**. In particular, a much lower weight on the number of customers of around 8.3% is likely to be appropriate (see sections 2.2.3 and 2.2.4).

Bottom-up model

[18] The terminology refers to the cost drivers used in these aggregate TOTEX models rather than the approach itself, which is clearly top-down in nature. The bottom-up TOTEX model should not be confused with the disaggregated modelling approach, which considers each activity area separately.
[19] Oxera (2021), 'Potential effects of uncertainty in ED2 and fast-tracking WPD in ED1 on the benchmark in ED2'.
[20] A technical description of the statistical procedure for weighting the top-down CSV is found in Ofgem (2014), 'RIIO-ED1: Final determinations for the slow-track electricity distribution companies – Business plan expenditures assessment', 28 November, paras. A5.1–A5.3.
[21] Note that an equivalently corrected TOTEX measure is not yet available. Therefore, our analysis will need to be updated once a TOTEX measure that corrects for the error is available.
[22] In UKPN's presentation at the Cost Assessment Working Group, the weight on customer numbers was estimated to be 25%, compared to the 31% found in this report. See NERA (2021), 'Summary of UKPN's Totex Modelling', 27 May, p. 8. Nonetheless, a 25% weighting on customer numbers is still inconsistent with operational insights, which would suggest a weighting of around 8.3%.
[23] Once updated and validated data is available, we will update our analysis and re-calculate the weights.
[24] When carrying out the analysis only up to 2020, the weight on the number of customers would be 31% (as opposed to 12% in ED1 and 24% with 2021 data). Ofgem's methodology therefore leads to a high level of volatility in the weights on customer numbers and MEAV, which may suggest that Ofgem's methodology is not sufficiently robust.

The driver of the bottom-up model is a CSV. At ED1, Ofgem used a statistical procedure to determine the weights on the seven scale drivers[25] that it considered relevant to the expenditures incurred by the DNOs.[26]

We have updated these with the industry spend proportions based on the latest data over the period 2011–20.

Overall results

In order to arrive at an overall efficiency score, Ofgem averages the predictions from the top-down and bottom-up models. **The estimated efficiency gaps relative to the UQ for SSEH and SSES are 2.4% and 2.9% respectively**.[27]

The key results are summarised in Table 2.1 below.

Table 2.1 SSES and SSEH's efficiency position under Ofgem's modelling approach at ED1 (%)

		Top-down	Bottom-up	Overall
Efficiency scores	SSEH	97.0	92.1	94.5
	SSES	97.0	93.0	95.0
	UQ	92.1	92.5	92.3
Gap to UQ	**SSEH**	**5.3**	**-0.4**	**2.4**
	SSES	**5.3**	**0.6**	**2.9**
R-squared		0.803	0.820	n.a.

Note: The gap to a UQ is calculated by taking ((SSEH's or SSES's efficiency score)/(UQ efficiency score) - 1).

Source: Oxera analysis.

However, we consider that Ofgem's approach at ED1 is unlikely to provide an accurate assessment of SSEH and SSES's efficiency scores. This is for the following reasons.

- Ofgem's modelling includes subsea cables, a highly atypical area of spending for SSEH (see section 2.2.2).
- Ofgem's approach to constructing the top-down CSV places a weight of 31% on the number of customers, which is operationally counter-intuitive. A weight that is consistent with operational insight would be around 8.3% (see section 2.2.3).
- Ofgem does not account for higher regional wages in Scotland (see section 2.2.4).

We account for these issues in the sections below to arrive at a view of SSEH and SSES's relative efficiency position.

[25] These are MEAV, units distributed, overhead length, total faults, total length, ONIs, and spans cut.
[26] A technical description of the statistical procedure for weighting the bottom-up CSV is found in Ofgem (2014), 'RIIO-ED1: Final determinations for the slow-track electricity distribution companies – Business plan expenditures assessment', 28 November, para. A5.4.
[27] These results do not include any post-modelling adjustments, such as qualitative adjustments, adjustments for the net-to-gross ratio, and adding back in excluded costs. However, we note that if these were considered, they would lead to very similar results for SSEH, and an improved efficiency position for SSES.

2.2.2 Accounting for subsea cables

SSEH's spend on subsea cables is atypical. Critically, SSEH's subsea cables activity is not well captured by the scale drivers in Ofgem's ED1 models.

Benchmarking relies on other companies having comparable activities against which SSE may be evaluated and there being balance in the model in terms of costs and for each element of this cost base associated cost drivers. However, subsea cables are an atypical area of spend for SSEH, which means that there are no appropriate comparators to assess the efficiency of SSE's spend in this area. Therefore, we recommend that the efficiency of subsea cables should be assessed separately on an engineering efficiency basis. See Oxera (2021), 'Company-specific and regional factors for RIIO-ED2' for further details.[28]

Therefore, as recommended in Oxera (2021), we exclude subsea cable costs and assets from the regression modelling for all DNOs. That is, for all DNOs we remove:

i. from total cable length, the length of subsea cables;

ii. from total MEAV, the MEAV attributable to subsea cables;

iii. from total faults, the number of subsea faults;

iv. from TOTEX, the amount of TOTEX attributable to subsea asset replacement and subsea faults.

Excluding subsea cables, the efficiency gaps relative to the UQ for SSES and SSEH are -2.1% (i.e. better than benchmark) and 3.5% respectively. SSEH's and SSES's efficiency scores are shown in Table 2.2 below.

Table 2.2 SSES and SSEH's efficiency position under Ofgem's modelling approach at ED1, excluding subsea cables (%)

		Top-down	Bottom-up	Overall
Efficiency scores	SSEH	94.1	86.3	90.0
	SSES	97.8	92.6	95.2
	UQ	92.5	92.6	91.9
Gap to UQ	**SSEH**	**1.7**	**-6.8**	**-2.1**
	SSES	**5.8**	**0.0**	**3.5**
R-squared		0.809	0.821	n.a.

Note: The gap to a UQ is calculated by taking ((SSEH's or SSES's efficiency score)/(UQ efficiency score) - 1).

Source: Oxera analysis.

2.2.3 Ofgem's composite scale variable (CSV) for top-down modelling

As set out in section 2.2.1, updating Ofgem's TOTEX top-down modelling with the latest data from 2011 to 2021 leads to a weight of 24% on customer numbers, compared to a 12% weight at ED1. However, as set out below, this is counterintuitive from an operational perspective.

[28] Oxera (2021), 'Company-specific and regional factors for RIIO-ED2', section 3.1.

Constructing a top-down CSV that is consistent with operational insight

The appropriateness of the constructed CSV for the top-down modelling depends on: (i) the scale drivers that are included; and (ii) the weight that is assigned to each scale driver. Which scale drivers are included should be based primarily on operational insight, with some support/cross-checks from statistical analysis.

We note that a range of different scale drivers are likely to be relevant when assessing costs.

- In Ofgem's own ED1 disaggregated modelling at the activity level, Ofgem considered the following seven scale drivers: MEAV, units distributed, overhead length, total faults, total length, ONIs, and spans cut.
- Similarly, Ofgem considered a range of scale drivers for its bottom-up aggregate TOTEX model at ED1, as shown in the second column of Table 2.3 below. In particular, Ofgem placed the highest weight on MEAV (c. 70%), followed by units distributed (c. 12%) and total faults (c. 9.5%).
- On both its bottom-up TOTEX model and its disaggregated activity cost modelling, we note that Ofgem did not use the number of customers for any of the cost areas. This may be because Ofgem considered the number of customers in its top-down TOTEX modelling, although with a much lower weight of 12% rather than the 24% that is obtained when using the most recent data. Post averaging of results across the models, the implicit weight on customers would be only around 3%.[29]
- In the Oxera study for the ENA, a number of scale drivers alongside customer numbers were identified as potentially suitable for constructing the top-down CSV, on the basis of interviews with the DNOs. These are MEAV, units distributed, network length, peak load and total faults.[30] However, the DNOs did not place a particularly high weight on the number of customers relative to other scale drivers, which is in contrast to the outcome from updating Ofgem's statistical approach that places a high weight of 24% on customer numbers.

Overall, the findings above suggest that while the number of customers may be a relevant scale driver to consider, a wider range of scale drivers should also be considered, and a 31% weight on the number of customers is clearly inappropriate.

To construct a top-down driver that is consistent with operational and engineering insight, SSE has identified appropriate cost drivers for each cost area, *given the available data*. Nonetheless, SSE states that these drivers are unlikely to be able to fully capture the efficient costs for each activity area. This is set out further in annex A1, which provides a more detailed description of the operational context around the cost drivers for each cost area. We note that when more evidence and data are made available over the price review, further work needs to be undertaken so that relevant drivers are better

[29] As, in ED1, Ofgem placed a 25% weight on the top-down results, 25% on the bottom-up results and 50% on the disaggregated modelling results.

[30] Oxera (2021), 'Assessment of cost drivers for RIIO-ED2 benchmarking – emerging findings', 29 March, slide 100. DNOs generally agree that MEAV is a useful and important variable that should be accounted for in CSVs.

accounted for in the cost assessment in a way consistent with operational insights.

On the basis set out above, we have calculated cost weights for the top-down CSV, as shown in the third column of Table 2.3 below.[31] **We find that a 72.1% weight should be placed on MEAV, a 13.2% weight on total faults, an 8.3% weight on the number of customers and 6.4% weight on peak load.**

Table 2.3 Percentage of TOTEX explained by a particular cost driver (%)

Cost drivers	Percentage of top-down CSV (Ofgem)	Percentage of bottom-up CSV (Ofgem)	Percentage of TOTEX (operational insight)[1]
MEAV	69.2	70.4	72.1
Units distributed	0.0	11.8	0.0
Overhead length	0.0	1.3	0.0
Total faults	0.0	9.5	13.2
Total length	0.0	2.8	0.0
Customers	30.8	0.0	8.3
ONI faults	0.0	1.8	0.0
Spans cut	0.0	2.3	0.0
Peak load	0.0	0.0	6.4

Note: the figures above do not change if subsea cables are excluded. [1] Further work needs to be undertaken to determine which cost drivers should be included within the CSV and the appropriate weights to be placed on each cost driver.

Source: Oxera analysis.

Results with an operationally intuitive top-down CSV, excluding subsea cables

In Table 2.4, we present SSES's and SSEH's efficiency gaps to the UQ using a top-down CSV that is consistent with operational insight. These results exclude subsea cables as this is a highly atypical area of spending for SSEH and should be assessed separately on an engineering basis (see section 2.2.2).

Using the amended top-down CSV, but still keeping Ofgem's three-region wage adjustment (discussed further in section 2.2.4), **the efficiency gaps relative to the UQ for SSES and SSEH are -4.4% (i.e. better than benchmark) and 1.5% respectively**.

[31] SSE has provided their view on appropriate cost drivers for the nine largest cost areas. These account for 81% of TOTEX. In order to construct a top-down scale driver, we scale up these proportions so that they amount to 100% of TOTEX.

