CEPA
economics matters

RIIO-ED2: Cost Assessment – Frontier Shift methodology paper

Ofgem

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FINAL REPORT

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EXECUTIVE SUMMARY

Ofgem has commissioned this report from CEPA on the methodology for setting the rate of 'frontier shift' for the RIIO-ED2 price control Draft Determinations.

Frontier shift is the rate at which a company at or close to the efficiency frontier can change its outputs relative to inputs. It captures changes in both the volume of inputs needed to produce a given level of output (or output produced for a given level of inputs) and in the price of inputs used. In the context of Ofgem's RIIO-2 framework, frontier shift encompasses both:

- **Ongoing Efficiency (OE).** The reduction in the volume of inputs required to produce a given volume of output, i.e. the productivity improvements that even the most efficient company is capable of achieving.
- **Real Price Effects (RPEs).** Ofgem sets price control allowances which are linked to a general inflation measure (CPIH) and certain price indices that reflect the external pressures on companies' costs. Ofgem refers to the difference between CPIH and those price indices as RPEs.

In this report we provide an independent, evidence-based assessment of the scope for ongoing efficiency improvements during RIIO-ED2 and provide a proposed approach for the RPE indexation mechanism. We anticipate that this will inform Ofgem's own analysis and assessment of these issues ahead of the Draft Determinations.

Ongoing efficiency

The foundation of our assessment is an analysis of the EU KLEMS database which is a useful source of information on historical productivity trends in the UK economy. This is in line with our approach to assessing the scope for ongoing efficiency improvements for the earlier RIIO-GD2 and T2 price controls.

There is strong regulatory precedent for using EU KLEMS to set the ongoing efficiency challenge but there are also limitations in any approach that relies exclusively on analysis of historical productivity growth rates to set the potential for productivity growth over future periods. Rather than selecting a particular value from the EU KLEMS analysis and applying it mechanistically, we recommend that Ofgem comes to a more holistic view about the potential for future frontier productivity improvements in the electricity distribution sector during the RIIO-ED2 period.

The results of our analysis of the 2019 EU KLEMS database are summarised in Table 1 below.

Table 1: Average historic TFP growth rates based on the 2019 EU KLEMS database (to 1 d.p.)

Average TFP growth (%)	Full time series (1995-2016)		Various business cycle definitions	
	VA	GO	VA	GO
Unweighted average of narrow comparator set	0.8%	0.4%	0.3 to 0.4%	0.2%
Unweighted average of expanded comparator set[2]	1.2%	0.6%	0.9 to 1.0%	0.5 to 0.6%
Weighted average of market Economy (all industries excluding L, O, P, Q, T, and U)	0.8%	0.4%	0.7 to 0.8%	0.3 to 0.4%

Source: CEPA analysis of EU KLEMS

[2] Comparator set 1 is the same as the targeted comparator set we used in our analysis ahead of RIIO-GD2/T2 and includes: Construction (F); Wholesale and Retail Trade: Repair of Motor Vehicles and Motorcycles (G);. Transportation and Storage (H); and Financial and Insurance Activities (K). Comparator set 2 includes the same industries plus: Professional, Scientific, Technical, Administrative and Support Service Activities (M-N); and Information and Communication (J).

We recommend that Ofgem interprets the evidence from EU KLEMS in light of a range of factors summarised below which provide different perspectives on the outlook for frontier productivity improvements; and consider the coherence of the ongoing efficiency challenge with the approach taken to other elements of the price control, including the core cost assessment process used to set the ‘catch up’ efficiency challenge.

First, we recommend that Ofgem takes into consideration the clear ambition to deliver transformational change in the electricity distribution sector over the RIIO-ED2 period. A more distributed and low carbon energy system will need to be underpinned by new technologies and business models, supported by a regulatory and policy environment that incentivises innovation and provides access to the necessary funding. This transition is a fundamental part of the digitisation strategies and transition from DNO to DSO on which the RIIO-ED2 business plans are based; and will be facilitated by the step change in allowances that might be released over the course of ED2 and by the innovation funding provided in previous price controls.

This transition may provide additional opportunities for frontier productivity growth in ED2 above and beyond what has been set in the past or what has been set in other regulated sectors. But it is not possible to quantify the impact on the potential for productivity growth in the electricity distribution sector with precision. We recognise that as part of the RIIO-GD2 and T2 appeals, while the CMA agreed with the principle that past innovation funding may lead to additional cost savings in the future, a range of concerns were identified with Ofgem’s approach to direct quantification of the impact on the OE challenge. As such, we consider that the impact of historical innovation funding and other ED2 specific factors described in this report should be considered qualitatively, e.g. with regards to the appropriate industries for inclusion in the EU KLEMS comparator sets or in understanding how the electricity distribution network sector may not be as affected as other sectors by the productivity puzzle following the Global Financial Crisis (GFC).

Our recommendation is consistent with Ofgem's own review of the evidence provided in the network companies' business plan submissions. It finds that all the network companies claim to have embedded cost efficiencies from previous innovation funding to varying degrees, although the basis on which the companies have done so is inconsistent. Therefore, we consider there is a risk that making individual adjustments to the OE challenge to take account of previous innovation funding specifically would 'double count' efficiencies that are already captured to some degree in the comparative benchmarking; however, this risk cannot be quantified based on the companies' submissions.

Second, we recommend that the potential for both embodied and disembodied technical change should be considered as part of the evidence base used to inform the ongoing efficiency challenge for RIIO-ED2. The Total Factor productivity (TFP) estimates derived from EU KLEMS only capture disembodied technical change, because the EU KLEMS methodology makes use of quality-adjusted inputs which are intended to control for embodied technical change.[3] As such, GO-based TFP growth rates calculated from the EU KLEMS database may underestimate the total potential for cost savings that can be achieved by network companies when quality improvements in the factor inputs are considered. This finding is established in recent UK regulatory precedent.[4]

Third, Ofgem should note that our analysis of the 2019 EU KLEMS database is limited to the period 1995 to 2016. This means that our analysis takes into account slower UK productivity growth since 2009. However, we do not consider that there is strong evidence to suggest that the slowdown in wider productivity growth since the GFC should fully impact on the potential for ongoing productivity gains in the energy sector. Our analysis of historical productivity growth over longer periods of time (including dating back to 1970) using the 2011 EU KLEMS database finds average annual TFP growth rates that are similar to or greater than the more recent estimates available from the 2019 EU KLEMS dataset.

[3] For example, the EU KLEMS methodology uses quality adjusted price deflators for capital inputs and a composition term for labour which captures factors such as changes in the workforce education level.

[4] Ofgem, Ofwat and the CMA have all considered the impact of embodied technical change on the level of productivity growth that can be achieved in the context of the PR19 and RIIO-T2/GD2 price controls.

Fourth, we recommend that Ofgem takes into consideration recent UK regulatory precedent. Growth accounting analysis using EU KLEMS data has been widely used to inform recent regulatory decisions on the ongoing efficiency challenge in different network price controls – including for RIIO-GD1/T1 and RIIO-GD2/T2 – and the final challenge applied in such decisions has been generally clustered around a value of 1% per annum.

Fifth, we recommend that Ofgem notes the network company submissions on ongoing efficiency, which range from 0.5% per annum for the least ambitious companies, up to 1% per annum for the most ambitious network companies.[5] Holding all else equal, we consider that there should be similar scope for frontier efficiency gains in RIIO-ED2 across all the network companies, and therefore Ofgem might consider whether all the DNOs should be able to at least match the higher level of ambition shown by some of the companies.

Sixth, we recommend that Ofgem exercises caution when considering the relevance of forward-looking, economy-wide productivity forecasts (such as those produced by the OBR and the Bank of England) to the ongoing efficiency challenge. These forecasts do not cover the whole RIIO-ED2 period. But more importantly, they are influenced by short-term macroeconomic factors including Brexit, Covid-19 and the ramifications of the Russian invasion of Ukraine. In our view the relevance of such factors to the potential for ongoing efficiency improvements in the electricity distribution sector over the ED2 period is limited, difficult to quantify, and likely to be outweighed by the stability of the price control framework and five-yearly control periods . These provide the network companies with longer and more stable planning horizons than other, more competitive sectors of the economy, and enables them to drive continual innovation and efficiency improvements through their supply chains.

Finally, we recommend that Ofgem also exercises caution when considering the use of historical productivity growth in the electricity distribution sector to set and/or adjust the ongoing efficiency challenge directly. We note that the results of previous analysis of historic productivity growth in the electricity distribution sector are highly variable and appear dependent on the set of assumptions used.[6] For example, the Energy Network Association's (ENA) advisors find that TFP growth in the electricity distribution sector between 2010/11 and 2019/20 ranges between -0.1% to 0.4% per annum[7] while the University of Cambridge Energy Policy Research Group estimate that TFP growth over RIIO-ED1 ranges between -0.5% to 3.8% per annum.[8]

The objective of the growth accounting analysis using EU KLEMS is to provide an external benchmark based on competitive (i.e. non-regulated) sectors for the productivity improvements that could be achieved in the energy network sector.[9] Using the rate of productivity growth achieved by the DNOs in RIIO-ED1 to set the benchmark would undermine this principle. However it might serve as a useful cross-check against which Ofgem might satisfy itself that, when combined with reductions in expenditure determined by the comparative benchmarking process, it is setting an overall efficiency challenge that is broadly consistent with a reasonable estimate of past productivity growth across the industry.

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[5] UKPN states that it has adopted an ongoing efficiency assumption of 1.0% per annum (UKPN (Dec 2021) RIIO-ED2 Business Plan 2023–2028, p184). But calculated on a like-for-like Compound Annual Growth Rate (CAGR) basis (i.e. the mean annual growth rate over five years) with other network companies, the Business Plan Data Templates provide an average ongoing efficiency assumption of 1.4% per annum across the ED2 period (CEPA analysis of EPN, LPN and SPN Business Plan Data Templates). Likewise, SSEN states that it has adopted an ongoing efficiency assumption of 0.7% per annum (SSEN (Dec 2021) RIIO-ED2 Business Plan Annex 15.1, p17). But calculated on a like-for-like CAGR basis the Business Plan Data Templates provide an average ongoing efficiency assumption of 0.97% per annum (CEPA analysis of SSEH and SSES Business Plan Data Templates).

[6] Specifically, the results appear sensitive to the incorporation of variables representing reliability, peak demand and customer satisfaction, and the profiling of capital expenditure.

[7] NERA (30 April 2021) "Ongoing Efficiency Improvement at RIIO-ED2".

[8] Ajayi, V., Anaya, K., and Pollitt, M. (November 2021) *Incentive regulation, productivity growth and environmental effects: the case of electricity networks in Great Britain*. University of Cambridge Energy Policy Research Group Working Paper No. 2126, available online.

[9] For example, Ofgem have set a consistent regulatory precedent in RIIO-T1/GD1 and RIIO-T2/GD2 to exclude the energy and water sector from the targeted comparator set within the growth accounting assessment of historic productivity growth.

Therefore, based on our analysis of the evidence available to this study, we recommend that Ofgem considers the following reference points for an ongoing efficiency challenge at a totex level (i.e. consistent across capex and opex)[10]:

- **0.5%,** consistent with the ongoing efficiency challenge proposed by the least ambitious companies. This would represent a pessimistic outlook for the frontier efficiency improvements possible in RIIO-ED2; consistent with a view in which the wider slowdown in productivity since the GFC acts as a brake on productivity improvements in the electricity distribution sector. The pessimism of this view is represented by the fact that it is below the average challenge of around 0.7% proposed by the companies.
- **1.0%,** consistent with the ongoing efficiency challenge proposed by the most ambitious companies. This would represent a relatively stable outlook for the frontier efficiency achievements possible in RIIO-ED2. It is in line with recent regulatory decisions for the OE challenge in other regulated sectors, which support the view that the quantitative analysis of EU KLEMS values in the 2019 dataset does not fully capture the scope for ongoing efficiency improvements in regulated networks in upcoming price control periods. In addition, in RIIO-ED1, Ofgem set company-specific OE challenges of between 0.8% and 1.1% per annum by adopting the challenge which was proposed by each of the slow-track companies..
- **1.2%,** which would represent a more stretching outlook for the frontier efficiency achievements possible in RIIO-ED2. This would suggest that the average historical TFP growth rates calculated from EU KLEMS significantly underestimate the frontier efficiency improvements that can be achieved in ED2, because of factors such as embodied technical change and the relevance of the post-2009 ‘productivity puzzle’ to ongoing efficiency improvements in the electricity distribution sector. This would also be consistent with a belief that in RIIO-ED2 the network companies will be able to achieve efficiencies closer to more dynamic competitive sectors, and that the available evidence suggests to Ofgem that in the main such efficiencies will not be captured in the comparative benchmarking process that sets the ‘catch-up’ efficiency challenge.