Table 2.4 SSES's and SSEH's gaps to UQ using top-down CSV from appropriately-weighted scale drivers, excluding subsea cables (%)

		Top-down	Bottom-up	Overall
Efficiency scores	SSEH	89.8	86.3	88.0
	SSES	94.4	92.6	93.5
	UQ	92.2	92.6	92.1
Gap to UQ	**SSEH**	**-2.6**	**-6.8**	**-4.4**
	SSES	**2.4**	**0.0**	**1.5**
R-squared		0.816	0.821	n.a.

Note: The gap to a UQ is calculated by taking ((SSEH's or SSES's efficiency score)/(UQ efficiency score) - 1).

Source: Oxera analysis.

2.2.4 Regional wage adjustments

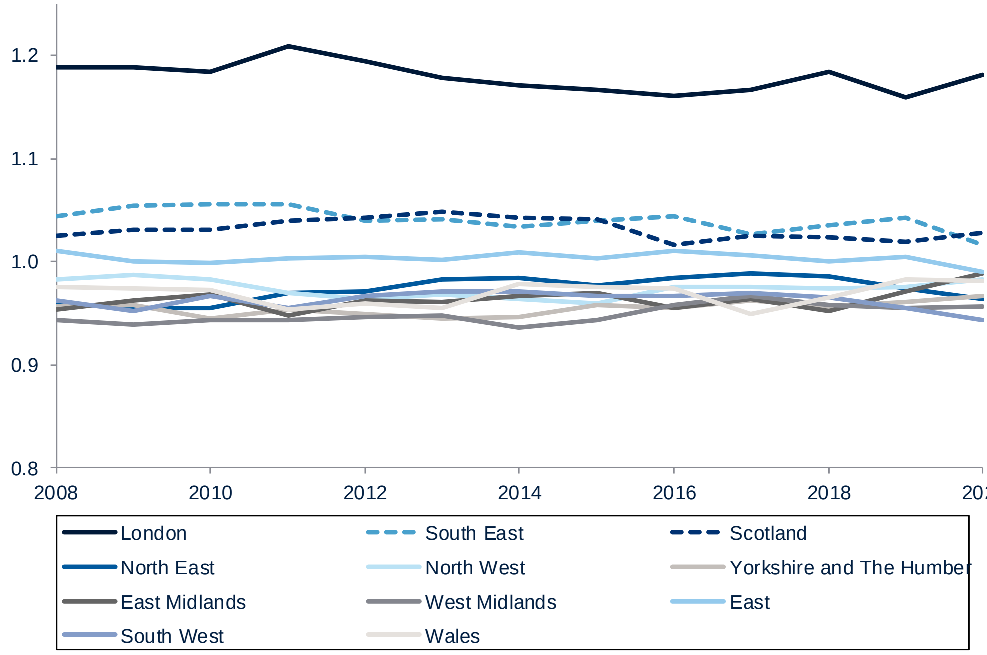
DNOs operating in regions where labour costs are higher incur higher expenditure compared to DNOs operating in regions with lower labour costs. These differences are driven by exogenous labour market factors.

To control for regional wage differences, in ED1 Ofgem undertook pre-modelling regional wage adjustments based on ONS ASHE data (at an occupational level) using three-regions.[32] Ofgem assumes that DNOs operating in London and the South East incur systematically higher labour costs than do DNOs operating in the rest of Great Britain (RoGB), and adjusts TOTEX to account for the element of expenditure that is due to different regional labour costs.[33] The labour cost index used for the RoGB is a simple average of the labour cost indices of the remaining nine regions (which includes Scotland).

However, analysis of the latest ONS ASHE data (using the same occupational split and approach as Ofgem) demonstrates that it is inappropriate to include Scotland as part of the RoGB when making regional wage adjustments. Figure 2.1 below shows that labour cost in Scotland is significantly and systematically above the national average, and aligned more closely to the South East than with the RoGB, the category that Ofgem has assigned it to. Therefore, the three regions approach used by Ofgem at ED1 underestimates the cost of labour that DNOs operating in Scotland can efficiently incur.

[32] ONS (2020), 'Earnings and hours worked, occupation by four-digit SOC: ASHE Table 14', available at: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/datasets/occupation4digitsoc2010ashetable14 (last accessed 27 May 2021).
[33] Ofgem reduces the TOTEX input for DNOs in high-cost regions by its 'regional cost adjustment' factor, as their regional labour costs are assumed to be above the national average. Conversely, Ofgem increases the TOTEX input for DNOs operating in the RoGB category by the amount of regional labour costs that are modelled as below the national average.

Figure 2.1 Regional wage indices based on occupation ONS ASHE data



Source: Oxera analysis based on ONS ASHE data.

Therefore, we adopt an amended three-region approach, which reassigns Scotland from the RoGB category to a category including the South East.

However, we note that the underlying economic drivers for high wages in Scotland are likely to be very different to those in the South East. According to SSEN, wages in Scotland are driven by a shortage of workers with the relevant skills, whereas in the South East high wages are due to the proximity to London. Wages might therefore develop differently in the future, which would then require an amendment to the grouping of regions (e.g. treating Scotland as its own region).[34,35] Nevertheless, based on the data currently available (see Figure 2.1) an amended three-region approach with Scotland and the South East in the same category is appropriate.

These results are presented in Table 2.5 below, and also include the changes described in sections 2.2.2 and 2.2.3.[36] Therefore, these results account for the cumulative impact of excluding subsea cables, using a more intuitive top-down CSV and accounting for higher wages in Scotland.[37]

[34] To test the robustness of our results, we present a sensitivity where we use a labour cost adjustment that treats each UK region separately in pre-modelling regional adjustments (which we denote as the ‘11-region approach’). We note that results for SSEH and SSES from the amended three-region and an 11-region approach are similar: SSEH and SSES’s gaps to the UQ are -7.2% and 0.5% respectively when Ofgem’s modelling is adjusted by the 11-region approach, compared to -6.7% and 0.9% respectively when Ofgem’s modelling is adjusted by the amended three-region approach.
[35] We note that once the TOTEX aggregated results have been triangulated with the bottom-up disaggregated results (see section 2.5), the gaps to the UQ with the 11-region approach are 4.9% better than the benchmark for SSEH and 2.4% less efficient than the UQ for SSES. In comparison, the gaps to the UQ for SSEH and SSES using the amended three-region scenario are 5.2% better than the benchmark and 2.0% less efficient than the benchmark respectively. This is driven by the UQ becoming slightly more stringent in the 11-region approach, at 93.2%, relative to the amended three-region approach, at 93.5%.
[36] Note that we also looked at ONS ASHE data using a sectoral, rather than occupational, breakdown. While the differences between regions over time are less clear, using a sector based pre-modelling regional wage adjustment further improves the estimated efficiency gap to the UQ for both SSEH and SSES.
[37] We note that Ofgem also considers other statistical diagnostic tests when evaluating its models, including the Ramsey RESET test, the Chow test for structural breaks, the VIF test and the Link test. When using the

The results show that SSEH's and SSES's overall efficiency scores are 86.2% and 93.2% respectively. **Relative to the UQ efficiency score of 92.4%, the gaps to the UQ for SSES and SSEH are -6.7% and 0.9% respectively**.[38]

Table 2.5 SSES and SSEH's efficiency positions under Ofgem's modelling approach at ED1, using the amended three-region wage approach and appropriately-weighted top-down CSV, excluding subsea cables (%)

		Top-down	Bottom-up	Overall
Efficiency scores	SSEH	87.9	84.5	86.2
	SSES	94.1	92.4	93.2
	UQ	92.0	92.5	92.4
Gap to UQ	**SSEH**	**-4.4**	**-8.7**	**-6.7**
	SSES	**2.2**	**-0.1**	**0.9**
R-squared		0.811	0.816	n.a.

Note: The gap to a UQ is calculated by taking ((SSEH's or SSES's efficiency score)/(UQ efficiency score) - 1).

Source: Oxera analysis.

2.2.5 TOTEX modelling: summary

Our approach to assessing SSEH and SSES's efficiency position builds on Ofgem's modelling at ED1 in three key areas.

- We have excluded subsea expenditure and assets, which is an atypical area of spending for SSEH.
- We have constructed a top-down CSV that accounts for a wider set of drivers and is better aligned with operational insight.
- We have accounted for higher regional wages in Scotland compared to the rest of GB.

Based on the TOTEX modelling, our view is that SSEH is an efficient company, with an efficiency gap of -6.7% (better than the UQ benchmark), while for SSES there is a small efficiency gap of +0.9%.

2.3 Disaggregated modelling

2.3.1 SSE's relative efficiency using Ofgem's models at RIIO-ED1

Ofgem's disaggregated modelling assesses each activity area separately. In order to inform SSE's business plan, we base our approach on Ofgem's approach at ED1 using the most recent data up to 2020.[39] We expect that our approach to assessing SSE's efficiency will be updated after Ofgem shares its data and publishes further information on its modelling approach for RIIO-ED2. In the light of significant changes to the demands on distribution networks—for instance, from electrification of heat, distributed energy generation, EV

updated data, both Ofgem's models and our amended models fail a number of these tests. Overall, the statistical performance is similar between these models. However, we consider that the more critical factor is to design models that are aligned with operational and engineering insight as focusing too heavily on statistical measures, which rely on a large number of strong assumptions (e.g. the skewness of the residuals), may not lead to intuitive models.

[38] Using Ofgem's three-region approach, but keeping all other specifications the same, the gaps to the UQ of 92.2% are -4.4% for SSEH and 1.5% for SSES.

[39] See footnote 9 for a further exposition on the data used.

charging—we expect that further changes to the methodology will be required.[40] We updated ten activity areas in total. These are: closely associated indirect costs (CAIs), asset replacement, business support, trouble call, non-op CAPEX, tree cutting, I&M, diversions, ONIs, and refurbishments. These areas cover 88% and 90% of SSES's and SSEH's costs respectively. Of the remaining activities, we note the following.

- Load-related CAPEX (namely, reinforcements, connections and TCP) is likely to be an important area of spend over ED2 to account for the electrification of heat and the impact of low carbon technologies (LCTs), such as distribution generation and electric vehicles (EVs) charging. However, given that only historical data is available to us, we have not considered these two activity areas in this report. Furthermore, we note that TCP spend has historically been a very small proportion of TOTEX.
- The remaining cost areas[41] each account for c. 1% of TOTEX or less. Therefore, we have not considered them in our analysis.

Based on aggregating the individual model results, SSES's and SSEH's efficiency scores and gaps relative to the UQ are shown in Table 2.6 below. SSEH is more efficient than the UQ, with a gap of 1.1%, while there is a gap of 4.6% for SSES.

Table 2.6 SSES's and SSEH's efficiency positions under Ofgem's disaggregated modelling approach at ED1 (%)

		Disaggregated Results
Efficiency scores	SSEH	96.3
	SSES	99.6
	UQ	95.3
Gap to UQ	SSEH	1.1
	SSES	4.6

Source: Oxera analysis.

However, we consider that there are a number of aspects of Ofgem's approach that should be amended to more accurately reflect SSEH and SSES's efficiency position.

- As set out in Oxera (2021), 'Company-specific and regional factors for RIIO-ED2', and as discussed above in the aggregate TOTEX modelling, subsea cables are an atypical activity for SSEH, and have not been well accounted for in Ofgem's approach to disaggregated modelling. This is detailed further in section 2.3.2.
- Ofgem's tree-cutting model at RIIO-ED1, when updated with the latest outturn data, is no longer operationally intuitive as the model suggests that more inspections drive lower costs. Updating Ofgem's model with the latest data yields implausibly large ranges of efficiency scores. This suggests that further model development is required in order to accurately assess tree-cutting costs. This is detailed further in section 2.3.3.

[40] See Oxera (2021), 'Potential effects of uncertainty in ED2 and fast-tracking WPD in ED1 on the benchmark in ED2', 28 October, for further discussion on uncertainty over ED2 and potential issues related to WPD's fast track allowance.
[41] These areas are: Reinforcement, Connections, ESQCR, Civil works, Op IT & Telecoms, Legal & safety, Smart meters, Rising Mains & Laterals, BT21CN, Technical Loss & Environmental, Flooding, Black Start, HVP, Diversions Rail Elec, TCP, QoS, HILP, Critical National Infra, SW 1-20, and NOCs other.

- Ofgem's approach in ED1 for a number of cost areas used forecast data from 2016–23. While we have updated for outturn data to 2020, forecasts for 2021–23 are now likely significantly outdated as they provided at ED1. We note that there is a particularly large discrepancy between actual and forecast costs in trouble call. Therefore, we do not use the forecast 2021–23 data for trouble call. The same issue may also impact other activities. We will update our analysis once new data (including forecast data over ED2) becomes available. This is detailed further in section 2.3.4.

2.3.2 Accounting for subsea cables in asset replacement

As stated in section 2.2.2, based on the recommendation in Oxera (2021) on regional factors, we consider Ofgem's assessment of subsea cables spend in its disaggregated modelling approach.[42]

Areas of spend affected by subsea cables

The two largest cost areas affected by subsea cable assets is asset replacement and faults. We focused on subsea cable assets and spend in asset replacement as this is the larger cost area of the two, where it accounts for 58%[43] of SSEH's subsea cable expenditure from 2016–20.[44] However, we note that faults spend is still a significant area of subsea cable spend, accounting for the remaining 42% of SSEH's subsea cable expenditure, (although SSEH is efficient on faults expenditure even with subsea expenditure included). Therefore, we consider that our analysis, which excludes only subsea expenditure in asset replacement, is likely to be *underestimate* SSEH's efficiency. However, as set out below, even when only removing subsea cables from asset replacement SSEH is still estimated to be efficient across the ten areas considered.

Nonetheless, we consider that a more complete assessment of SSEH's subsea cable should include the faults activity area, and any other areas of spend that may be significantly affected by subsea cables. As such, we will extend the exclusion of subsea cables to fault costs and activities once the forecast data becomes available.

Subsea cables in asset replacement

At ED1, Ofgem determined SSEH's efficient subsea cable spend using an expert's view of efficient unit costs for the replacement of SSEH's subsea cables. This is based on an operational and engineering assessment, and is beyond the scope of this report.

However, as Ofgem's expert view is likely outdated, and diverges significantly from the actual expenditures recorded, and given the atypical nature of this expenditure we exclude subsea cables from asset replacement activity. We recommend that the efficiency of subsea cables is assessed separately on an engineering efficiency basis.

The impact on the efficiency scores for asset replacement (not across all ten disaggregated cost areas) is shown in Table 2.7 below. While removing subsea cable spend improves SSEH's efficiency score from 124.3% to 105.4%, there is still a significant gap relative to the UQ of 11.1% (excluding

[42] Oxera (2021), 'Company-specific and regional factors for RIIO-ED2', section 3.1.
[43] As a proportion of total subsea cable spend in asset replacement and faults.
[44] Over the period 2011–20, asset replacement accounts for a much larger proportion of subsea cable spend, at 75%.

subsea).[45] For SSES, the gap to the UQ is 22.3% after subsea cables are excluded.

Table 2.7 Efficiency scores, including and excluding subsea cables, for the asset replacement cost area (%)

		Including subsea cables	Excluding subsea cables
Efficiency scores	SSEH	124.3	105.4
	SSES	116.0	115.9
	UQ across all ten cost areas	95.3	94.8
Gap to UQ	**SSEH**	**30.5**	**11.1**
	SSES	**21.7**	**22.3**

Source: Oxera.

The impact on SSEH's and SSES's efficiency positions across the ten disaggregated cost areas is shown in Table 2.8 below.

Removing subsea cables improves SSEH's estimated relative efficiency, with its gap to the UQ falling from 1.1% to -2.0% (i.e. better than benchmark). As SSES does not have any subsea cable spend over the period, its efficiency scores are unaffected, but the gap to the UQ moves slightly from 4.6% to 5.1% due to the improvement of the overall UQ.

Table 2.8 SSES's and SSEH's efficiency positions under Ofgem's disaggregated modelling approach, including and excluding subsea cables from asset replacement (%)

		Ofgem's approach (2016–20 actual data)	Results excluding subsea cables (2016–20 actual data)
Efficiency score	SSEH	96.3	92.9
	SSES	99.6	99.6
	UQ	95.3	94.8
Gap to UQ	**SSEH**	**1.1**	**-2.0**
	SSES	**4.6**	**5.1**

Source: Oxera analysis.

2.3.3 Stability of Ofgem's tree-cutting model

Ofgem assesses tree-cutting costs using a regression model consisting of two cost drivers: the number of spans cut, and the number of spans inspected. Operationally, one would expect that the higher the number of spans cut or spans inspected, the higher the costs.

We have found that Ofgem's model does not yield intuitive results when using the latest outturn data. At ED1, Ofgem estimated the model over forecast ED1 data from 2016–23.[46] We have updated Ofgem's modelling by estimating the model using actual outturn data for ED1, i.e. 2016–20. After updating, Ofgem's model provides unintuitive results—suggesting that the number of spans inspected reduces the network's costs. This is explained in more detail in

[45] We use the UQ across all ten cost areas rather than for asset replacement only as the UQ company on asset replacement is not necessarily the UQ company overall.
[46] Ofgem (2014), 'RIIO-E1: Final determinations for the slow-track electricity distribution companies', 28 November, para. A3.17.

annex A2. Therefore, we exclude the 'number of spans inspected' variable from the model. The results are shown in Table 2.9 below.

Using the adapted tree-cutting model, SSEH's efficiency gap relative to the UQ is 0.8% and SSES's 4.7%.

Table 2.9 SSES's and SSEH's efficiency positions under Ofgem's disaggregated modelling approach, using an amended tree-cutting model,%

		Ofgem's approach (2016–20 actual data)	Results with adapted tree-cutting regression (2016–20 actual data)
Efficiency score	SSEH	96.3	95.7
	SSES	99.6	99.4
	UQ	95.3	94.9
Gap to UQ	**SSEH**	**1.1**	**0.8**
	SSES	**4.6**	**4.7**

Source: Oxera analysis.

Nonetheless, **we note that the range of efficiency scores in this model is very large, ranging from 53% to 166%** (SSES's and SSEH's efficiency score are 166% and 73% respectively). Furthermore, the model fit has worsened since the model was estimated at ED1 (see annex A2). There are likely to be omitted factors from this model that are being incorrectly recognised as inefficiency. For example, the model assumes that efficient cost per span cut will be the same across different companies, but this may not necessarily be the case.

Therefore, we consider that further model development should be undertaken to accurately assess tree cutting costs.

2.3.4 Trouble call and use of forecast data

In ED1 Ofgem used a unit cost approach to assess trouble call spend for a range of asset types. Of those, low-voltage and high-voltage underground cable faults are the most significant expenditure items.

Other trouble call spend is assessed through a regression approach (overhead lines).

At ED1, Ofgem calculated average unit costs from 2016–23 for each company using forecast data. Then, Ofgem calculated the median of these average unit costs across all companies. Ofgem bases its assessment of modelled trouble call costs for each company on these median unit costs.

While we have updated Ofgem's modelling to use actual data until 2020, forecasts (made in 2015, pre-RIIO-ED1) are still used for 2021–23.

However, there are significant differences between the forecast and outturn median unit costs in the industry that are used to calculated modelled costs. This is presented in annex A3.

Forecast median unit costs are consistently lower than actual median unit costs. Therefore, it is unlikely that the 2021–23 forecasts are a valid basis for calculating modelled costs. As such, in order to provide a more robust estimate of the relative efficiency of SSE's trouble call costs, we restrict the period on which unit costs are calculated to only 2016–20.[47]

The results are shown in Table 2.10 below. **SSEH's and SSES's efficiency gaps relative to the UQ are 1.6% and 4.6% respectively.**

Table 2.10 SSES's and SSEH's efficiency position under Ofgem's disaggregated modelling approach, using only 2016–20 actual data to assess HV and LV UG faults

		Ofgem's approach (2016–20 actual data)	Results adjusted unit costs for trouble call (2016–20 actual data)
Efficiency score	SSEH	96.3	95.8
	SSES	99.6	98.6
	UQ	95.3	94.3
Gap to UQ	**SSEH**	**1.1**	**1.6**
	SSES	**4.6**	**4.6**

Source: Oxera analysis.

We note that Ofgem's ED1 modelling may not account for all drivers that are operationally relevant to trouble call spend resulting from underground cable faults. For example, older cables approaching the end of their life are more likely to experience faults, and hence to incur trouble call spend, than newer cables. Therefore, the age profile of assets, in particular of LV[48] and HV[49] underground cables, is likely an operationally relevant driver of trouble call spend. However, Ofgem's modelling in ED1 does not account for the age profile of assets, though there could be operational reasons for doing so. These factors may need to be accounted for within Ofgem's modelling at ED2.

2.3.5 Additional considerations for disaggregated modelling in ED2: potential sources of bias

In addition to the areas above, there are other potential biases that could arise from disaggregated modelling. In particular, as each cost area is assessed using a different methodology, there could be distortions to the modelling due to cost allocation issues, or trade-offs and synergies between different cost areas.

For example, based on information from SSE, we understand that SSE tends to rely more heavily on external contractors for its asset replacement activities compared to other DNOs. This means that SSE's asset replacement costs would tend to be higher, while it may incur lower costs in other areas, such as closely associated indirect costs (CAIs).