Real price effects

Ofgem intends to set an RPE indexation mechanism for RIIO-ED2, in line with its RIIO-ED2 Sector Specific Methodology Decision. The RPE indexation approach ensures that the network companies’ expenditure allowances are adjusted to account for external changes in input prices that are beyond their control. As part of the price control review, Ofgem sets a forecast RPE allowance based on a forecast of a composite of independently produced price indices that together form an ‘forecast RPE index’. In aggregate these external price indices should broadly reflect the network companies’ most significant expenditures, and the external factors affecting these expenditures which may cause changes in input prices that are significantly different to economy-wide measures of inflation.

Each year – as part of Ofgem’s Annual Iteration Process – Ofgem will calculate the difference between the relevant forecast and outturn price indices used to calculate the RPE allowances. The DNOs will be allowed to recover those differences from consumers in future years (if outturn prices were higher than forecast) or return them to consumers in the form of lower charges (if outturn prices were lower than forecast).

In line with Ofgem’s intention to set a high materiality threshold for RPEs, we recommend that the RPE indexation mechanism only applies to **labour expenditure** and **materials expenditure**. These were the only expenditure categories that amounted to more than 10% of DNO totex on a notional company basis. None of the other expenditure categories (plant & equipment; transport; other) passed our materiality tests.

We have assessed a variety of independently produced price indices to determine which were the most appropriate and broadly reflective of the real price effects faced by the DNOs in respect of labour costs and materials costs.

[10] For the avoidance of doubt, none of these reference points should be seen as being equivalent to directly taking any single value from the set of core EU KLEMS analysis. Each of the reference points is based on a review of the set of core EU KLEMS values and the wider evidence base providing context for the interpretation of the core EU KLEMS values.

Following our assessment, we recommend that Ofgem adopts the following price indices as part of the indexation mechanism:

Labour expenditure

- ONS Average Weekly Earnings (AWE) Private Sector Index: Seasonally Adjusted Total Pay Excl Arrears
- BCIS Civil Engineering
- BEAMA Electrical Engineering Labour

Materials expenditure

- BCIS PAFI Pipes and Accessories: Aluminium
- BCIS Pipes and Accessories: Copper
- BCIS Structural Steelwork – Materials: Civil Engineering Work
- FOCOS Resource Cost Index of Infrastructure: Materials

For ONS AWE Private Sector Index, we recommend that Ofgem sets the forecast equivalent to the difference between the OBR's March 2022 forecast of earnings growth and the OBR's forecast of the Consumer Price Index (CPI) for the years in which those are available, and 1.0% thereafter based on the long-term average historic RPE.[11]

We developed our own RPE forecast for all the other price indices shown above because relevant independently produced forecasts are not available. Having considered the proposals put forward by the network companies, the ENA, and their advisors, we recommend that Ofgem sets the forecasts of such indices based on the average historical difference between the annual growth in each price index and the Consumer Price Index including owner occupier housing costs (CPIH). This results in an RPE forecast that is constant across the RIIO-ED2 period.

We also considered the proposals put forward by some of the network companies[12], the ENA and its advisors (NERA) to generate larger RPE allowances by uplifting the RPE forecasts and outturn price indices to take account of what NERA describes as "*persistent differences between the rate of growth in* [the] *selected benchmark indices and the rate of growth in the DNO unit costs*".[13] However, we did not find the arguments and supporting evidence provided to be convincing of the need for such an adjustment. In particular, we are concerned that such an adjustment would violate the principle that the RPE indexation mechanism ensures that consumers bear the risk of external price pressures.

Our recommended RPE forecast is shown in Table 2 below, based on the notional DNO cost structure.

Table 2: Forecast RPE index – Financial Years Ending – 2022 to 2028

Index	2022	2023	2024	2025	2026	2027	2028
Forecast (Totex) RPE index	1.3%	0.4%	0.7%	1.0%	1.0%	1.0%	1.0%

Source: CEPA analysis

[11] OBR (March 2022) "March 2022 Economic and fiscal outlook – supplementary economy tables" available online. In line with other areas of the price control, Ofgem uses a financial year CPI forecast that is calculated by giving 75% weight to the OBR's calendar year CPI forecast for year *t* and 25% weight to the forecast for year *t+1*.

[12] NPg and SPEN adopt the 'mean adjustment' uplifts. SSEN and WPD highlight concern in their business plan submissions but do not adopt the uplifts in their BPDTs.

[13] NERA (June 2021) "Price Effects for the RIIO-ED2 Price Control Review", p45.

1. INTRODUCTION

Ofgem commissioned a partnership of CEPA, AFRY Management Consulting (AFRY) and Economic Consulting Associates (ECA) to provide economic advice for RIIO-ED2. This independent report has been prepared by CEPA under this Economic Strategic Partner contract for RIIO-ED2.

The subject of this report is the concept known as 'frontier shift', which is the rate at which a company at or close to the efficiency frontier can change its outputs relative to inputs. It captures changes in both the volume of inputs needed to produce a given level of output (or output produced for a given level of inputs) and in the price of inputs used. In the context of Ofgem's RIIO-2 framework, frontier shift encompasses both:

- **Ongoing Efficiency (OE).** The reduction in the volume of inputs required to produce a given volume of output, i.e. the productivity improvements that even the most efficient company is capable of achieving.
- **Real Price Effects (RPEs).** Ofgem sets price control allowances which are linked to a general inflation measure (CPIH) and certain price indices that reflect the external pressures on companies' costs. Ofgem refers to the difference between CPIH and those price indices as RPEs.

In this report, we set out analysis and advice which will form part of the evidence base, along with Ofgem's own analysis and assessments, for Ofgem's proposals for the OE challenge and RPE indexation in the ED-2 Draft Determinations (DD).

1.1. Scope of our work on Ongoing Efficiency

Sections 2, 3 and 4 of this report consider the evidence base and outlook for frontier or Ongoing Efficiency improvements which should be achievable across the ED2 period.

In line with the approach set out in Ofgem's RIIO-ED2 Sector-Specific Methodology Decision paper (SSMD),[14] we have focused on analysing the EU KLEMS dataset to identify historical productivity improvements in relevant benchmarks for the electricity distribution companies. We have also reviewed the electricity distribution networks' (DNOs) RIIO-2 Business Plan submissions to understand their proposed rationale and estimates of their scope to achieve ongoing efficiencies. In addition, we have reviewed other evidence to inform the context in which estimates from the EU KLEMS dataset can be interpreted when setting the scope for frontier efficiency improvements in RIIO-ED2. This includes forward-looking economy-wide productivity growth estimates from credible sources such as the Bank of England (BoE) and the Office for Budget Responsibility (OBR).

This report does not cover the wider process of determining totex allowances for RIIO-ED2 – either in terms of efficiency gains identified through the comparative benchmarking process, or the application of the OE and RPE values in the practical calculation of totex allowances.

1.2. Scope of our work on Real Price Effects

In its RIIO-ED2 Sector Methodology Decision, Ofgem confirmed its intention to make use of an indexation mechanism to account for RPEs.[15] This will replace the approach of fixing ex ante RPE allowances that was used in RIIO-1. A similar indexation approach was applied in the RIIO-GD2 and RIIO-T2 price controls.

In Section 5 of this report, we set out the steps required to select the appropriate price indices on which the indexation mechanism will operate, from which we then propose a set of forecasts for RPE allowances at the start of

[14] Ofgem (December 2020) *RIIO-ED2 Sector Methodology Decision: Annex 2 Keeping bills low for customers.*

[15] Ofgem (December 2020) *RIIO-ED2 Sector Methodology Decision: Annex 2 Keeping bills low for customers.*

the RIIO-2 period. There will be an annual true-up of the RPE allowances after the relevant index/indices are published each year, and a final true-up will occur at the end of RIIO-2 as part of the close-out process.

As part of this advice to Ofgem on RPEs, we have considered the information and views provided by DNOs in their Business Plan submissions and subsequent clarificatory questions. Where our recommendations are materially different from their proposals, we discuss the rationale for our decision.

1.3. Structure of the report

The rest of this report is structured as follows:

- Section 2 discusses growth accounting analysis and how this may inform Ofgem’s decision regarding the OE challenge for the network companies to achieve over the RIIO-2 period.
- Section 3 discusses other sources of evidence which Ofgem may want to consider in setting the OE challenge.
- Section 4 draws together the evidence on OE and suggests a range which Ofgem can consider in determining an appropriate OE challenge for RIIO-ED2.
- Section 5 focuses on RPEs and sets out the different steps in the analysis to develop the RPE indexation mechanism for RIIO-ED2.
- Appendix A provides further detail behind our approach to the growth accounting analysis.
- Appendix B provides further detail behind our detailed process for RPE index selection.

2. GROWTH ACCOUNTING ANALYSIS

Ofgem's Sector Specific Methodology Decision (SSMD)[16] set out that a growth accounting approach based on the EU KLEMS database would be a useful source of information to inform the OE challenge for RIIO-ED2.

The growth accounting approach is based on the use of indirect comparators to estimate the level of historical technical change, or productivity growth, that has been achieved over time. This approach defines output as a function of inputs (such as capital and labour). Variation in inputs should explain at least some of the observed variation in output. The 'residual' growth in output that cannot be explained by the growth in inputs is attributed to productivity improvements resulting from the combination of different factors of production. This is referred to as 'disembodied technical change'.

The EU KLEMS database provides measures of outputs, inputs and disembodied technical change for the 28 countries in the EU, plus the US and Japan.

2.1. Approach to core growth accounting analysis for RIIO-ED2

The following sub-sections describes our core approach to analysing the EU KLEMS database to inform the OE challenge for RIIO-ED2. Appendix A discusses in more detail the key choices that are required to develop a range of productivity estimates using EU KLEMS data, and the views on growth accounting analysis provided in support of the DNOs proposals for the OE challenge.

2.1.1. Choice of EU KLEMS dataset

We have considered two separate EU KLEMS datasets, which vary in time period, included metrics and industry classification:

- The 2011 release of the EU KLEMS database uses the NACE 1.1 industry classification, contains long-run data covering the period between 1970 to 2007 and productivity data based on GO and VA output measures.
- The 2019 release of the EU KLEMS database uses the NACE 2 industry classification, covers the period 1997 to 2016 and contains productivity data based on VA output measures only. This dataset covers the Global Financial Crisis (GFC) and the period of lower productivity growth that has been subsequently recorded in the UK.

We base our analysis on the evidence from the 2019 EU KLEMS dataset, as we consider that the growth accounting should account for the most recently available evidence on UK productivity growth.[17] But we also include in this report our analysis of the 2011 dataset to show the sensitivity of the growth accounting estimates.

2.1.2. Choice of time period

Conceptually, productivity growth tends to accelerate during periods of economic expansion and decelerate during periods of recession. Therefore, the most robust approach to assessing historical productivity growth is to assess average productivity growth over a complete business cycle, which should help to mitigate against the risk of developing an overly optimistic or pessimistic view of productivity growth potential.[18]

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[16] Ofgem (2020) *RIIO-ED2 Sector Methodology Decision: Annex 2 Keeping bills low for customers,* available on ofgem.gov.uk

[17] We note that an updated EU KLEMS database that includes data on the period between 1995 and 2018 was published by the Luiss University in 2022 (Release 2021). This dataset was subject to revision at the time of drafting and has not been included in our analysis for this paper. A further EU KLEMS database (Release 2022) was published by the Vienna Institute for Economic Studies in 2022. This dataset does not include any data for the UK.