In principle, Ofgem's approach of setting the benchmark at the aggregate level across all disaggregated cost areas rather than each individual cost area should mitigate this issue. Where there are two equally efficient ways to meet a need, Ofgem's approach should lead to the same modelled costs for the DNO, and therefore lead to neutral incentives to DNOs as to how they choose to

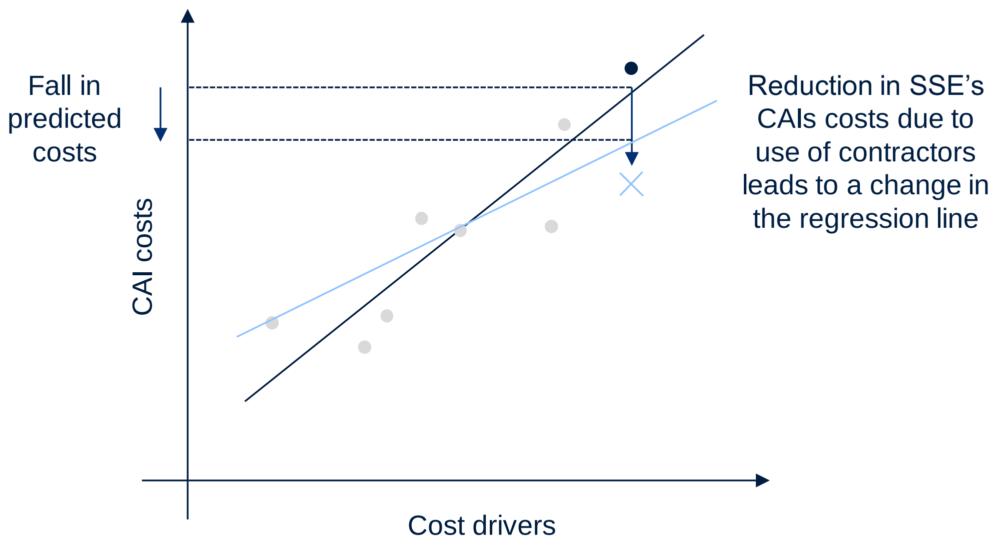
[47] We note that modelling for other disaggregated cost areas may also rely on outdated forecast 2021–23 data. However, at this stage, we do not undertake a detailed analysis of the discrepancies between forecast and actual data for other disaggregated cost areas in order to decide whether 2021–23 data should be excluded. When companies' latest forecast data is shared, the modelling will need to be updated and we will re-examine this issue.
[48] Townsend, F. and Duncan, J., (2021), 'RIIO-ED2 Engineering Justification Paper LV Underground Mains and Service, Draft V5.1', 7 June, pp. 8–9.
[49] Townsend, F. and Duncan, J., (2021), 'RIIO-ED2 Engineering Justification Paper 6.6kV/11kV Underground Cables, Draft V4.1', 8 June, pp. 5–6.

meet a need. For instance, ideally, Ofgem's approach would quantify the efficient costs associated with CAI activities, and DNOs could choose whether to use these costs to carry these activities out themselves, or pay contractors to carry out these activities.

In practice, this may not necessarily hold, as set out in the following example. Suppose SSE spends an extra £100m in asset replacement due to its use of external contractors, and correspondingly £100m less in CAIs. Ideally, the disaggregated modelling framework should lead to the same overall total modelled costs for SSE (as the SSE's use of contractors has not resulted in a loss of efficiency since total costs are the same). However, it is likely that SSE's **use of contractors would lead to lower predicted costs and thus a lower overall estimated efficiency**, as:

- **asset replacement predicted costs will remain the same** as the cost prediction is driven by volumes, and asset replacement volumes have not changed due to the use of contractors; and
- **CAI predicted costs are likely to fall** because it is determined using regression analysis, with MEAV and new assets installed as explanatory variables, which are invariant with respect to asset replacement activity.[50] Due to the mechanics of regression analysis, a reduction in SSE's CAI costs, keeping the explanatory variables constant, will lead to a reduction in SSE's predicted costs. The graphical intuition behind this is set out in Figure 2.2 below; SSES has one of the highest MEAV levels in the industry. However, our conclusions are not dependent on the values of the cost drivers of SSEH and SSES relative to the industry. This is because regression methods plot a line of best, so a reduction on SSE's CAI costs will necessarily lead to a reduction in its predicted costs, regardless of the its cost driver levels relative to the rest of the industry.

Figure 2.2 Change in modelled CAI costs if CAI costs are reallocated to asset replacement due to use of contractors on asset replacement.



Source: Oxera.

[50] Ofgem (2014), 'RIIO-ED1: Final determinations for the slow-track electricity distribution companies', 28 November, para. 3.25.

While we have used the example of spending on contractors above, these issues are also potentially relevant for other issues, e.g. wherever there are synergies or trade-offs between different cost areas, or where there are cost allocation issues.

Therefore, while there are benefits to using disaggregated models in that they may be able to better capture the drivers that best reflect the activities in each cost area, there are also risks that need to be considered. We will reassess these issues further once further data and information on Ofgem's methodology is available .

2.3.6 Disaggregated modelling: summary

Table 2.11 presents the efficiency scores for SSEH and SSES resulting from the disaggregated modelling approach with the adjustments described in sections 2.3.1–2.3.3. The results show that, under the disaggregated modelling approach, SSEH is an efficient company, performing 1.8% better than the UQ company. SSES is relatively inefficient, with a 5.2% gap to the UQ.[51,52] However, we note that some of this gap is driven by the SSES being a significant outlier in the tree-cutting activity area, where further model development is needed.

Table 2.11 SSES and SSEH's efficiency position under disaggregated modelling (%)

		Ofgem's approach (2016–20 actual data)	Accounting for adjustments set out in sections 2.3.1–2.3.3
Efficiency score	SSEH	96.3	91.8
	SSES	99.6	98.4
	UQ	95.3	93.5
Gap to UQ	**SSEH**	**1.1**	**-1.8**
	SSES	**4.6**	**5.2**

Source: Oxera analysis.

For the purposes of informing their business plan, SSE also asked us to examine efficiency estimates for business support costs (BSCs) and closely associated indirect costs (CAIs). Based on Ofgem's methodology updated to 2020 data, we find that SSEH is efficient on BSCs while SSES is efficient on CAIs relative to the upper quartile (across all disaggregated areas).[53] However, SSEH has a gap of 0.9% on CAIs and SSES a gap of 0.1% on BSCs relative to the upper quartile. This is shown in Table 2.12 below.

[51] These results do not include any post-modelling adjustments, such as qualitative adjustments, adjustments for the net-to-gross ratio, and adding back in excluded costs. However, we note that if these were considered, they would lead to very similar results for SSEH, and an improved efficiency position for SSES.
[52] We have not applied our regional wage adjustments, as set out in section 2.2.4. However, this is unlikely to materially impact the results, given that SSEH is already relatively efficient under the disaggregated modelling.
[53] This is relative to the upper quartile benchmark across all the disaggregated cost areas. As set out in footnote 45, this is because benchmarking at the individual cost area level may lead to an overly stringent benchmark as the UQ company in a specific cost area may not be the same as that as the UQ company across all disaggregated cost areas. If calculating the gaps for BSCs and CAIs on each cost area individually, SSEH and SSES would be efficient relative to the UQ on BSCs, while on CAIs, SSEH and SSES would have gaps of 9.8% and 2.2% respectively.

Table 2.12 SSES and SSEH's efficiency position for CAIs and BSCs (%)

		CAIs	BSCs
Efficiency score	SSEH	94.4	93.1
	SSES	87.8	93.6
	UQ	93.5	93.5
Gap to UQ	**SSEH**	**0.9**	**-0.4**
	SSES	**-6.1**	**0.1**

Source: Oxera analysis.

2.4 What is the appropriate benchmark?

The appropriate benchmark needs to be determined by empirical evidence on the precision and quality of the cost modelling. For example, if the models are imprecise, then it is less certain whether deviations from the modelled cost predictions are due to company inefficiencies or due to excluded factors.

At ED1, Ofgem used a UQ benchmark. The CMA at PR19 also adopted a UQ benchmark, rejecting Ofwat's proposals to use a more stringent benchmark.[54]

However, we note that a UQ benchmark is ad hoc, lacks theoretical grounding and is not aligned with academic literature. As stated above, the choice of benchmark needs to be determined by further evidence. We will examine this issue when forecast data becomes available.

Furthermore, an important consideration given the uncertainty over ED2 is the period over which the benchmark is calculated. In Oxera (2021), we discuss how uncertainty in the forecast data, cost and scenario inconsistencies and the risk of anticipatory spending could distort the benchmark.[55] The benchmark, alongside other changes to the overall modelling approach, could be used to address some of these issues, as discussed further in the note.

For the purposes of providing evidence to help SSE determine an efficiency assumption for its Business Plan, we use a UQ benchmark based on Ofgem's and other regulatory precedent.

2.5 Overall conclusion on SSE's relative efficiency

In this section, we present SSEH and SSES's efficiency position incorporating all the analysis above for the purposes of informing SSE's business plan, noting that further updates to the modelling will be needed once more data is made available.

Averaging the results across the TOTEX and disaggregated modelling (in sections 2.2.5 and 2.3.6 respectively), **SSEH's and SSES's efficiency gaps relative to the UQ are -5.2% and 2.0% respectively**.

Based on these results, SSEH is an efficient company, while SSES has an estimated inefficiency gap of 2.0%.

[54] CMA (2021), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations. Final report', 17 March, paras 4.407 and 4.494.
[55] See Oxera (2021), 'Potential effects of uncertainty in ED2 and fast-tracking WPD in ED1 on the benchmark in ED2', 28 October.

Table 2.13 SSEH's and SSES's relative efficiency position (%)

		TOTEX	Disaggregated	Results
Efficiency score	SSEH	86.2	91.8	88.6
	SSES	93.2	98.4	95.4
	UQ	92.4	93.5	93.5
Gap to UQ	**SSEH**	**-6.7**	**-1.8**	**-5.2**
	SSES	**0.9**	**5.2**	**2.0**

Note: after the efficiency scores from the TOTEX and disaggregated approaches are averaged, the UQ is then re-calculated. This is why the UQ efficiency score of the overall results is not necessarily the average of the UQ of the TOTEX and disaggregated results.

Source: Oxera analysis.

3 Ongoing efficiency assessment: evidence from the performance of the UK economy and sectors

This section focuses on assessing the scope for ongoing efficiency improvements for SSE over RIIO-ED2.

The main results are summarised in the box below.