[18] See OECD (2003) *Measurement of aggregate and industry level productivity growth,* page 119, available on oecd.org

However, there are practical challenges in being able to confidently define and identify individual and/or complete business cycles, and as such there is no clear consensus on when the most recent UK business cycle started and ended (particularly in recent regulatory determinations) because:

- There are different ways of identifying the business cycle. We use a definition based on the 'output gap' which is an approach previously employed by the OBR, Bank of England, HM Treasury and others.[19] We used this approach to setting the time period of analysis in our advice to Ofgem ahead of RIIO-T2/GD2, and it was also used by Ofwat in PR19.[20] But the advisers to some of the network companies have used growth rates identified in EU KLEMS instead.[21]
- By definition there are three points during the business cycle when the output gap will be zero: at the start and end of the business cycle, and when moving from a phase where the output gap is positive to negative, (or vice versa). This means that the cycles identified may differ depending on what judgement has been applied with respect to the start / end point.
- National accounts data is often subject to historical revisions which reflect genuine uncertainties about the underlying data. This means that the technical definition of the output gap can change over time because of data revisions. This can change the judgement on the start / end point of the business cycle, and therefore the data included in the calculation of the average TFP growth between the start and end point. For example, in our analysis of the output gap, it is close to zero in the period between 2015 and 2019 so it requires some judgement to be applied as to when the most recent business cycle ended.

Definitions of business cycles

A common approach to determining a business cycle is to observe the fluctuations of actual output around potential output. Under this approach, a complete business cycle is defined is defined as the point of zero output gap to another point of zero output gap, including both a peak and a trough. Figure 2.1 shows the most recently available information on the UK output gap[22] available at the time of writing from the World Economic Outlook (WEO) Database published by the IMF in October 2021.[23]

[19] The output gap is the difference between the economy's current level of activity and the potential level consistent with stable inflation in the long term. A negative output gap is associated with lower rates of capital and labour utilisation, implying some spare capacity in the economy. A positive output gap is associated with higher rates of resource utilisation and, if sufficiently positive, evidence of 'overheating' which would put upward pressure on wage growth and inflation.

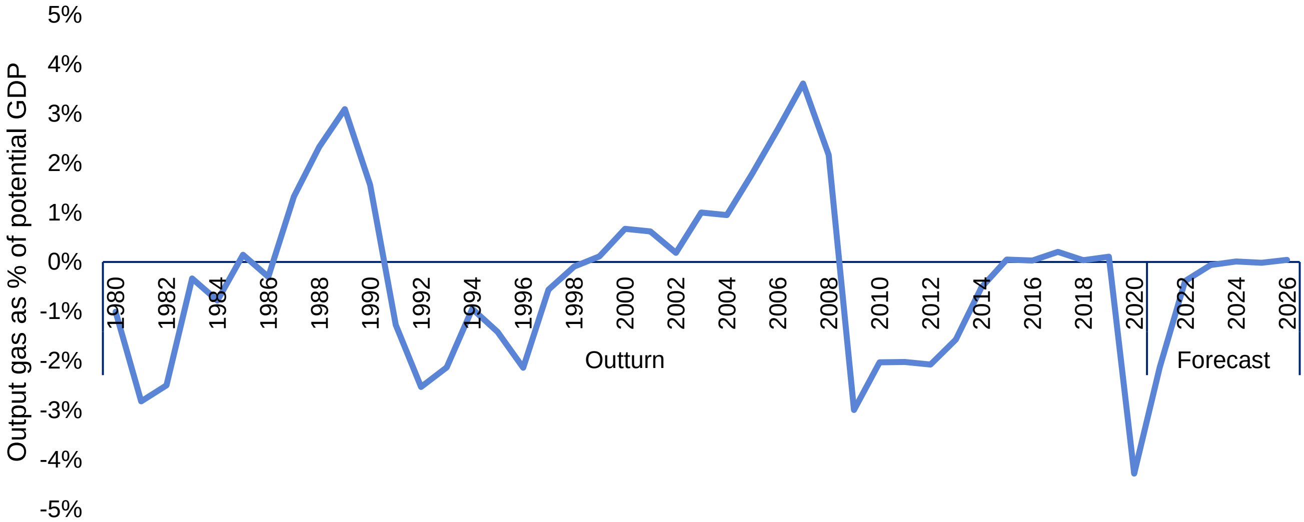
[20] We note that Ofwat's advisors took a blended approach and considered time periods based on their definition of the business cycle and based on the maximum amount of data available from the EU KLEMS database.

[21] Oxera (29 November 2021) "Establishing an appropriate efficiency challenge", p28.

[22] Information on the historic output gap can be subject to ongoing statistical revision and review. As such, we consider that the most recently available information should be used to inform our definition of the business cycle. We note that the information on the output gap reviewed in this report was published after Ofgem's Final Determination for RIIO-T2/GD2.

[23] IMF (2021), World Economic Outlook Database, available on imf.org

Figure 2.1: The UK output gap, 1980-2026



Source: IMF WEO data

Alternative text: *Line graph of the UK output gap as a % of potential GDP, indicating that the output gap was around zero in 1998-99, 2008 and between 2015 to 2019.*

Figure 2.1 appears to show that a business cycle that starts around 1998-99 (the output gap is zero having been negative through most of the 1990s) and ends at some point between 2015 and 2019 (where the output gap remains very close to zero over several years – i.e. the economy is performing close to potential). This incorporates a period where the output gap is positive (broadly 1998-99 to 2008) and where it is negative (broadly 2008 to 2015).[24]

Appropriate number of business cycles

We also need to consider how many business cycles should be captured in our analysis. Focusing only on the most recent business cycle might place too much weight on a period where the potential for productivity growth was significantly different to the potential for future growth. Specifically, UK productivity growth since the GFC has been lower than its longer term average, but this does not necessarily reflect the potential productivity growth that the network companies can achieve during the ED2 period. The reasons for this are explained elsewhere in this report and have been considered previously by both Ofgem[25] and the CMA.[26]

As there is no clear regulatory precedent around the start and end point of the business cycles in the UK, or on which time periods are most appropriate for use in this type of analysis, we analysed:

- Productivity growth over different definitions of the most recent complete business cycles; and
- Using the entire time series available from a particular EU KLEMS data set. This approach removes any subjectivity around defining the start and end point of a business cycle and was followed by Ofgem in RIIO-

[24] A technical definition very narrowly applied to Figure 2.1 might find that the period 2007-2019 represents the most recent business cycle (with 2007 being the start and 2014 being the year with zero output gap during the business cycle). But we consider such a definition too narrow given its reliance on the output gap being slightly positive in 2017; and misaligned with the data series availability in the 2019 EU KLEMS release which provides TFP growth rates only up to 2016 for the UK.

[25] Ofgem (3 February 2021) "RIIO-2 Final Determinations – Core Document (REVISED)", para 5.23, available online.

[26] CMA (28 October 2021) "Energy Licence Modification Appeals – Final determination Volume 2B: Joined Grounds B, C and D", para 7.87, available online.

T1/GD1.[27] NERA also proposed this approach in its report on Ongoing Efficiency for the Energy Network Association (ENA).[28]

This approach will help to inform a rounded view on historic productivity growth and will also help to reduce the dependency of our analysis on a particular technical business cycle definition. The approach of considering different possible business cycle periods is also consistent with the CMA's approach as part of its determination for the RIIO-T2/GD2 appeals.[29] Our choice of time periods for the core analysis are illustrated in Table 2.1 below.

Table 2.1: Choice of time periods

EU KLEMS database	Choice of time period
2019 EU KLEMS database (1997-2016)	Full time series • 1995-2016 Business cycles based on our review of WEO[30] data • 1998-2015 • 1998-2016 • 1999-2015 • 1999-2016

Source: CEPA analysis

2.1.3. Productivity metrics

We consider that the growth accounting analysis of EU KLEMS data to inform a totex challenge should use both GO and VA productivity metrics for TFP. This approach is consistent with the evidence base which we used in our advice to Ofgem ahead of RIIO-GD2/T2, by the CMA in the RIIO-GD2/T2 appeals, and Ofwat and the CMA for PR19.

Productivity metrics using VA and GO

There has been a long-standing debate over which definition of output is more appropriate as a source of evidence to inform the OE challenge. In practice, both GO and VA measures of productivity have their advantages and disadvantages and no consistent view has emerged from previous regulatory decisions over which measure is more relevant when setting the OE challenge.

One argument in favour of GO measures is that by identifying intermediate inputs as a controllable factor of production, it is the most appropriate industry-level measure of technical change which reflects the business decisions which are taken by firms. But producing consistent sets of GO measures across industries requires careful treatment of inter-industry flows of intermediate products, because there is a risk that GO measures may double-count some intermediary inputs as outputs and inputs when economy wide data is used.

So, this means that one argument in favour of using VA measures is that by omitting intermediate inputs from consideration, it is a more robust measure of productivity when aggregated data is used. Another advantage of the VA measure is that it is more directly available from the latest EU KLEMS data. For example, only VA measures of productivity are published in the 2019 EU KLEMS dataset. As the 2019 EU KLEMS database does not include all the data required to calculate GO productivity growth estimates, we have applied the approximation outlined in Section A.1.3 to convert VA TFP to GO terms. Any mis-measurement in the flow of intermediate inputs across industries may lead to the conversion from VA measures to GO measures which is set out in Section A.1.3 failing to

[27] Ofgem considered productivity growth over the full time series which was available from the 2009 release of the EU KLEMS database. This covered the period from 1970 to 2007.

[28] NERA (30 April 2021) "Ongoing Efficiency Improvement at RIIO-ED2", p78.

[29] CMA (2021), *RIIO-2 Energy Licence Modification Appeals - Summary of Final Determination*, available on services.gov.uk

[30] The World Economic Outlook (WEO) database published by the International Monetary Fund.

hold. As GO TFP measures can only be obtained from the 2019 EU KLEMS dataset after VA TFP measures are first calculated, we report the VA TFP measures first throughout this report.

Practical advantages and disadvantages of each measure are summarised in

Table 2.2 below.

Table 2.2: Advantages and disadvantages of VA and GO measures of productivity

Advantages and disadvantages	Value Added (VA)	Gross Output (GO)
Impact of vertical integration	• VA TFP measures of productivity are shown to be more sensitive to outsourcing decisions and the degree of vertical integration between industries.	• GO TFP measures of productivity are less sensitive to outsourcing decisions (i.e., substituting labour for intermediate inputs) and the degree of vertical integration between industries.
Technical progress	• VA TFP is shown to be a better measure of productivity in cases where technical progress operates on primary inputs.	• GO TFP is a better measure of productivity where technical progress affects all factors of production proportionately.
Inter-industry flows	• VA measures of productivity are robust to using aggregated data as intermediate inputs are omitted from consideration.	• GO measures of productivity may be problematic when aggregated data is used because it may double-count intermediary products as outputs (for producers) and as inputs (for firms using intermediary inputs).
Data availability	• VA measures of productivity are published directly in the 2019 EU KLEMS publication.	• GO measures of productivity are not directly available in the most recent 2019 EU KLEMS release. [31] • The growth in GO TFP using this calculation must be calculated using an approximate conversion.

Source: CEPA analysis of OECD (2003)[32]

Productivity metrics using TFP and labour productivity (LP) measures

We consider that there can be benefit to informing analysis of EU KLEMS data using a broad range of productivity measures that includes estimates of both TFP and labour productivity (LP). This approach is consistent with the precedent established across regulatory price controls where regulators have typically informed their growth accounting assessment of EU KLEMS data using both TFP and PFP measures of productivity. For example, in RIIO-GD2/T2 we used both TFP and LP measures in the advice that informed Ofgem's assessment of the OE challenge for opex and capex/repex.[33]

For ED2 we recommend that Ofgem applies an OE challenge at totex-level, which is therefore consistent across both opex and capex/repex. Therefore, our analysis in this section is focused on TFP only.