Box 3.1 Ongoing efficiency assessment

- For the assessment of the scope for ongoing efficiency improvements for SSE over RIIO-ED2 we consider a growth-accounting approach using EU KLEMS data.
- We determine that ongoing efficiency improvements should be calculated based on **GO-TFP growth** in **industries that correspond to DNO activities** over **full business cycles**.
- We identify construction (F), repair and installation of machinery and equipment (C31-C33), transport and storage (H49–H53), and manufacturing of electrical equipment (C27) as comparator sectors for CAPEX activities.
- We identify transport and storage (H49–H53), professional, scientific, technical, administrative and support service activities (M-N), telecoms (J61) and IT and other information services (J62–J63) as comparator sectors for OPEX.
- We identify one complete business cycle in the EU KLEMS database, 2007–16.
- Based on this approach, we determine the scope of likely ongoing efficiency improvements over RIIO-ED2 to be 0.4% p.a. (with a range of 0.3–0.6% p.a. based on a range of sensitivities we have carried out).
- We have also considered alternative approaches to directly estimate ongoing efficiencies. In particular, we examined the unit cost reductions achieved by benchmark and frontier companies in the sector, and used stochastic frontier analysis to decompose changes in cost over time into catch-up and ongoing efficiencies. These provide estimates in the range of 0.1–0.6% p.a., which are consistent with those based on the EU KLEMS data.
- **Based on these alternative approaches, the EU KLEMs analysis and a range of sensitivities we have carried out, we find that an ongoing efficiency assumption of 0.4% p.a., with a range of 0.1–0.6% p.a., is likely to be appropriate over ED2.**

3.1 Approaches to estimating productivity

The ongoing efficiency (OE) target captures the degree to which an efficient firm can reduce costs due to technological change. OE is part of the change in efficient costs (or frontier shift), the rest, input price changes, will be reflected by indexing totex allowances to inflation (CPIH) and by applying Real Price Effects (RPEs). OE does not contain catch-up efficiency, i.e. the rate at which a company must improve efficiency to catch up with the most efficient firm as this is already reflected in the benchmarking (see section 2).

The rate of ongoing efficiencies in a regulated sector can be estimated using direct or indirect approaches.[56] Both rely on the assumption that the past rate of technological progress is a good indicator of the potential future rate.

- **Indirect approaches** rely on the use of indirect comparators to derive a benchmark. They involve the selection of sectors with characteristics comparable to the assessed companies (DNOs), and assume that the rate of technological progress in the selected set of comparators is a good indicator of the rate of technological progress in the DNO market. Existing studies and UK regulatory precedent typically consider sector-level data from the EU KLEMS database. We undertake a primary analysis of EU

[56] For a review, see Oxera (2016), ‘Study on ongoing efficiency for Dutch gas and electricity TSOs’, January.

KLEMS data (indirect approach) and refer to regulatory precedents where appropriate in section 3.2.

- **Direct approaches** involve direct comparisons over time across different companies (DNOs in this case) to estimate the frontier-shift improvements that DNOs have achieved historically. Common approaches consider either data envelopment analysis (DEA)[57] or SFA.[58] We consider unit cost trends for the benchmark companies and ongoing efficiency estimates based on SFA in section 3.3.

3.2 Oxera analysis of EU KLEMS data

Our approach broadly follows the framework set out in Oxera's April 2016 report for the Dutch regulator (Authority for Consumers & Markets, ACM),[59] and is made up of several components, including:

- the productivity measure(s) and database to be used;
- the period over which historical productivity performance will be examined;
- the set of comparator sectors;
- the weights attached to these sectors;
- any adjustments that need to be made.

3.2.1 Productivity measures

There are several ways in which productivity can be measured. Total factor productivity (TFP) corresponds to the change of overall inputs require to produce the output. Partial factor productivity (such as labour productivity LP) focuses on the change of a specific input needed to produce the given output. If correctly specified, partial factor productivity can be applied as a productivity challenge for the appropriate components (e.g. labour productivity to labour costs), or one can apply TFP to TOTEX.

In our analysis, we focus solely on TFP rather than on partial factor productivity or missing productivity measures for the following reasons.

- Mixing these different productivity components yields biased results.
- Consistently applying the various factor productivities to the appropriate part of the cost base causes practical difficulties in the need to differentiate the exact cost component that needs to be assessed with the appropriate productivity target. TFP, in contrast, can be applied to total TOTEX.
- Setting different OE targets for different cost components incentivises the use of one expenditure component over the other (e.g. substituting labour with capital). This contradicts the basic intention of the TOTEX framework. In contrast, using TFP productivity challenge for all type of expenditure imposes no incentives for certain types of expenditure.

[57] DEA is a mathematical non-parametric approach that is widely used internationally when benchmarking regulated companies. For a more detailed discussion, see Thanassoulis, E. (2001), 'Introduction to the Theory and Application of Data Envelopment Analysis: A Foundation Text with Integrated Software', Springer.
[58] SFA is an econometric, parametric approach that, unlike DEA, accounts for statistical noise by making functional form and distributional assumptions. For a more detailed discussion, see Kumbhakar, S.C., Wang, H.J. and Horncastle, A.P. (2015), *A practitioner's guide to stochastic frontier analysis using Stata*, Cambridge University Press.
[59] Oxera (2016), 'Study on the ongoing efficiency for Dutch gas and electricity TSOs', January.

In a growth accounting context, productivity growth can be estimated using the gross output (GO) or value added (VA) methods. GO represents the total output of a firm, industry or economy, and can be considered as the 'end-product'. VA, by contrast, represents the incremental value that a firm, industry or economy has added in the production process. In other words, VA is GO minus any intermediate input consumed in the production process (such as materials, services procured from external organisations, and energy consumed in the production process). With positive productivity growth, VA TFP growth estimates will be higher than GO TFP by construction.

The literature clearly outlines the conceptual difference between GO and VA measures and provides guidance as to which measure is most appropriate in the context of estimating productivity change at the sector level (as is required by the approach used in this paper).[60] In particular, the raw VA-TFP estimate can only be applied to a subset of TOTEX (excluding intermediary goods) or, alternatively, has to be adjusted by the share of intermediary good if applied to TOTEX. TFP-GO estimates, by contrast, can be applied to TOTEX without adjustment. VA-TFP is thus a **biased** estimate for ongoing efficiency when cross-industry inputs (e.g. outsourcing) are relevant; GO-TFP, in contrast, is robust to cross-industry inputs and therefore the better choice. GO-TFP may be problematic when highly aggregated data (such as economy-wide data) is used because it may double count intermediary products as outputs (for firms producing these goods) and as inputs (for firms using these as intermediary inputs). This issue is of lesser importance if productivity is estimated on the industry level.

For these reasons, the OECD concludes that the VA-based measure is 'not a good measure of technology shifts at the industry or firm level'.[61]

Based on the conceptual reasons presented and the guidance of external bodies, our work thus focuses on GO-TFP.

If VA TFP is to be used, then either further adjustment (scaling the estimate down by the share of intermediates in the cost base) will be required, or VA-TFP should only be applied to a more narrowly defined cost base (i.e. excluding intermediaries). We provide an estimate of VA-TFP excluding intermediary inputs in section 3.2.5.

3.2.2 Period of analysis

The growth accounting approach measures productivity as a 'residual', i.e. the proportion of output growth that is not explained by growth in inputs. This approach is based on economic theory, which assumes that firms are fully able to adjust the use of input factors, such as labour or capital, as a reaction to output fluctuations. In practice, this behaviour is not without friction. For example, firms do not hire and fire workers in reaction to short-term demand fluctuations because such behaviour is associated with considerable cost. As a result, **measured productivity growth is volatile and pro-cyclical with output changes**. That is, productivity is higher during periods of growth and lower during periods of recession.

To derive a 'long-term' forecast for ongoing efficiency, this pro-cyclical nature of productivity needs to be taken into account. For example, the estimated productivity benchmark will clearly be too high if the considered time period

[60] OECD (2001), 'Measuring Productivity OECD Manual Measurement of Aggregate And Industry-level Productivity Growth', p. 25.
[61] Ibid., p. 16.

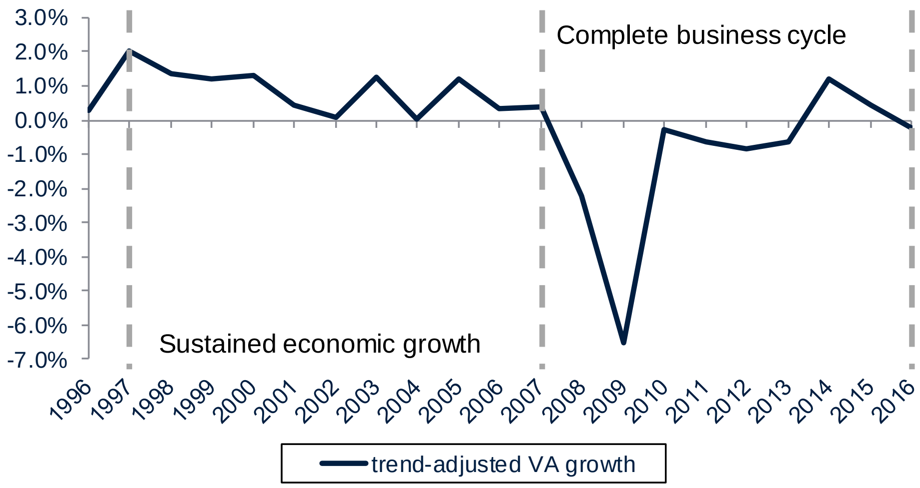
focuses on years with economic growth (for example, during the late 1990s and early 2000s), while the estimated productivity benchmark will be too low if the time period focuses only on years with economic decline (the years around the financial crisis in 2009).

The length of a business cycle is typically estimated based on information about the output gap—that is, the difference between actual output and the some measure of 'potential' output. A business cycle is considered as a point of zero output gap to another point of zero output gap, including a peak and a trough. This means that a business cycle should contain **one** period with a positive output gap and **another** period with negative output gap.

Defining a business cycle is difficult in practice, and different datasets and different approaches may come to different conclusions. Simple approaches, requiring the least amount of data, base the business cycle on the output gap, where the output gap is defined as the difference between actual output from its trend. A more complex or composite approach also uses the output gap but combines various indicators of spare capacity to construct the output gap.[62]

Based on EUKLEMS data (Figure 3.1), we consider that the 2007–16 period provides the most appropriate period for estimating a benchmark for ongoing efficiency improvements, for two main reasons. First, given that recent economic forecasts suggest that the economy-wide productivity reduction in the UK will persist in the medium term, we consider that the 2007–16 period is more likely to be representative of the economic conditions over ED2. Second, this period covers a complete business cycle and thus accounts for the pro-cyclicality of productivity.

Figure 3.1 Business cycle analysis using EUKLEMS data



Source: Oxera analysis of EU KLEMS data. We define a business cycle as beginning and ending with a 0% output gap, i.e. after a period of below- and above-trend output growth. The output gap is defined as the difference between the actual output growth and the 'potential' output growth of an economy. Potential output growth is usually estimated as the long-run average output growth of the economy.

3.2.3 Comparator selection

Based on data on comparable sectors in the economy, it is possible to estimate the historical rate of frontier shift that other sectors have achieved.

[62] For example, see Dupasquier, C. and St-Amant, A. (1999), 'A survey of alternative methodologies for estimating potential output and the output gap', *Journal of Macroeconomics*, **21**:2, pp. 577–95; Orphanides, A. and Norden, S. (2002), 'The Unreliability of Output-Gap Estimates in Real Time', *Review of Economics and Statistics*, **84**:4, pp. 569–83.

We focus on sectors that share at least common activities with DNOs. Given that we follow an activity-based approach, we do not examine economy-wide comparators. Such a broad selection of comparator would lead to sectors with dissimilar activities being used to set the OE target and imposes high risk that sectors sharing no common activities with DNOs bias the OE target.

We chose the comparator sectors presented in Table 3.1 on the basis of the similarity of their business procedures to DNOs, and starting from the set of comparators chosen by Ofgem in T2 and our previous assessment of those[63] and our previous work for electricity DNOs in ED1.[64] We have further refined this comparator set slightly by adding additional sectors for OPEX activities to better capture activities such business support, grid metering, grid maintenance, and planning.

Finally, based on operational insight from SSE and Ofgem's approach in RIIO-1, we mapped comparators to each expenditure category by matching them to corresponding activities in the gas distribution sector using the methodology followed in our work for the ACM.[65]

We further conducted sensitivity analysis to test how the inclusion of other sectors that were previously considered as comparators by Ofgem would impact results.

Table 3.1 Comparator sectors

Expenditure category				
CAPEX	Construction (F)	Other manufacturing; repair and installation of machinery and equipment (C31–C33)	Transport and storage (H49–H53)	Total manufacturing: Electrical equipment (C27)
OPEX	Transport and storage (H49–H53)	Professional, scientific, technical, administrative and support service activities (M–N)	Telecoms (J61)	IT and other information services (J62–J63)

Source: SSE and Oxera, based on Ofgem (2012), 'RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix', July, p. 21 (given that in ED1 Ofgem accepted DNO's ongoing efficiency assumptions).

3.2.4 Weighting approach

The final productivity estimate can be derived using unweighted and weighted averages across the comparator sectors. The unweighted average measure is a simple average of the comparator set, with no assumptions on the importance of each activity to the cost base. A weighted average measure based on DNOs' cost structure could be considered a more 'complete' measure, but it also rests on the assumption that the weights used for the analysis are accurate.

In previous determinations, Ofgem used both weighted and unweighted averages, with the weights determined by the *relative importance of the*

[63] Oxera (2020), 'Critique of RIIO-2 ongoing efficiency analysis', September.
[64] Oxera (2013), 'The potential for frontier shift in electricity distribution', June.
[65] Oxera (2016), 'Study on the ongoing efficiency for Dutch gas and electricity TSOs', prepared for the ACM, April.

sectors in the economy. However, this weighting approach does not account for the industry-specific cost structure of DNOs.

To overcome this, in calculating productivity growth we map comparators to the corresponding cost categories and give them equal weights (within an expenditure category). We then consider a weighted average where the weights are reflective of the cost structure of a notionally efficient company. As SSEH has been assessed as a broadly efficient company (see section 2.5), we use its cost split to construct the weights shown in Table 3.2.[66]

Table 3.2 Weights for expenditure categories (%)

Expenditure category	SSEH	Industry
CAPEX	37	44
OPEX	63	56

Source: Oxera based on data from SSE.

For the purposes of this report, we weight each of the comparator sectors equally within the expenditure category. We note that this approach is simplified and may not be appropriately aligned with DNO activities. Going forward, we may re-examine the weighting of sectors to better align with DNO activities, depending on access to appropriate data.

3.2.5 Results

We estimate GO-based TFP growth based on the 2019 released EU KLEMS data over the period 2007–16. We then:

- map the (refined) set of comparator sectors to expenditure categories;
- calculate productivity estimates for each expenditure category as the equally weighted average of productivity measures for the relevant comparator sectors;
- calculate the overall productivity measure as an average of the productivity measures for individual categories of expenditure, weighted according to SSES' and SSEH's cost structure.

Our analysis uses data from the 2019 release of EU KLEMS, which is based on NACE Rev.2 industry classification. This new released version is more in line with national account data, and incorporates the contribution of intangible assets.[67]

Applying this approach, we estimate productivity growth of 0.4% p.a. (Table 3.3).

Table 3.3 Frontier-shift (productivity growth) estimates, 2007–16 (%) p.a.

	TFP
CAPEX (unweighted average)	0.2
Construction	0.2

[66] Note that using the average cost breakdown for both SSE networks is extremely similar to cost breakdown for SSE (the proportion of capex is 40% for SSE, 39% for SSES and 41% for SSEH.
[67] We note that when considering GO-based TFP growth for the period 2007-2016 across all sectors (i.e. not just the identified comparator sectors), productivity growth is only at around 0.1% p.a.

Other manufacturing; repair and installation of machinery and equipment (C31–C33)	0.9
Transportation and storage	-0.6
Total manufacturing – Electrical equipment	0.3
OPEX (unweighted average)	0.5
Transportation and storage	-0.6
Telecommunications	0.9
IT and other information services	0.9
Professional, scientific, technical, administrative and support service activities	0.9
Ongoing efficiency (weighted average: 37% CAPEX, 63% OPEX)	**0.4**

Source: Oxera based on EU KLEMS data, 2019 release.

In addition, we conduct sensitivity analysis and report the results in Table 3.4 and Table 3.5.

In our main analysis, we use the (OPEX and CAPEX) expenditure shares of the most efficient network operator to aggregate the 'targeted' sector-specific productivity growth rates. As the growth accounting approach does not discriminate between efficient and inefficient firms, we use the industry average expenditure shares as a sensitivity. Table 3.4 shows that our results are robust to the chosen weighting scheme as the estimated productivity growth is almost identical.

We further conducted several sensitivities to investigate the effect of changes to the selected comparator sectors. For this, we considered two sectors that were considered by Ofgem in previous determinations: repair of motor vehicles and motorcycles, and financial and insurance activities. Including the former does not change the proposed ongoing efficiency challenge, while the latter decreases it slightly to 0.3%.

We also investigate the sensitivity of the estimate to the chosen time period. Our main estimate (see section 3.2.2) is based on the period 2007–16 (as established from an analysis of EU KLEMS). The time period 2006–16 matches the most recent business cycle using the OBR's most recent data, and yields an estimate that is unchanged from our central estimate. As it is more appropriate for the analysis to focus on more recent data (which is more indicative of likely progress in for ED2) we do not consider the period of sustained economic growth preceding 2007 in our estimate, especially considering that the COVID-19 pandemic could be as impactful as the 2008 financial crisis.[68]

One final sensitivity was conducted using VA-based productivity. The unadjusted VA measure of 0.7% yields a higher estimate than our main results, but it is only applicable to part of the cost base (i.e. excluding intermediaries). To provide a comparable figure to the GO-based benchmarks, this VA benchmark has been appropriately scaled by the share of intermediary goods in network sectors to make it applicable to TOTEX. The classification of cost categories into intermediates and non-intermediates is presented in Table 3.4

[68] Oxera (2019), 'Establishing an appropriate efficiency challenge', November.

below. Note that the identification of a subset of expenditure that corresponds to the VA spending is not straight forward and involves judgement. Therefore, GO TFP applied to all expenditure (including intermediary goods and services) is our preferred approach.

Table 3.4 Intermediary calculation based on cost shares

Cost component	Forecast share in TOTEX, %	Intermediates
Labour	32.1	No
Pensions	4.4	No
Contractors	34.4	Yes
Materials	18.7	Yes/No
Wayleaves	1.5	
Street works	0.1	No
Related party margins	0.8	No
Other	8.1	No
Total	100.0	
Share of non-intermediates	**47.0–65.6**[1]	

Source: Oxera analysis. Shares in TOTEX provided by SSE based on RRP reporting.

Notes: [1] Depending on whether Materials is included as an intermediate or not.

To arrive at a figure that is comparable to a GO estimate, we multiply the VA benchmark with the share of non-intermediates in TOTEX (34.4–53.0%). The estimate for adjusted VA is similar to our main result of 0.4% (with a range of 0.3–0.6%).

It is not possible to identify precisely a subset of expenditure that corresponds to the VA spending. Therefore, GO TFP applied to all expenditure (including intermediary goods and services) is our preferred approach. However, we provide this adjustment for comparison to our GO-based benchmark and note that its consistency with our GO-based approach provides further support for the GO-based result.

We summarise the results of our sensitivity analysis in Table 3.5.

Table 3.5 Frontier-shift sensitivities, % productivity growth p.a.

Change in assumption	Estimate
Industry average expenditure weights	0.4
Included repair of motor vehicles and motorcycles	0.4
Included financial and insurance activities	0.3
2006–2016 period	0.4
VA (scaled down by the share of intermediates in the cost base)	0.3–0.6
VA (unadjusted), but only applicable to costs excluding intermediaries	0.7

Source: Oxera based on EU KLEMS data, 2019 release.

We note that the results are consistent with the findings of the report by NERA commissioned by the ENA (which used a different approach from that outlined in this report), which concluded that 0.3% p.a. was an appropriate benchmark for ongoing efficiency for the DNOs (and a figure of 0.5% p.a. based on EU KLEMS).[69]

[69] NERA (2021), 'Ongoing Efficiency Improvement at RIIO-ED2', 30 April.

In conclusion, based on our analysis of EU KLEMS data, an ongoing efficiencies assumption of 0.4% p.a. is likely to be appropriate, with a range of 0.3-0.6% based on the sensitivities we have carried out.

3.3 Direct estimates of ongoing efficiency

An alternative approach to using the EU KLEMS data, which estimates the scope for ongoing efficiency indirectly by identifying comparators in other sectors, is to estimate the ongoing efficiency that has been historically achieved in the electricity distribution sector. In particular, we consider:

- the annual reduction in unit costs of the benchmark companies (section 3.3.1); and
- ongoing efficiency estimates based on SFA (section 3.3.2).