2.1.4. Comparator sets

We propose using two types of comparator set:

[31] For example, the 2019 EU KLEMS release does not include data on gross output and intermediate input volumes for the UK.

[32] OECD (2003) *Measuring Productivity – Measurement of Aggregate and Industry-Level Productivity Growth*, available on oecd.org

[33] Ofgem (2020), *RIIO-2 Final Determinations – Core Documents*, available on ofgem.gov.uk

- Two alternatives for a set of comparator industries chosen for comparability of activities with those in electricity distribution network sector.
- An economy-wide sample of competitive industries to capture broader productivity trends.

Annex A.4 includes a comparison of these comparators with the comparator industries proposed by the growth accounting analysis submitted by the DNOs.

NACE 2 comparator industries in 2019 EU KLEMS dataset

To cover the time periods based on the 2019 EU KLEMS dataset, we have considered the sample of NACE 2 comparator industries that we used as the targeted set to inform the OE challenge proposed by Ofgem for RIIO-GD2 and RIIO-T2. This narrow set uses an unweighted average of:

- Construction (F);
- Wholesale and Retail Trade: Repair of Motor Vehicles and Motorcycles (G);
- Transportation and Storage (H); and
- Financial and Insurance Activities (K).

Having reviewed recent analysis produced by the CMA and by the DNOs advisers, we decided that it would also be appropriate to test an alternative 'expanded' comparator set which introduces two additional industries within the pool of selected comparators:

- 'Professional, Scientific, Technical, Administrative and Support Service Activities' (M-N); and
- Information and Communication (J).

The 'Professional, Scientific, Technical, Administrative and Support Service Activities' category reflects some of the technical and administrative activities which the network companies routinely undertake and should be reflected in the unweighted average. Moreover, it is not obvious to us why this category would be applicable in setting the OE challenge in the water sector, but not in the energy sector.[34]

We recognise that there are differences between the electricity distribution sector and the 'Information and Communications' industry in EU KLEMS. By including this industry as one of six industries in the expanded comparator set we are not saying they are exactly alike. Rather, we use the 'Information and Communications' industry to ensure that the overall comparator set better reflects the potential for increased innovation and productivity growth due to the digital transformation of the electricity distribution sector which the network companies expect to deliver during ED-2.

For example, to support this transformation, the network companies have requested an approximate doubling of their expenditure on Information Technology & Telecommunications over the next five years compared to ED-1[35]. If this expenditure is released, we expect it to include means to monitor, manage, and operate the distribution networks digitally, remotely and in real-time. The network companies will also make investments to facilitate the transition towards DSO status which (if implemented effectively) should enable them to reduce the cost of operating their future networks; and they will find new means to reduce costs thanks to dedicated RIIO-1 cost allowances to fund greater innovation.

The economy-wide sample is the average of the market economy figures in EU KLEMS – defined as all industries excluding real estate activities (L), public administration & defence (O), education (P), health & social work activities

[34] CMA (17 March 2021) "Ofwat Price Determinations – Final report" para 4.521, available online.

[35] CEPA analysis of company submitted costs compared to actual ED-1 expenditure (on a normalised basis).

(Q), arts, entertainment and recreation (R), other social services (S), activities of households as employers (T), and activities of extraterritorial organizations (U). The figures are weighted by the contribution of the sector to GDP.

NACE 1.1 comparator industries in 2011 EU KLEMS dataset

To cover the time periods based on the 2011 EU KLEMS database, we have considered the sample of NACE 1.1 comparator industries used by Ofgem to set the OE challenge for RIIO-GD1 and RIIO-T1.[36] This sample also includes a targeted set of industries which are comparable to the activities undertaken by DNOs as well as economy-wide samples which captures broader productivity trends.

The narrow set is the same as the targeted comparator set we used for RIIO-GD2/T2:

- Construction (F);
- Sale, Maintenance & Repair of Motor Vehicles/Motorcycles, Retail Sale of Fuel (G50);
- Transport & Storage (I60-I63); and
- Financial Intermediation (J).

As described for the 2019 EU KLEMS data set above, we have also tested the inclusion of two additional industries to create an expanded comparator set:

- Post and Telecommunications (I64); and
- Renting of Machinery and Equipment and Other Business Activities (K71-74).[37]

The economy-wide sample is the average of historical productivity growth in all industries excluding Real Estate, Renting and Business Activities (K); Public Admin and Defence, Compulsory Social Security (L); Education (M); Health and Social Work (N), Other Community, Social and Personal Services (O); Private Households with Employed Persons (P); Extra-Territorial Organisations (Q)). Figures are weighted by sector contribution to GDP.

2.2. Results from core growth accounting analysis for RIIO-ED2

Table 2.3 shows TFP average growth rates for the core EU KLEMS analysis that we conducted on the 2019 EU KLEMS database. We find that VA TFP growth ranges from between 0.3% to 1.2% while GO TFP growth ranges from between 0.2% and 0.6% depending on the selected industry sample and time period.

Table 2.3: Average historic TFP growth based on the 2019 EU KLEMS database (to 1 d.p.)

Average TFP growth (%)	Full time series (1995-2016)		Business cycles (WEO data)	
	VA	GO	VA	GO
Unweighted average of narrow comparator set 1 ('RIIO-GD2/T2')	0.8%[38]	0.4%	0.3 to 0.4%	0.2%
Unweighted average of expanded comparator set 2	1.2%	0.6%	0.9 to 1.0%	0.5 to 0.6%
Market economy (all industries excluding L, O, P, Q, T, and U)	0.8%	0.4%	0.7 to 0.8%	0.3 to 0.4%

Source: CEPA analysis of EU KLEMS

[36] Ofgem (2012), RIIO-T1/GD1: Real price effects and ongoing efficiency appendix, available on ofgem.gov.uk

[37] I64 and K71-74 are the closest NACE1 industry classifications to NACE2 industry classification groups M-N and J.

[38] The higher growth rate found for this industry sample across the full time period is driven by a high growth rate in the 'Financial and Insurance Activities (K)' sector between 1997 and 1998. This time period is not included in any of the business cycle periods based on WEO data.

3. INTERPRETING THE GROWTH ACCOUNTING ANALYSIS

This section discusses the other factors that we considered in interpreting the EU KLEMS evidence on historical productivity improvements to inform the setting of a forward-looking OE challenge for RIIO-ED2. These include:

- Regulatory precedent in using EU KLEMS analysis to set the OE challenge.
- The OE challenges which are proposed by the electricity distribution companies.
- Limitations of the efficiency measures calculated from EU KLEMS data in terms of capturing embodied technical change.
- Economy-wide productivity forecasts that are available for the UK economy as well as the macroeconomic factors which may influence the scope of future productivity improvements, such as the UK's departure from the European Union (Brexit) and the COVID-19 pandemic.
- The relevance of the wider productivity slowdown since the GFC for the frontier efficiency improvements achievable by the electricity distribution networks during RIIO-ED2.
- Reviews of the historical productivity performance of the DNOs, including analysis submitted by the ENA and analysis undertaken by the University of Cambridge Energy Policy Research Group.

3.1. Recent UK regulatory precedent

Table 3.1 below demonstrates that growth accounting analysis using EU KLEMS data has been widely used to inform recent regulatory decisions on the OE challenge in different network price controls – including for RIIO-GD1/T1 and RIIO-GD2/T2. The OE challenge has been generally clustered around a value of 1% per annum.

RIIO-ED1 is a notable exception in Table 3.1. In that case, Ofgem set the OE challenge by adopting the challenge which was proposed by each of the slow-track companies.[39] The challenges proposed by these companies varied between 0.8% and 1.1%.

[39] Ofgem (2014) RIIO-ED1: *Final Determinations for the slow-track electricity distribution companies*, available on ofgem.gov.uk

Table 3.1: Recent UK regulatory decisions on OE

Year	Price control	Decision-making body	OE challenge	Use of EU KLEMS data
2021	RIIO-GD2/T2[40]	CMA	0.95% for capex/repex 1.05% for opex	✓
2021	PC21[41]	UR	0.6% for capex 0.8% for opex	✓
2020	*RIIO-GD2/T2[42]*	*Ofgem**	*1.15% for capex/repex* *1.25% for opex*	✓
2020	PR19[43]	CMA	1.0%	✓
2019	*PR19[44]*	*Ofwat**	*1.1%*	✓
2017	RP6[45]	UR	1.0%	✓
2016	GD17[46]	UR	1.0%	✓
2014	RIIO-ED1[47]	Ofgem	0.8-1.1%	✗
2014	PC15[48]	UR	1.0%	✓
2014	RP5 (NIE)[49]	Competition Commission	1.0%	✓
2012	RIIO-GD1/T1[50]	Ofgem	0.7% for capex/repex 1.0% for opex	✓

** OE challenge revised downwards by CMA in subsequent appeals process*

Source: CEPA analysis of past regulatory decisions

3.2. Companies' proposals on ongoing efficiencies

All the network companies explicitly refer to a consultancy report commissioned by the ENA into OE for RIIO-ED2.[51] SSEN's submission also refers to another consultancy report produced by Oxera on catch-up and frontier efficiency growth.[52]

[40] CMA (2021), *RIIO-2 Energy Licence Modification Appeals - Summary of Final Determination*, available on services.gov.uk

[41] UR (2021), *PC21 Final Determination - Main Report*, available on uregni.gov.uk

[42] Ofgem (2020), *RIIO-2 Final Determinations - Core Documents*, available on ofgem.gov.uk

[43] CMA (2021), *Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Final Report,* pages 248-249. Available on services.gov.uk.

[44] Ofwat (2019), *PR19 Final Determinations - Securing Cost Efficiency. Technical Appendix*, available on ofwat.gov.uk

[45] UR (2017), *Transmission & Distribution 6th Price Control (RP6) - Final Determination*, available on urengni.gov.uk

[46] UR (2016), Price Control for Northern Ireland' Gas Distribution Networks GD17 – Final Determination, available on uregni.gov.uk

While the network companies drew from similar external sources of evidence, they have assumed different levels of ambition in the final business plans:

- ENWL[53] includes a challenge of 1% per annum, and UKPN[54] states that it has adopted a 1% per annum challenge.
- SSEN[55] states an assumed challenge of 0.7% per annum.
- NPg[56], SPEN[57], and WPD[58] all include an ongoing efficiency challenge of 0.5% per annum.

3.3. Embodied technical change

Productivity improvements can be categorised into embodied and disembodied technical change.

- **Embodied technical change** refers to the productivity gains which are made from employing new inputs relative to the use of a comparable amount of pre-existing inputs. As an example, embodied technical change may arise from updating the quality of an existing stock of machinery or through the employment of a more skilled workforce.
- **Disembodied technical change** refers to the productivity gains which are made through the process by which output is produced from inputs of a given quality. For example, disembodied technical change may arise through the introduction of new business practices which employ a more efficient approach to utilising inputs within the production process.

This distinction is important because TFP estimates developed using the EU KLEMS database are intended to capture disembodied productivity growth only. This is a result of the EU KLEMS methodology which makes use of quality-adjusted inputs which are intended to control for embodied technical change.[59] As efficiencies can be generated through embodied and disembodied technical change, the TFP estimates developed using data contained in the EU KLEMS database (such as those outlined in Section 2.2 above) may underestimate the potential for productivity improvements which could be delivered through quality improvements which are embodied within the capital and labour inputs.

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[47] Ofgem (2014), *RIIO-ED1: Final Determinations for the slow-track electricity distribution companies*, available on ofgem.gov.uk

[48] UR (2014), Water & Sewerage Services Price Control 2015-21 – Final Determination, available on urengni.gov.uk

[49] Competition Commission (2014) Northern Ireland Electricity Limited price determination, A reference under Article 15 of the Electricity (Northern Ireland) Order 1992, Final determination, available on service.gov.uk

[50] Ofgem (2012), RIIO-T1/GD1: Real price effects and ongoing efficiency appendix, available on ofgem.gov.uk

[51] NERA (April 2021) *Ongoing Efficiency Improvement at RIIO-ED2*. Prepared for the Energy Networks Association

[52] Oxera (2021) *Establishing an appropriate efficiency challenge*.

[53] ENWL (2021) *Our plan to lead the North West to Net Zero.* p110

[54] UKPN states that it has adopted an ongoing efficiency assumption of 1.0% per annum (UKPN (Dec 2021) RIIO-ED2 Business Plan 2023–2028, p184). But calculated on a like-for-like CAGR basis with other network companies, it has adopted an average ongoing efficiency assumption of 1.4% per annum across the ED2 period (CEPA analysis of EPN, LPN and SPN BPDTs).

[55] SSEN states that it has adopted an ongoing efficiency assumption of 0.7% per annum (SSEN (Dec 2021) RIIO-ED2 Business Plan Annex 15.1, p17). But calculated on a like-for-like CAGR basis it has adopted an average ongoing efficiency assumption of 0.97% per annum (CEPA analysis of SSEH and SSES BPDTs).

[56] NPg (2021) *Our Business Plan for 2023-2028*. p188

[57] SPEN (2021) *Annex 5D.5 – Ongoing Efficiency*. p5

[58] WPD (2021) Business Plan 2023-2028 Final Submission. p153

[59] For example, the EU KLEMS methodology uses quality adjusted price deflators for capital inputs and a composition term for labour which captures factors such as changes in the workforce education level.

The following sub-sections sets out our considerations on embodied technical change and the extent to which productivity estimates based on EU KLEMS may underestimate the level of cost savings which can be made when quality improvements are taken into account.

Regulatory precedent

The potential for the EU KLEMS to underestimate the level of historic TFP growth has been considered as part of UK regulatory precedent. For example, Ofwat considered the potential for the EU KLEMS data to underestimate the level of embodied technical change as part of its Final Determination for the water companies in England and Wales in PR19. This consideration formed a key source of evidence in informing the final OE challenge. In particular, Ofwat considered the potential for embodied technical change as a key justification for setting an OE challenge towards the top of the range developed by their advisors. Ofwat's advisors compiled a range of evidence which suggested that embodied technical change may represent up to 60% of total productivity growth. This quantification was challenged by the water companies that appealed to the CMA.[60]

Ofgem also considered the potential for EU KLEMS to underestimate the level of embodied technical change as part of its Final Determination for RIIO-T2/GD2.[61]

Following the PR19 Final Determination, several water companies appealed to the CMA on the OE challenge that was set by Ofwat. As a result, the CMA considered the potential for EU KLEMS data to underestimate embodied technical change in detail. In its Provisional Findings and its Final Report, the CMA agreed with the principle that an upward adjustment for embodied technical change may be appropriate. However, the CMA did not consider evidence provided by Ofwat's consultants regarding the magnitude of the adjustment to be robust. Instead, the CMA decided to consider embodied technical change as a qualitative factor for consideration in the choice of the OE challenge.[62]

Similarly, in its Final Determination in the Energy Licence Modification Appeals, the CMA stated that "[…] *the reliance on embodied technical change should be commensurate with the reliance on GO measures* [therefore] *we find that it was appropriate for GEMA to place some weight on embodied technical change*".[63]

Companies' views on embodied technical change

The ENA's advisors (NERA) have set out views on embodied technical change and EU KLEMS as part of their consultancy support to the DNOs for RIIO-ED2.[64]

While NERA agrees that productivity growth based on EU KLEMS data is intended to account for disembodied technical change only, they raise concerns regarding the extent to which in practice the EU KLEMS data controls for input quality over time.[65] NERA argues that if EU KLEMS mis-measures any changes in input quality over time, then its estimates of productivity growth will contain impacts related to embodied technical change. They argue that this form of mis-measurement is an explanation for the high levels of productivity growth observed in some industries such as telecommunications. Based on these considerations, NERA argue that any attempt to adjust the

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[60] Europe Economics (2019) *Real Price Effects and Frontier Shift – Final Assessment and Response to Company Representations*, page 67. Available on ofwat.gov.uk

[61] Ofgem (2020), *RIIO-2 Final Determinations – Core Documents*, available on ofgem.gov.uk

[62] CMA (2021) *Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Final Report,* pages 248-249. Available on services.gov.uk.

[63] CMA (2021) "Energy Licence Modification Appeals 2021 – Final determination Volume 2B: Joined Grounds B, C and D" para 7.259, available online.

[64] NERA (April 2021) *Ongoing Efficiency Improvement at RIIO-ED2*. Prepared for the Energy Networks Association, available online at ssenfuture.co.uk.

[65] For example, the ENA's advisors point out that EU KLEMS only distinguishes between three levels of educational attainment in labour.

OE challenge for embodied technical change on top of the estimates developed using EU KLEMS therefore double-counts embodied technical change.

The NERA paper also raises several criticisms of the analysis undertaken by Ofwat's advisors for PR19 which suggested that embodied technical change may represent up to 60% of total productivity growth.

Summary of our conclusions on embodied technical change

We consider that Ofgem should consider both the potential for embodied and disembodied technical change when reviewing the evidence on growth accounting to inform the OE challenge for RIIO-ED2. As outlined above, TFP estimates developed from the EU KLEMS database are intended to capture disembodied technical change only. As such, productivity measured developed using EU KLEMS data only may underestimate the total potential for cost savings that can be achieved when quality improvements embedded within factor inputs are considered.

While this view is supported by recent regulatory precedent and CMA findings, we note the arguments set out by the DNOs which suggest that the imperfect nature of the EU KLEMS database may result in some embodied technical change being included in the EU KLEMS data. However, it is not possible to conclude from their analysis that the evidence would support Ofgem placing significant weight on their concerns.

We consider that embodied technical change may be an important factor in driving productivity growth and cost savings over time. As such, commensurate with the reliance on GO measures of TFP growth obtained from the EU KLEMS dataset, the potential for embodied technical change is a qualitative factor used to inform our assessment of the growth accounting evidence from EU KLEMS. We consider that this view is consistent with the precedent set by the CMA in their reviews of the OE challenge set for PR19 and for RIIO-GD2/T2.

3.4. RIIO-ED2 CONTEXT FOR DEFINING APPROPRIATE COMPARATOR SETS

Ofgem and the companies have set out a clear ambition to deliver transformational change in the electricity distribution sector over the RIIO-ED2 period. The period will be fundamental to the development of a more decentralised and digitalised electricity distribution system that can support the decarbonisation of heat and transport, the increased use of flexibility, and the integration of new decentralised sources of generation. Meeting the transformational ambition will require a step-change from the DNOs – for example, by responding to more renewable energy being produced locally and by taking on DSO functions.

We consider that this step-change in the capabilities of the networks and the price control framework to deliver this transformation presents an opportunity for the broader transformation of DNO operations. That is, the delivery of the increased ambition over RIIO-ED2 should enable new opportunities for economies of scale and scope for further optimisation of internal business processes and operations.

In addition, we note that the rapid evolution of the electricity distribution sector required to meet decarbonisation targets presents opportunities for efficiencies which may not be available to other regulated sectors. For example:

- Traditional electricity network models have been based on centralised power generation with a unidirectional flow from plant to user. The rapid development of increased demand side participation and distributed generation on the electricity distribution network has led to an increasingly decentralised network model.
- New technological advancements in digitalisation and data-sharing have transformed the ability of DNOs to optimise their operations and effectiveness. For example, smart metering and other smart devices on network installations can enable DNOs to make decisions around the operation of the distribution network informed by a suite of newly available operational data. This digital evolution might allow the DNOs to realise higher rates of productivity growth somewhat closer to that achieved in more digitally enabled industries, which we reflect in our selection of industries for the expanded comparator set in the EU KLEMS analysis.

This transformation will be further supported by the provision of innovation funding to the network companies. Ofgem has encouraged innovation in the energy sector for over a decade via various innovation mechanisms as part of the price control or through innovation competition. As more companies innovate and embed those new innovative practices into their day-to-day operations or overall business model, the more efficient the company should be. In turn, these efficiencies should drive productivity growth either through improvements in output quality or a reduction in input costs over time.[66]

Company views on RIIO-ED2 context for OE challenge

In the Sector-Specific Methodology Consultation (SSMC) paper for RIIO-ED2, Ofgem proposed to "consider whether innovation funding previously awarded to DNOs could deliver efficiency benefits over ED2".[67] In response to this proposal, five DNOs argued that past innovation funding should not be used to inform the OE challenge for RIIO-ED2, for reasons including:

- EU KLEMS data already includes innovation efficiencies from competitive industries.
- There is no established quantitative relationship between innovation funding and productivity.
- Previous innovation funding was not targeted towards efficiency gains and thus would not necessarily result in greater efficiency in RIIO-ED2.
- Increasing the OE challenge based on past innovation would reduce future incentives to innovate.
- The cost assessment process would already account for efficiency improvements in technologies and processes incentivised by the price control in RIIO-ED1, so adding a further challenge for past innovation onto the OE assumption would double count innovation.

Having received these responses, Ofgem stated in the SSMD for RIIO-ED2 (published in December 2020) that they would "consider whether past innovation funding awarded in previous price controls could lead to further efficiencies beyond those in competitive sectors in RIIO-ED2 and investigate the appropriate methodology for capturing this effect quantitatively in their ongoing assumption".[68,69]

As part of their assessment of alternative evidence on OE, the NERA (on behalf of the ENA) provide a discussion of the derivation and implementation of the innovation uplift by Ofgem in the RIIO-GD2/T2 Final Determinations. NERA argue that it would be inappropriate to adjust the OE challenge for RIIO-ED2 to account for historical innovation funding, on the basis that:

- the benefits of innovation expenditure are already included in NERA's own estimates of historical OE improvements (discussed in Section 3.7.1);
- DNOs would have less incentive to use innovation funding if that funding will ultimately be deducted from allowances in future regulatory periods;
- a retroactive clawback of funding increases uncertainty and unpredictability for companies and is thus not consistent with stable regulatory practice.

[66] We also note that past innovation funding provided to the network companies may have enabled them to avoid the worst effects of the sustained period of low productivity growth following the GFC.

[67] Ofgem (July 2020) *RIIO-ED2 Sector Methodology Consultation: Annex 2 Keeping bills low for consumers,* available on ofgem.gov.uk

[68] Ofgem (December 2020) RIIO-ED2 Sector Methodology Decision: Annex 2 Keeping bills low for consumers, available on ofgem.gov.uk

[69] Ofwat has expressed a similar interest with respect to PR24 – see Ofwat (May 2021) "PR24 and beyond: Creating tomorrow, together" p17, available online.

In addition to the arguments presented above, several DNOs explain that the cost savings achieved from historic innovation are already accounted for in their RIIO-ED2 Business Plans. For example:

- ENWL state that they have "baked the benefits of previous innovation into our forward plan".[70]
- SPEN note that the cost savings achieved from innovations delivered in RIIO-ED1 and expected over RIIO-ED2 are already accounted for in their business plan totex submission, estimated to total £87m.[71]
- SSEN state that they have embedded £19m of benefits from ED1 innovation (including from the Network Innovation Allowance) which are to be realised over RIIO-ED2 into their business plan.[72]
- WPD have embedded £723m of savings into their business plan, which includes learning from their Ofgem-funded Innovation Programme amongst other initiatives.[73]

Our recommendation

Based on the discussion above, we consider that the context of the RIIO-ED2 price control suggests that opportunities for efficiency gains above and beyond what has been observed in other regulated sectors may be possible.

However, we note that the magnitude of any additional improvements is highly uncertain and dependent on the wider evolution of the electricity distribution sector over the RIIO-ED2 period. We also note that some of the new synergies and opportunities presented by the evolution of the DNOs' role may already be captured to some extent within the network companies' business plan submissions to Ofgem.