3.3.1 Unit costs of benchmark companies

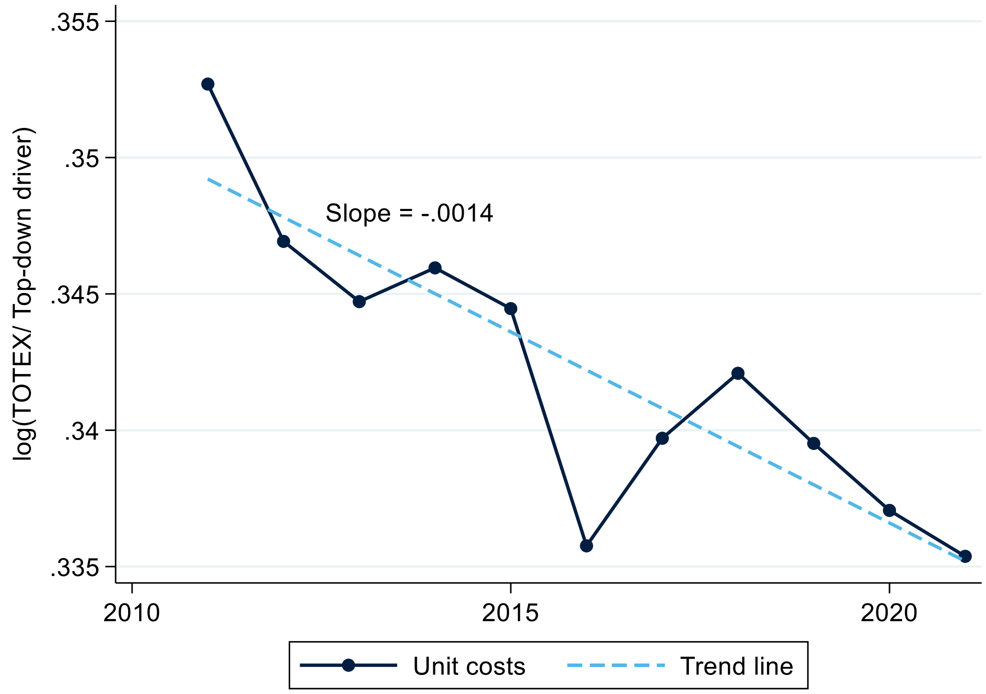
The unit cost trends of the benchmark companies in the sector provide a high level view of the scope of the potential for ongoing efficiencies in the sector (as reductions in costs for the leading companies are less likely to have been driven by catch-up efficiencies, especially if these companies have consistently been at or close to the frontier). Based on Ofgem's top-down and bottom-up TOTEX models updated to 2021 data (excluding subsea cables costs and assets),[70] we identify the benchmark companies (SPN, SSEH, LPN and ENWL). We calculate their unit costs, using the top-down and bottom-up scale drivers as the denominator. We then take an average of the unit costs of each companies in each year and calculate the trend in unit costs.

This is shown in Figure 3.2 and Figure 3.3 respectively. Based on this analysis, we find that the benchmark companies have achieved unit cost reductions of around 0.1-0.4% p.a. (depending on whether the top-down or bottom-up drive is used to calculate unit costs).[71]

We note that these estimates are net of real price effects. While a full assessment of real price effects is outside the scope of our report, we note that RPE indices were declining over DPCR5 (2011-2014)[72] and remained broadly stable from 2015-2017.[73] Therefore, while we would carry out a more in-depth assessment at a later stage, real price effects may be broadly neutral over our estimation period (2011-21). Therefore, the cost trends below may provide a first approximation to the ongoing efficiencies that have historically been achieved.

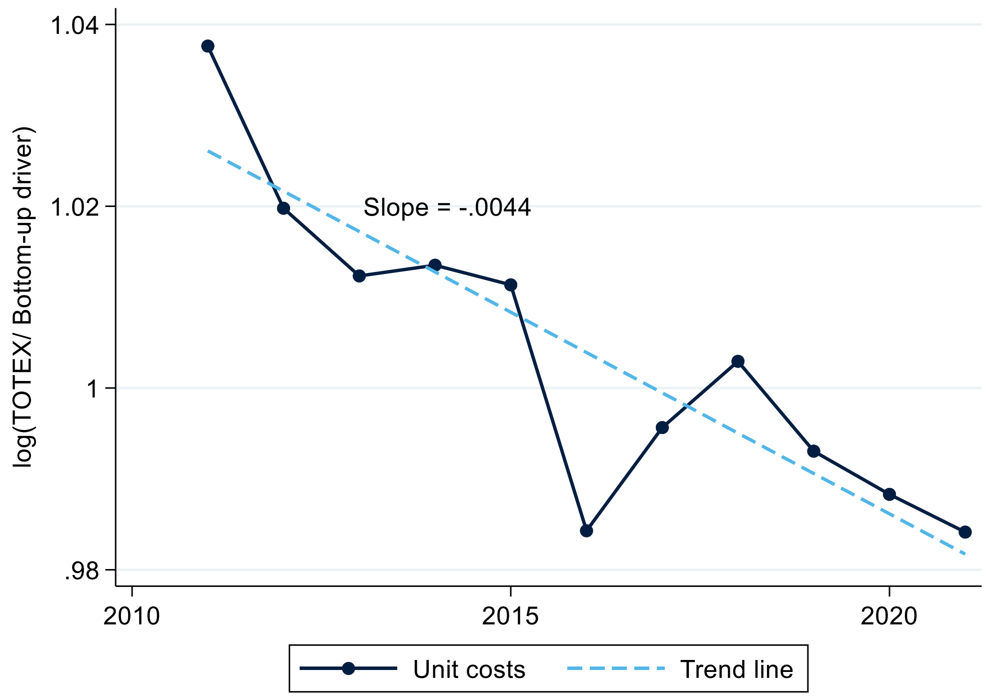
[70] See section 2.2, and in particular, section 2.2.2 for a further discussion.
[71] In Figure 3.2 and Figure 3.3, the variable on the y-axis is the log of unit costs. Therefore, mathematically, the percentage change in unit costs across years can be calculated from the year-on-year difference in the log of unit costs. A slope of -0.0014 and -0.0044 from the figures below means that the benchmark companies have reduced their costs by 0.14% and 0.44% p.a. when calculating unit costs based on the top-down and bottom-up scale driver respectively.
[72] Ofgem (2014), 'Consultation on the treatment of real price effects for RIIOED1 slow-track electricity distribution network operators', 28 August, Figure 1.
[73] CEPA (2018), 'Review of the RIIO Framework and RIIO-1 Performance', March, figure 2.4

Figure 3.2 Average unit costs of the benchmark companies: top-down scale driver



Source: Oxera.

Figure 3.3 Average unit costs of the benchmark companies: bottom-up scale driver



Source: Oxera.

As a sensitivity, we restricted the analysis to only the frontier company, SPN, which achieved unit cost reductions of 0.2-0.6% p.a. (figures not shown).

The evidence based on unit cost analysis therefore suggests that an appropriate ongoing efficiencies assumption is likely to be in the range of 0.1%-0.6% p.a.

3.3.2 Estimates of frontier shift using stochastic frontier analysis

Another method to directly estimate the level of ongoing efficiencies is SFA. SFA is an estimation method decomposes changes in inefficiency over time into catch-up and ongoing efficiency.[74] We estimate SFA models based on Ofgem's top-down and bottom-up model specifications. We include a time trend in the inefficiency term to catch-up up over time, whilst the time trend in the frontier specification captures ongoing efficiencies. We present our estimates in Table 3.6 below.

Table 3.6 Estimates of ongoing efficiency using stochastic frontier analysis, based on Ofgem's specifications, 2011-2021.

	Top-down	Bottom-up
Frontier		
Scale driver	0.758***	0.862***
	(0)	(0)
Time trend (ongoing efficiency estimate)	-0.006	-0.001
	(0.117)	(0.839)
Constant	6.226	2.139
	(0.438)	(0.770)
Inefficiency		
Time trend (catch-up estimate)	-0.084	-0.141**
	(0.186)	(0.0258)
Constant	165.9	279.9**
	(0.195)	(0.0277)
N	154	154
Test for existence of inefficiency at the 5% level	Passed	Passed

Note: number in parantheses are p-values. * statistically significant at the 10% level; ** statistically significant at the 5% level *** statistically significant at the 1% level.

Source: Oxera

[74] For a reference on SFA, see Kumbhakar S. and Lovell C. (2003), 'Stochastic frontier analysis. Cambridge university press', Cambridge University Press, March 10, or Kumbhakar S., Hung-Jen W., and Alan H. (2015), 'A practitioner's guide to stochastic frontier analysis using Stata', chapter 11, Cambridge University Press.

Based on our analysis, we estimate that the sector achieved ongoing efficiency improvements of 0.6% p.a. based on the top-down model, while the bottom-up model suggests that a small ongoing efficiencies assumption of c. 0.1% p.a.

We note, however, that these estimates are statistically insignificant (particularly for the estimates based on the TOTEX bottom-up model). We consider that to obtain robust estimates, further model development once an updated dataset is published (with any data errors or inconsistencies addressed) may be needed.

Nonetheless, we note that these results are consistent and are of the same order of magnitude as those presented in the preceding sections.

3.4 Conclusion

We have carried out three different methods to estimate the scope for ongoing efficiencies over ED2. These are summarised in Table 3.7 below. **Overall, we find an ongoing efficiencies assumption of 0.4% p.a. over ED2 is appropriate, with a range of 0.1-0.6% p.a based on sensitivities and other sources of evidence.** We understand that SSE has proposed a challenge of 0.7% p.a. within its business plan, which would be considered to be challenging based on the evidence presented in this report.

Table 3.7 Estimates of ongoing efficiencies based on a range of approaches

Approach	Ongoing efficiencies estimate
Analysis of EU KLEMS data	0.4% (0.3-0.6%)
Unit cost reductions achieved by the benchmark and frontier company	0.1-0.6%
Stochastic frontier analysis	0.1-0.6%

Source: Oxera.

4 Conclusions

This report provides recommendations on an appropriate efficiency challenge that SSE should include in its business plan submission for its two networks, SSES and SSEH. This includes an assessment of catch-up efficiencies and ongoing efficiencies.

Catch-up efficiencies

We have based our assessment of catch-up efficiencies on Ofgem's approach at ED1. This consists of two aggregated (TOTEX) models and disaggregated cost models (which model the various cost areas individually). However, we note that with the ED2 cost modelling methodology still to be developed and no forecast data across the DNOs available, this assessment of SSE's performance will need to be revised. Further changes to the methodology may also be required to account for the demands that DNOs will be facing from distributed energy generation, EV charging and the electrification of heat. The methodology should also be robust to uncertainty, cost and scenario inconsistencies in the forecast data, as well as any potential distortionary effects from anticipatory spend.[75]

In order to appropriately assess SSES's and SSEH's efficiency, we have made a number of changes to Ofgem's methodology. On the aggregated TOTEX modelling, we have:

- enabled a more like-for-like comparison between DNOs by removing subsea cables assets and costs from the modelling;
- constructed a top-down driver that is consistent with operational insight as applying Ofgem's methodology on the updated data leads to a counterintuitive weight of 31% on customer numbers;
- accounted for higher regional wages in Scotland relative to the other parts of Great Britain.

On the disaggregated modelling, we have:

- removed subsea cables assets and costs from the asset replacement as Ofgem's ED1 assessment is now outdated;
- amended Ofgem's tree-cutting model to remove a cost driver that now has an operationally counter-intuitive coefficient;
- amended Ofgem's trouble call modelling to exclude outdated 2021–23 forecasts.

Combining the results across the TOTEX and disaggregated modelling, **we find that SSEH is an efficient company, performing 5.2% better than the UQ, while SSES is estimated to be 2.0% less efficient than the UQ.**

Ongoing efficiencies

We have assessed the scope for ongoing efficiency improvements for SSES and SSEH using a growth-accounting approach based on the EU KLEMS data.