Therefore, we recommend that Ofgem reflects on the experience of RIIO-GD2/T2 – particularly with regards to the 'innovation uplift'. We note that whilst the CMA agreed with the principle that past innovation funding may lead to additional cost savings, in its decision regarding the OE challenge set for RIIO-GD2/T2 it set out a range of concerns with the quantification presented by Ofgem in support of the uplift.[74] In particular, the CMA found that:

- Ofgem had erred in relying on the assumption that all innovation funding received by the network companies could result in cost reduction. As such, Ofgem were deemed to have erred in the quantification of the benefits from innovation funding.
- Ofgem had erred in assuming that all innovating funding was incremental. Ofgem did not submit evidence showing that it had tried to quantify the extent of double-counting with R&D spending in the wider economy, nor show that it had taken this into account qualitatively.
- Ofgem had erred because the approach double-counted savings already embedded in company business plans. This view was based on evidence submitted by the network companies which showed that some innovation funding was spent on projects which had resulted in cost savings. Thus the benefits of innovation funding embedded in the business plans was above zero.

[70] Electricity North West (December 2021) *RIIO-ED2 Business Plan Annex 20: Costing and benchmarking our plan*, page 22.

[71] SP Energy Networks (December 2021) *RIIO-ED2 Business Plan Annex 5D.5: Ongoing Efficiency*, page 6.

[72] Scottish and Southern Electricity Networks Distribution (December 2021) *RIIO-ED2 Business Plan Annex 15.1 Cost Efficiency Paper*, page 25.

[73] Western Power Distribution (December 2021) *RIIO-ED2 Business Plan Destination: Net Zero Business Innovation and Efficiency Strategy*, page 9.

[74] Competition & Markets Authority (October 2021) *Cadent Gas Limited, National Grid Electricity Transmission plc, National Grid Gas plc, Northern Gas Networks Limited, Scottish Hydro Electric Transmission plc, Southern Gas Networks plc and Scotland Gas Networks plc, SP Transmission plc, Wales & West Utilities Limited vs the Gas and Electricity Markets Authority Final determination Volume 2B: Joined Grounds B, C, and D.*

- Ofgem had erred in not sufficiently considering the incentive consequences of the innovation uplift. In particular the CMA considered that Ofgem should have considered the relative incentives for companies to invest in cost-focused projects relative to projects focused on delivering other benefits such as environmental improvements.

As such, Ofgem should take care to establish a clear evidential basis for the justification of ED2 specific factors (such as previous innovation funding) when setting the OE challenge. In particular, Ofgem should note that:

- Consumer benefits may not always be realised in future cost savings. For example, some innovation may result in improvements to output quality or the delivery of wider environmental benefits.
- Several DNOs claim that cost savings achieved through innovation funding and other RIIO-ED2 developments are already embedded within their RIIO-ED2 Business Plans. Ofgem's own review of the evidence provided in the network companies' business plan submissions finds that the basis on which these cost savings are quantified and 'embedded' is inconsistent. But it is possible that efficiencies specifically linked to previous innovation funding are partly captured by the comparative benchmarking, and therefore Ofgem should consider that possibility as it makes an 'in the round' assessment of the ongoing efficiency challenge.
- The CMA noted that the innovation uplift proposed by Ofgem for RIIO-T2/GD2 had the potential to distort the incentives for the network companies to pursue innovation which does not directly result in cost savings.

Overall, we consider that there is scope for Ofgem to take the particular context of the RIIO-ED2 price control into account when interpreting the evidence set out in this report, including the EU KLEMS evidence on historical productivity improvements to inform the setting of a forward-looking OE challenge. In particular, we believe that the net zero, digital and institutional transformation of the electricity distribution system does present scope for new opportunities to innovate and to adopt more productive technologies in ways that will allow the network companies to deliver an increase in outputs, commensurate with the anticipated increase in allowed expenditure. Therefore, we recommend that Ofgem takes this transformation into account as it considers the differences in productivity growth implied by the inclusion of more dynamic industries in our EU KLEMS comparator sets; but it should stop short of including a quantified 'uplift' to the OE challenge to reflect the impact of individual factors.

3.5. Economy-wide productivity forecasts and macroeconomic factors

We have explored forward-looking estimates of productivity improvements in the UK economy as part of the context for the ongoing efficiency improvements that may be achievable in RIIO-ED2. In this section, we consider the latest productivity forecasts and supporting commentary available from the OBR and the BoE, as well as related submissions by the network companies.

3.5.1. Productivity growth forecasts

Table 3.2 below shows the latest UK labour productivity growth forecasts available from the OBR and the BoE.

Table 3.2: Economy-wide productivity forecasts (labour productivity)

	2022	2023	2024	2025	2026
BoE	-0.5%	1.0%	1.0%	-	-
OBR	-0.2%	1.0%	1.6%	1.3%	1.3%

Source: Office for Budget Responsibility (output per hour)[75] and Bank of England (GDP per hour worked)[76]

We note that there are difficulties associated with using this evidence as direct inputs into the quantification of OE challenge:

- These forecasts reflect assumptions around the evolution of economy-wide productivity growth over time. Such forecasts may not reflect the potential for frontier productivity improvements by energy networks.
- Productivity forecasts are typically subject to revision. This can reduce their stability and reliability as a basis for informing a fixed ex-ante OE challenge. NERA points out that the OBR has typically revised their productivity growth forecasts down over time. As such, they support placing limited weight on forward-looking productivity forecasts when informing the OE challenge for RIIO-ED2.[77]
- The productivity forecasts produced by the OBR and BoE reflect the growth in LP over time. As outlined in Section 2.1.3, we consider that TFP measures reflect the most appropriate benchmark for the level of cost efficiencies that the network companies can achieve over RIIO-ED2. As such, these forecasts are not directly comparable to our analysis based on historic TFP growth outlined in Section 2.2.

Therefore, we recommend that Ofgem exercises caution when considering the relevance of forward-looking, economy-wide productivity forecasts to the ongoing efficiency challenge for RIIO-ED2.

3.5.2. Macroeconomic factors

Recent macroeconomic developments may also influence the scope for future efficiency gains in the electricity distribution sector. This is particularly the case in circumstances where the root cause of those developments has a material impact on the way in which the network companies can carry out their activities, organise their supply chains, and/or generally manage their regulated businesses. In this section, we discuss the possible impacts of two key macroeconomic factors: Brexit and the Covid-19 pandemic.

Brexit

The UK exit from the EU (Brexit) represents a major change in the operation of the UK economy, particularly through the associated changes in legislation and trading arrangements with the EU. There is broad consensus among economists that Brexit will have negative effect on the UK economy, although the timing and magnitude of the impacts are uncertain.

For example, the OBR's analysis shows that the impact of Brexit will have a stronger adverse impact over the long-run than Covid-19 (discussed in more detail below). In particular, the OBR estimate that the Trade and Cooperation Agreement (TCA) reached between the UK and the EU in 2021 will lead to a 4% reduction in UK productivity growth over the long-run.[78] There is also evidence to suggest that Brexit has already had immediate adverse impacts on the UK economy in the short-run. For example, the OBR has also shown that UK trade volumes fell sharply after the TCA came into effect.[79]

[75] Office for Budget Responsibility (March 2022) *Economic and Fiscal Outlook* page 12, available on gov.uk

[76] Bank of England (February 2022) *Monetary Policy Report February 2022* page 12, available on bankofengland.co.uk

[77] NERA (April 2021) *Ongoing Efficiency Improvement at RIIO-ED2*. Prepared for the Energy Networks Association, p58.

[78] OBR (October 2021) *Economic and Fiscal Outlook*, available on obr.uk

[79] OBR (October 2021) *Economic and Fiscal Outlook*, available on obr.uk

Evidence from the companies

NERA (on behalf of the ENA) argue that the adverse impacts of Brexit are likely to impact on the electricity distribution companies over RIIO-ED2.[80] In particular, NERA argues that:

- Trade barriers and supply chain disruption may require extra resources for the procurement of imported inputs by DNOs.
- Regulatory changes associated with the decoupling of UK and EU regimes may require the diversion of DNOs' management resources.
- Brexit may affect incentives and ability to innovate across the wider economy, while reduced interaction between the UK and the EU may slow the spread of innovations from abroad.

Impact of Brexit on our assessment of OE over the RIIO-ED2 period

While we acknowledge the potential avenues through which Brexit may impact DNO productivity, we do not consider there to be sufficient evidence to suggest that a 'Brexit adjustment' to the OE challenge is warranted. For example, we note that the primary mechanism through which Brexit will impact on productivity is through international trade with the European Union. We consider that the applicability of this transmission mechanism to the electricity distribution sector is relatively limited.

We also note that while NERA considers that Brexit may reduce the future scope for ongoing efficiencies through a number of channels, it does not suggest a quantitative adjustment to the OE assumption for RIIO-ED2.

COVID-19 pandemic

It is now over two years since COVID-19 evolved into a global pandemic, with unprecedented ramifications on society and the economy. Having endured several lockdowns, the UK (as of June 2022) is currently subject to relatively few, if any, restrictions which impact the operation of the economy, although several behavioural impacts of the pandemic (such as home-working) have endured. In this section, we assess whether there is any robust evidence on the likely impact of the COVID-19 pandemic on ongoing efficiency in the electricity distribution sector.

Figure 3.1 and

Table 3.3 below provide estimates of quarter-on-quarter (QoQ) growth in output per hour for each quarter since Q2 2020, for the whole economy and selected industries.[81] The significant disruption in the early stages of the COVID-19 pandemic is clearly visible in the data, which show a large drop in labour productivity (apart from water supply) in Q2 2020 followed by a large bounce-back in Q3 2020.

[80] NERA (April 2021) *Ongoing Efficiency Improvement at RIIO-ED2*. Prepared for the Energy Networks Association, pages 59-60, available on ssenfuture.co.uk

[81] ONS (January 2022) *Labour economy breakdown of contributions, whole economy and sectors*, available on ons.gov.uk

Figure 3.1: QoQ growth in output per hour for selected industries.

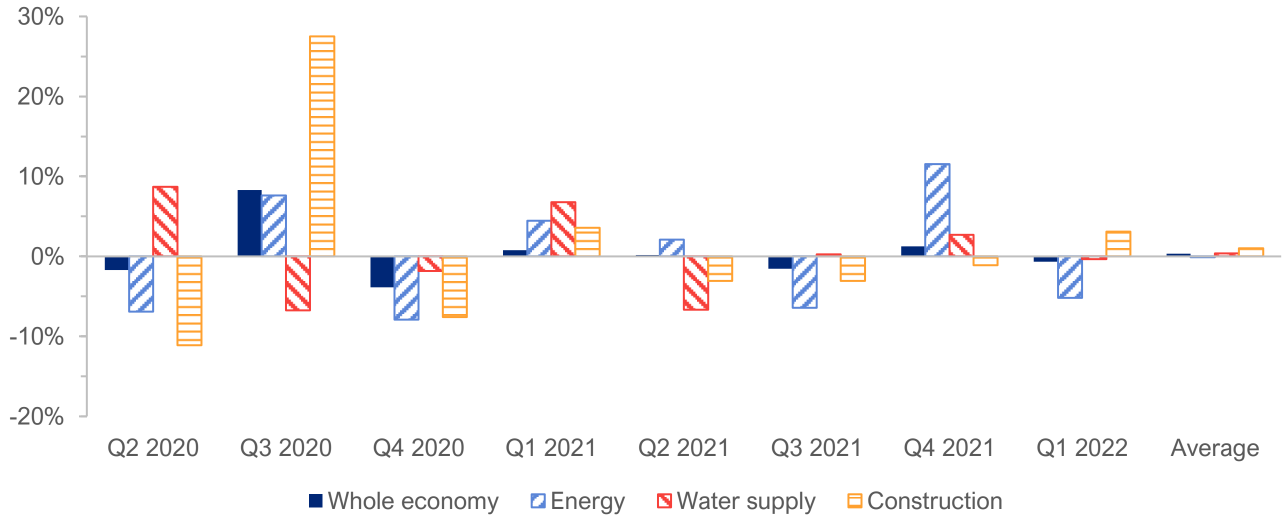

Table 3.3: QoQ growth in output per hour for selected industries.

Industry	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3	2021 Q4	2022 Q1	Average
Whole economy	-1.7%	8.3%	-3.9%	0.8%	0.2%	-1.5%	1.3%	-0.7%	0.3%
Energy	-6.9%	7.6%	-7.9%	4.4%	2.1%	-6.4%	11.5%	-5.2%	-0.1%
Water supply	8.7%	-6.7%	-1.8%	6.8%	-6.7%	0.2%	2.7%	-0.3%	0.4%
Construction	-11.1%	27.5%	-7.6%	3.6%	-3.1%	-3.1%	-1.1%	3.1%	1.0%

Source: CEPA analysis of ONS output (GVA) per hour data. Average column uses arithmetic mean.

As shown in

Table 3.3 above, the underlying volatility in the data makes it difficult to quantify the true impact of the pandemic on productivity growth going forward.

Evidence from the companies

NERA (on behalf of the ENA) discuss the likely impact of the COVID-19 pandemic on ongoing efficiency in the electricity distribution sector.[82] They argue that the COVID-19 pandemic may have persistent negative impacts on UK TFP growth which should be accounted for in the OE assumption for RIIO-ED2. They cite reports by the OBR and BoE which conclude that economic scarring from the pandemic will have long-lasting effects on economy-wide productivity, through mechanisms such as:

- loss of human capital through reduced on-the-job learning;
- loss of social capital from fewer informal interactions between colleagues;
- diversion of resources to COVID-related tasks; and
- reduced research and development (due to lower business confidence or the need to reduce costs).

NERA also note that the BoE has estimated that within-firm TFP will be approximately 1% lower in the medium term than it would have been without the COVID-19 pandemic. NERA does not consider it appropriate to apply a

[82] NERA (April 2021) *Ongoing Efficiency Improvement at RIIO-ED2*. Prepared for the Energy Networks Association, pages 60-61, available on ssenfuture.co.uk

quantitative adjustment to historical productivity growth estimates to account for the long-term consequences of COVID-19, given the uncertainty around the degree to which the electricity distribution sector will be affected. Instead, it suggests that COVID-19 should be considered as a qualitative factor supporting a downwards adjustment to the OE assumption for RIIO-ED2.

Impact of COVID-19 on our assessment of OE over the RIIO-ED2 period

The impact of Covid-19 on productivity growth in the electricity distribution sector during RIIO-ED2 remains highly uncertain, more than two years after the onset of the pandemic in the UK. Whilst most industries were severely affected by, and had to adjust to, new social distancing regulations, the utilities sectors were less affected and were able to continue business operations. We expect that most network companies have experienced some supply chain disruption and issues with sub-contractor availability during the pandemic, as well as increased costs for the provision of PPE. However, we expect the impact of this to be marginal relative to total expenditure across the industry.

It is not immediately clear how the COVID-19 crisis will affect ongoing opportunities for innovation and efficiencies for network companies during the ED2 period. It may affect other sectors more materially, particularly where short-term demand for their goods and services is uncertain and affected by consumer concerns about public health and/or behavioural responses (such as an increased propensity for remote working). However, the UK government and devolved administrations have now removed Covid-19 restrictions and there are few if any ongoing Covid-19 related factors that should impact on the longer-term rate of ongoing efficiency improvements that can be achieved in the energy network sector.

As such, we agree with NERA that it would not be appropriate to apply a quantitative adjustment to the OE challenge to account for the impact of the Covid-19 pandemic. We note that the CMA reached a similar conclusion for PR19 and RIIO-GD2/T2.[83] Moreover, we find that there is insufficient evidence to support making even a qualitative adjustment at this point in time. Should Ofgem wish to reconsider the impact of Covid-19 on the network companies at a later date and when any impacts are more certain, we would recommend focusing on additional costs efficiently incurred rather than an ex-post adjustment to the ongoing efficiency challenge – unless there is strong evidence that it would be appropriate to do so, because those impacts have a persistent effect on network company productivity.

3.6. Relevance of the time period for EU KLEMS analysis

Our core EU KLEMS analysis uses the 2019 dataset which has data for the period 1995-2016. We discuss in this section the observed slowdown in UK productivity growth observed since 2008 and its implications of the extent to which it means the available time period in the 2019 dataset is a good representation of the outlook for the future productivity growth in RIIO-ED2.

The productivity slowdown

Since the GFC in 2008-2009, economy-wide productivity growth in the UK has been below its long-term trends. For example, the OBR reports that annual growth in output per worker (i.e. labour productivity) averaged around 0.3% per annum between 2008 and 2018, compared to 2.3% between 1990 and 2007.[84]

Suggested explanations put forward to explain this 'productivity puzzle' include measurement issues, reduced business investment, compositional effects, labour market factors and impaired financial markets.[85] Another

[83] CMA (October 2021) *Cadent Gas Limited, National Grid Electricity Transmission plc, National Grid Gas plc, Northern Gas Networks Limited, Scottish Hydro Electric Transmission plc, Southern Gas Networks plc and Scotland Gas Networks plc, SP Transmission plc, Wales & West Utilities Limited vs the Gas and Electricity Markets Authority Final determination Volume 2B: Joined Grounds B, C, and D.* page 165.

[84] Office for Budget Responsibility (March 2020) *Economic and Fiscal Outlook*.

[85] Office for Budget Responsibility (2012) *Economic and Fiscal Outlook – the Productivity Puzzle*.

explanation is that low UK productivity growth is driven by a few major industries. For example, the BoE found that the fall in UK productivity since the financial crisis is attributable to the performance of just four sectors: manufacturing, finance, ICT and professional services. It also found that manufacturing and finance alone accounted for three-quarters of the total fall in productivity.[86]

NERA suggests that this productivity slowdown should be accounted for when considering the historical growth accounting evidence for RIIO-ED2.[87] While they acknowledge uncertainty around how much the electricity distribution sector has been affected by the productivity slowdown, they consider that the disproportionate impact in the manufacturing and finance sectors is likely to have been mirrored in the electricity distribution sector.

To inform the OE challenge for the network companies in RIIO-ED2, we recognise that UK productivity growth has been weak over the past decade. However, we note that the underlying causes of the UK's productivity slowdown remain open to debate, which makes it difficult to assess the extent to which the economy-wide slowdown is more or less relevant to the network companies. For example, many of the explanations for the productivity puzzle emphasise the weak recovery of business investment since the GFC. We consider that this should not be a major factor influencing productivity in the electricity distribution sector, which is protected by regulated revenue streams[88] from a monopoly service.

As such, we do not consider it appropriate to apply an explicit adjustment to the OE challenge to reflect the productivity slowdown, as (1) our growth accounting analysis incorporates the effects of the slowdown by including post-GFC data and (2) there is a lack of compelling evidence regarding whether and how the slowdown has materially impacted the electricity distribution sector.

Assessment of TFP based on the 2011 EU KLEMS database

Given the arguments raised by some of the appellants in the recent Energy Licence Modification Appeals for RIIO-GD2/T2, we suggest that there is a benefit to reviewing average productivity growth over a longer period of time (than the most recent business cycle alone) based on the 2011 EU KLEMS database which covers the period from 1970 to 2007.

Reviewing productivity over a longer period of time can help extrapolate away from short-term fluctuations in productivity growth rates. We note that NERA's report on ongoing efficiency for the ENA considered growth accounting evidence on EU KLEMS from the period from 1970 to 2007 only.

We show average TFP growth rates based on our assessment of the 2011 EU KLEMS database in Table 3.4 and Table 3.5 below. Specifically, we show TFP growth rates over the entire data series based on the 2011 EU KLEMS database along with TFP growth rates over the most recent business cycle in the 2011 EU KLEMS dataset (based on WEO data).

[86] Bank of England (2018) *The fall in productivity growth: causes and implications.*

[87] NERA (April 2021) *Ongoing Efficiency Improvement at RIIO-ED2*. Prepared for the Energy Networks Association, pages 56-59, available on ssenfuture.co.uk

[88] For example, a regulated revenue stream should provide the DNO's with a greater ability to protect innovation and investment activity and maintain scale during periods of low or negative productivity growth in the wider economy than comparable competitive sectors facing much greater uncertainty over demand.

Table 3.4: Average historic VA TFP growth based on the 2011 EU KLEMS database (to 1 d.p.)

Average VA TFP growth (%)	Full time series	Business cycles based on WEO data	
	1970-2007	1990-2007	1991-2007
Unweighted average of narrow comparator set 1 ('RIIO-GD2/T2')	1.1%	1.7%	1.8%
Unweighted average of expanded comparator set 2	1.2%	2.1%	2.3%
Weighted average of market Economy (all industries excluding L, O, P, Q, T, and U)	1.0%	1.0%	1.3%

Source: CEPA analysis of EU KLEMS

Table 3.5: Average historic GO TFP growth based on the 2011 EU KLEMS database (to 1 d.p.)

Average GO TFP growth (%)	Full time series	Business cycles	
	1970-2007	1990-2007	1991-2007
Unweighted average of narrow comparator set 1 ('RIIO-GD2/T2')	0.5%	0.8%	0.8%
Unweighted average of expanded comparator set 2	0.6%	1.1%	1.2%
Weighted average of market Economy (all industries excluding L, O, P, Q, T, and U)	0.4%	0.5%	0.6%

Source: CEPA analysis of EU KLEMS

As shown in Table 3.4 and Table 3.5 above, we find a higher level of average TFP growth based on our assessment of the 2011 EU KLEMS database. VA TFP growth is shown to range between 1.0% per annum and 2.3% per annum while GO TFP growth is shown to range between 0.4% per annum and 1.2% per annum. The higher level of average productivity growth is partly explained by the fact that the 2011 EU KLEMS dataset does not include the period of low productivity growth that is recorded in the years following the GFC.

3.7. Historical efficiency improvements in the energy sector

One of the challenges of directly estimating outturn productivity growth in a sector subject to price cap regulation is that outputs are generally not purchased at market prices. In such circumstances, the conventional growth accounting approach to calculating TFP growth by comparing the value of outputs against the value of inputs is very challenging.

In this section, we review two sources which have attempted to assess average historic productivity growth in the electricity distribution sector based on methods which do not rely on the typical growth accounting approach.

While both sources in this section provide interesting analysis which Ofgem might use to reflect on the historic performance of the DNOs over RIIO-ED1, we recommend that Ofgem exercises caution when considering the use of historical productivity growth in the electricity distribution sector to precisely calibrate the ongoing efficiency challenge, because the results appear sensitive to the choice of assumptions and variables. Given the range of reported results, Ofgem will need to give further consideration as to how it will triangulate between them and broadly equate the values to the total efficiency challenge being set for ED2.

3.7.1. Companies' evidence on historical efficiency improvements

In its advice to the ENA on the scope for ongoing productivity improvements during ED2, NERA estimates outturn TFP growth observed in the electricity distribution sector over the period from 2010/11 to 2019/20. NERA's analysis shows that TFP growth in the electricity distribution sector over this period ranged from between -0.1% to 0.4% per annum. This range reflects the impact of different assumptions and methodological choices.

Summary of analytical approach

NERA bases its approach on the development of a weighted index of outputs which are not dependent on either revenue or market prices. The output variables are: number of customers; total network length (km); network-wide peak demand (MW); energy delivered (GWh); customers interrupted, excluding exceptional events (CI); customer minutes lost, excluding exceptional events; and installed capacity of distributed generation (MW).

NERA develops five criteria to aid its selection of 'output' variables:

1. "The output is a measure of or proxy for the services delivered to customers;
2. The output drives costs;
3. It is possible to estimate a cost weight for the output;
4. It is possible to combine the output with other outputs that meet these criteria; and
5. Consistent data for the output is available as a sufficiently long time series."