[75] See Oxera (2021), 'Potential effects of uncertainty in ED2 and fast-tracking WPD in ED1 on the benchmark in ED2', 28 October.

Our approach to assessing OE broadly follows the framework set out in our April 2016 report for the Dutch regulator (ACM).[76]

Based on this approach, **we determine the scope of likely ongoing efficiency improvements over RIIO-ED2 to be 0.4% p.a. We also considered a number of sensitivities that supported this figure, as well as other methods of directly estimating the scope for ongoing efficiencies, producing a range of 0.1–0.6% p.a.**[77]

Total potential for efficiency improvements

The overall results of our top-down analysis suggest that **SSEH is efficient, excluding subsea cable costs for benchmarking purposes, while SSES is 2.0% less efficient than the UQ**. In addition to SSES improving its efficiency by 2.0%, **both networks can improve their efficiency through ongoing efficiency improvements of 0.4% p.a. (which should be offset by any estimated real price effects)**. These results are summarised in Table 4.1 below.

Table 4.1 Estimated relative inefficiency and ongoing efficiency benchmark for SSEH and SSES

Area	Main findings
SSEH gap to UQ	0% (SSEH is efficient relative to the UQ)
SSES gap to UQ	2.0%
Ongoing efficiency improvements for SSEH and SSES per annum	0.4 (0.1–0.6%) p.a.

Source: Oxera analysis.

We understand that this represents just one piece of evidence that SSE will use when determining its efficiency assumption for its Business Plan.

[76] Oxera (2016), 'Study on the ongoing efficiency for Dutch gas and electricity TSOs', January.
[77] We note that, despite differences in approach, these results are consistent with the 0.3% p.a. estimate and 0.1-0.5% range estimated by NERA on behalf of the ENA. NERA (2021), 'Ongoing Efficiency Improvement at RIIO-ED2', 30 April.

A1 Operational insight on cost drivers by activity area

SSE provided views on the appropriate cost driver for the nine largest cost areas, which account for 81% of TOTEX across the industry from 2011 to 2020.[78] SSE have also identified issues with the selected scale driver, which may suggest the need for additional modelling or other adjustments.

Table A1.1 Initial operational views on the appropriate drivers for each cost area[1]

Cost area	Appropriate driver given available data	Issues	% of TOTEX
CAI	MEAV	While a weighting can be constructed using MEAV based on asset type installed within network, this is not necessarily reflective of CAI required. For example, MEAV is more heavily weighted towards underground cables than overhead lines, but the CAI costs of these two components of MEAV are materially the same.	23.5
Asset replacement	MEAV	Ofgem does not model the age profile of assets, instead assuming an equal distribution of replacement. In reality, DNOs replace assets based upon age, as DNOs with newer age profiles typically have lower allowances than DNOs with older age profiles	17.1
Business support	MEAV	While a weighting can be constructed using MEAV based on asset type installed within network, this is not necessarily reflective of business support costs required. For example, MEAV is more heavily weighted on underground cables rather than overhead lines, but the business support costs are materially the same.	11.8
Trouble call	Total faults	Ideally, the mix of faults would be accounted for. Potentially, there could be a secondary driver linked with MEAV, which reflects the mix of network, as well as age profile.	10.4
Reinforcement	Peak demand (primarily)	This is customer and generator driven, and likely linked with network peak demand	5.0
Inspection & Maintenance	MEAV		4.0
Connections	Customer numbers (primarily)	This is primarily customer driven. Potentially, there could be a secondary driver of peak demand linked to DNOs' capacity constraint.	3.9
Tree cutting	Spans affected by trees	We have not used this scale driver in the analysis as the variable is missing for SSEH from 2011 to 2020.	3.0
ONIs	Customer numbers	The number of general enquiries received by DNOs are likely correlated to customer numbers.	2.6

[78] The Ofgem STATA files we have access to construct the bottom-up CSV from 27 cost areas, one fewer than the 28 cost areas listed in its RIIO-ED1 Final Determination document. Some of the cost areas listed in the STATA files are not in the Final Determination, and vice versa. Moreover, the 27 cost areas listed in the STATA files account for only 94% of TOTEX. Given these data constraints, we are unable to derive the actual distribution of TOTEX across cost areas. However, we consider that the distribution of scale drivers of the nine largest cost areas, which account for 81% of TOTEX, are representative of the overall TOTEX distribution. We therefore pro-rate the percentage of TOTEX driven by each scale driver in our analysis.

Note: [1] Further work needs to be undertaken to determine which cost drivers should be included within the CSV and the appropriate weights to be placed on each cost driver.

Source: SSE analysis.

A2 Issues with the updated version of Ofgem's tree-cutting model

Ofgem assesses tree-cutting costs using a regression model consisting of two cost drivers: the number of spans cut and the number of spans inspected. Operationally, one would expect that the higher the number of spans cut or spans inspected, the higher the costs.

In particular, comparing columns A and B in Table A2.1 below, the coefficient on the log of number of spans inspected is no longer aligned with operational insight—it has fallen from 0.457 (where a 1% increase in the number of spans inspected leads to 0.457% *increase* in tree cutting costs) to -0.0294 (where a 1% in spans inspected leads to a 0.0294% *decrease* in tree cutting costs).

We also note that the model fit using outturn data from 2016–20 is worse than when Ofgem used outturn data from 2016–23. The R-squared, a measure of model fit, has fallen from 0.855 to 0.607. This means that Ofgem's tree-cutting model is a poorer basis on which to forecast a company's efficient costs.

There may be a number of reasons for this, such as data issues. In the outturn data, we note that there were a number of years in which companies did not inspect any spans. For example, EPN had 0 spans inspected in 2018 and 2019.

Another reason may be that the models estimated by Ofgem for tree-cutting at ED1 on forecast data are not able to explain actual costs well, as evidenced by the lower R-squared. This suggests that further model development is required.

Table A2.1 Tree-cutting regression models

	Ofgem at ED1 (2016–23) (A)	**ED1 outturn data (2016–20) (B)**	**ED1 outturn data, spans cut only (2016–20) (C)**
Dependent variable	Log(tree cutting costs)	Log(tree cutting costs)	Log(tree cutting costs)
Log(number of spans cut)	0.680*** (0.002)	0.776*** (0.000)	0.746*** (0.000)
Log(number of spans inspected)	0.457*** (0.039)	-0.0294 (0.630)	
Constant	-10.1*** (0.000)	-5.56*** (0.000)	-5.568*** (0.000)
R-squared	0.855	0.607	0.601
N	104	62	65

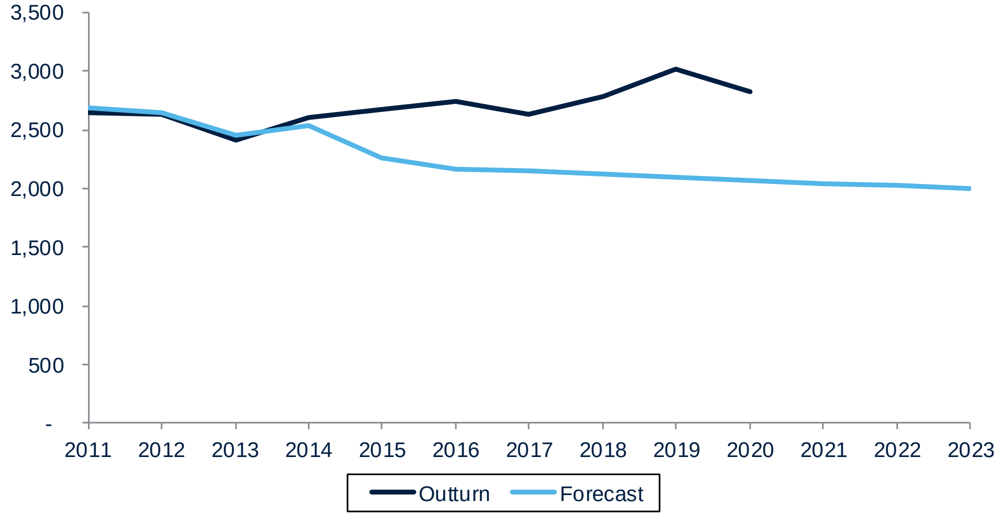
Note: *** signifies a 99.9% significance level, ** signifies a 99% significance level and * signifies a 95% significance level of the coefficient estimate.

Source: Oxera analysis and Ofgem (2014), 'RIIO-E1: Final determinations for the slow-track electricity distribution companies', 28 November, p. 194.

A3 Differences in forecast and outturn costs for trouble call

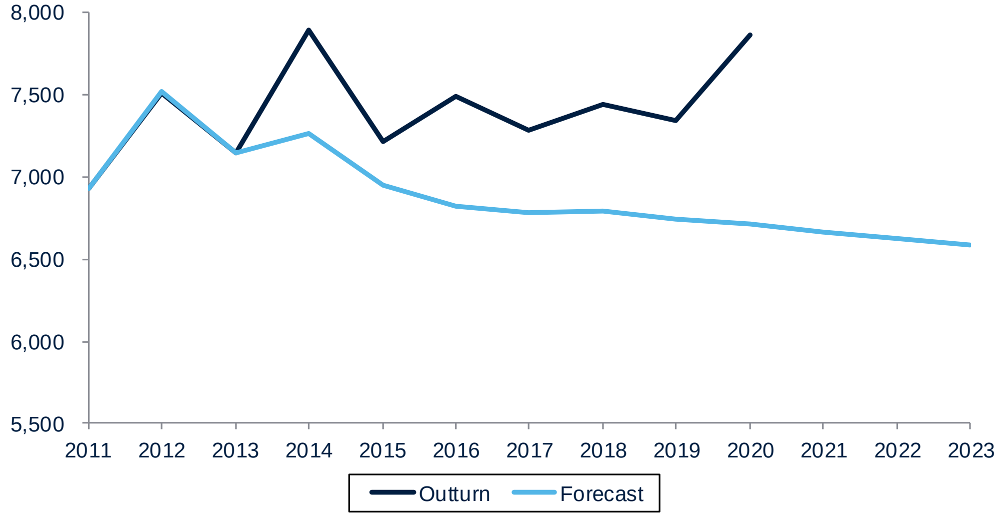
There are significant differences between the forecast and outturn median unit costs in the industry that are used to calculated modelled costs for trouble call. These are shown in Figure A3.1 and Figure A3 below for low-voltage underground and high-voltage underground cables respectively.

Figure A3.1 Median unit cost in the industry of LV UG cables fault (£ per fault)



Source: Oxera analysis.

Figure A3.2 Median unit cost in the industry of LV UG cables fault (£ per fault)



Source: Oxera analysis.

Forecast median unit costs are consistently lower than actual median unit costs. Therefore, it is unlikely that the 2021–23 forecasts are a valid basis for calculating modelled costs.

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