The growth of output from each year to the next is then calculated as the weighted combination of the growth rate in each constituent output category[89]:

$$\frac{Output\ Index_t}{Output\ Index_{t-1}} = \left(\frac{Output\ 1_t}{Output\ 1_{t-1}}\right)^{weight\ 1} \times \left(\frac{Output\ 2_t}{Output\ 2_{t-1}}\right)^{weight\ 2} \times \ldots$$

Once the output index is defined, the growth in TFP can be calculated by dividing the output index by another index of total expenditure (i.e., an index of inputs).

While this approach succeeds in developing a measure of TFP which is independent of market revenues, the analysis depends on a wide range of analytical choices and assumptions.

The first of these relates to the choice of input and output variables. NERA defines the 'inputs' as total costs, calculated as the sum of capital and operating costs. These are defined as follows:

- **Capital costs** are modelled as annuitised payments on the MEAV, as it is the existing asset base rather than capital expenditure in a given year that is used to provide distribution services. Underlying these calculations are the assumptions of (a) a real vanilla weighted average cost of capital (WACC) of 3.57%;[90] (b) all DNOs have the same WACC; and (c) an asset life of 45 years.

- **Operating costs** are taken from statutory accounts, excluding exceptional items and net of depreciation and amortisation. Pass-through costs are subtracts to exclude items not covered within totex. The costs are deflated using factor price indices and notional cost structures from ED1.

Other important assumptions are:

- Each output variable that is included in the output index needs to be specified and weighted. NERA applies an econometric approach involving cost regressions to specify the weighting of each output variable within the output index.

- As all output variables cannot be included in the same econometric model due to limitations relating to collinearity and the sample size, NERA develops a range of different model specifications which each inform a different output index.

[89] This type of index is called a Törnqvist index.

[90] This is the arithmetic average of the ED1 WACC from 2015/16 to 2019/20.

The final TFP growth estimates along with the model specifications used to derive them based on the approach outlined above is illustrated in Table 3.6 below:

Table 3.6: Output variables, weights and results from Törnqvist indices constructed by NERA

Weight on variable	Model 1	Model 2	Model 3	Model 4	Model 5[91]
Customer numbers	54.2%		97.5%		91.7%
Network length	45.8%			93.1%	
Peak demand		86.2%			
Distributed generation		13.8%	2.5%		
Customers interrupted				6.9%	8.3%
Average TFP growth	**-0.07%**	**0.03%**	**0.36%**	**0.16%**	**0.29%**

Source: NERA (2021)

Applicability to RIIO-ED2

NERA argues that its estimates of historical productivity growth in the electricity distribution sector provide the most relevant and directly applicable evidence regarding the appropriate forward-looking OE challenge for RIIO-ED2. This argument is based on the view that the most recent TFP growth rates achieved by the DNOs (rather than independent comparator industries) capture the most recent productivity trends which could be replicated over the ED2 period.

While we consider that NERA's analysis of outturn productivity growth in the electricity distribution sector over RIIO-ED1 provides a useful source of evidence for Ofgem to consider, we have concerns over its applicability to setting the forward-looking OE challenge for RIIO-ED2. In particular:

- We consider that the primary evidence based used by Ofgem to inform the OE challenge for RIIO-ED2 should be based on the level of frontier productivity growth that is achieved by competitive industries in the wider economy. The objective of the growth accounting analysis of historic productivity growth us to provide an external benchmark from competitive industries for the productivity improvements that could be achieved in the energy network sector.[92] Relying on the level of productivity growth that was achieved by the DNOs over RIIO-ED1 may undermine this principle.[93]
- Informing the OE challenge for RIIO-ED2 based on historic productivity growth achieved in the electricity sector may introduce distortionary incentives for the network companies in ED2. For example, the network companies' incentive to outperform their cost targets may be distorted if it is understood that the challenge for future price controls would be informed by the level of outturn productivity growth over RIIO-ED2.
- We also note that the analysis undertaken for the ENA is highly dependent on the construction of the input and output indices as well as the analytical assumptions used to convert them into an estimate of TFP. For example, NERA notes that models which include distributed generation or customer interruptions lead to higher estimated rates of TFP growth, suggesting that a part of historical productivity growth has been achieved through outputs which are not captured in conventional scale variables. Moreover, the MEAV approach to creating a proxy for capital expenditure may overstate costs and understate productivity growth, particularly if capital assets were originally constructed at lower costs.

[91] Model 5 also includes dummy variables for each DNO to allow for DNO-specific fixed effects.

[92] For example, Ofgem have set a consistent regulatory precedent in RIIO-T2/GD2 and RIIO-T1/GD2 to exclude the energy and water sector from the targeted comparator set within the growth accounting assessment of historic productivity growth.

[93] For example, Ofgem have typically omitted the energy and water sector from the targeted comparator set within its growth accounting assessment of historic productivity growth for RIIO-T2/GD2 and RIIO-T1/GD1.

3.7.2. Analysis by the Energy Policy Research Group (2021)

In addition to the evidence submitted by the network companies, we have also reviewed independent research into productivity growth in the electricity distribution and transmission sector that was published by the University of Cambridge Energy Policy Research Group (Ajaya et al., 2021).[94] The research is based on data collected from Ofgem and covers the period from 1991/92 to 2018/19.

Using a range of model specifications, the research finds that annual TFP growth in the electricity distribution sector ranges between -5.5% and 3.8% per annum.

Summary of analytical approach

Ajayi et al. (2021) estimate the growth in historic TFP using data envelopment analysis (DEA)[95] to construct a Malmquist index, which decomposes productivity growth into various components, such as efficiency change, technical change and scale change.

The construction of the Malmquist requires a range of modelling choices and assumptions. For example:

- Each output variable that is included in the output index needs to be specified and weighted. Ajayi et al. (2021) uses energy distributed, customer numbers and network length as output variables within the baseline model used in the research.
- The input index also needs to be specified. This requires a range of assumptions around the construction of a consistent index of capex and opex costs for each of the DNOs. Ajayi et al. (2021) also include inputs around customer minutes lost (CML) as an input variable within some of the model specifications in their analysis.
- A range of TFP estimates are then calculated by dividing the output index by the index of input costs.

Based on the range of assumptions set out above, Ajayi et al. (2021) estimate a wide range of productivity growth estimates for the electricity distribution sector. For example, they find TFP growth of 0.8% per annum over the period from 1991/92 to 2018/19. Using the decomposition of the Malmquist index, they find that most of this growth is driven by technical change (i.e., a shift in the technology frontier).

Under their baseline model, Ajayi et al. (2021) find TFP growth of -5.5% per annum over the DPCR5 price control and TFP growth of -0.5% per annum over the first four years of the RIIO-ED1 price control period. But when non-monetised factors are considered (such as CML, losses and emissions costs and customer satisfaction), Ajayi et al. (2021) find that TFP growth in the first four years of the RIIO-ED1 period increases to 3.8% per annum.

Applicability to RIIO-ED2

Ajayi et al.'s findings illustrate how conventional measures of productivity growth which focuses on cost efficiency may not capture all productivity improvement delivered by the DNOs over time, such as improvements in output quality. As such, we consider that this paper provides a useful source of information for Ofgem when considering the outturn performance of the electricity distribution sector over time.

But as with the NERA analysis, we have similar reservations around the applicability of these findings to the evidence base used to set the forward-looking OE challenge for ED2. In addition, the findings developed by Ajayi et al. (2021) are highly dependent on the model specifications and assumptions used in the analysis. For example, the estimate of historic TFP growth achieved in the electricity distribution sector ranges from between -5.5% per annum to 3.8% per annum. The more extreme estimates produced by this study are outside the range of evidence

[94] Ajayi, V., Anaya, K., and Pollitt, M. (November 2021) *Incentive regulation, productivity growth and environmental effects: the case of electricity networks in Great Britain*. University of Cambridge Energy Policy Research Group Working Paper No. 2126, available online.

[95] DEA is a non-parametric method commonly used in the academic literature to measure productivity.

developed using a growth accounting analysis of outturn productivity growth achieved in external competitive industries.

Given the range of reported results, if Ofgem intends to make further use of this study then it will need to give further consideration as to how it will triangulate between the available estimates of historical productivity growth in order to compare them to the total efficiency challenge being set for ED2.

CEPA economics matters

4. SETTING THE OE CHALLENGE

Setting the final OE challenge requires a view to be taken on the EU KLEMS analysis presented in Section 2 in the context of the different factors considered in Section 3. It is helpful to consider these factors as different perspectives on the outlook for frontier efficiency improvements. For example:

- which historical time period(s) best reflects the outlook for future productivity growth; and
- whether ongoing efficiency improvements in energy networks are more strongly driven by economy-wide productivity or by sector-specific factors.

Whilst there is strong regulatory precedent for using EU KLEMS to set the ongoing efficiency challenge, there are also limitations in any approach that relies exclusively on analysis of historical productivity growth rates to set the potential for productivity growth over future periods. Rather than selecting any particular value from the analysis of EU KLEMS described in Section 2 and applying it mechanistically, we recommend that Ofgem comes to a more holistic view about the potential for future frontier productivity improvements in the electricity distribution sector during the RIIO-ED2 period.

In this section we set out how Ofgem might bring these different perspectives together into a holistic view, and take into account the coherence of the ongoing efficiency challenge with the approach taken to other elements of the price control, including the core cost assessment process used to set the ‘catch up’ efficiency challenge.

4.1. SUMMARY OF CORE RESULTS FROM GROWTH ACCOUNTING APPROACH

The core results from the EU KLEMS analysis described in section 2 consider:

- **The most recently available evidence on industry-level productivity growth in the UK**. As such, we base the reference range on the evidence from the 2019 EU KLEMS dataset only. This dataset covers the GFC and the period of lower productivity growth that has been subsequently recorded in the UK.
- **The longest time periods available in the 2019 EU KLEMS data set**, which covers 1995-2016. This will help to reduce the dependency of our analysis on a particular technical business cycle definition.
- **Both GO and VA measures of TFP growth.** As discussed in Section 2.1.3, there is no consistent regulatory precedent around the use of VA or GO measures of TFP growth when setting the OE challenge. As such, we consider that weight should be placed on both measures when informing the OE challenge for RIIO-ED2. We note that this consideration is supported by recent regulatory precent established by the CMA in its review of the RIIO-T2/GD2 and PR19 price control determinations.
- **Multiple comparator sets.** This includes an economy-wide sample of competitive industries to capture broader productivity trends, and two alternatives for a set of comparator industries chosen for comparability of activities with those in electricity distribution network sector.

4.2. INTERPRETING THE EU KLEMS RESULTS IN THE CONTEXT OF A FORWARD-LOOKING OE CHALLENGE

RIIO-ED2 context

Ofgem and the companies have set out a clear ambition to deliver transformational change in the electricity distribution sector over the RIIO-ED2 period to enable the network companies to respond to Net Zero whilst transitioning towards a decentralised, decarbonised, and digitalised energy system. This transition is supported by the step change in allowances that might be released over the course of ED2 as well as the dedicated innovation funding provided in previous price controls – where it is likely that there are benefits which the network companies have not yet been able to factor into their submitted costs for RIIO-ED2. This may provide additional opportunities for frontier productivity growth in RIIO-ED2 above and beyond what has been set in the past or what has been set in other regulated sectors. This context should then inform a forward-looking OE challenge.

However, it is not possible to quantify the impact of this context on the potential for productivity growth in the electricity distribution sector over the RIIO-ED2 period with precision. We recognise that while the CMA agreed with the principle that past innovation funding may lead to additional cost savings in the future, a range of concerns were identified with Ofgem's approach to direct quantification of the impact on the OE challenge. As such, we consider that the impact of the RIIO-ED2 specific factors described in this report, including but not limited to historical innovation funding, should be considered only qualitatively –, e.g. with regards to the appropriate industries for inclusion in the comparator set or in understanding how the electricity distribution network sector may not have been affected as much as other sectors by the productivity puzzle following the GFC.

Embodied technical change

We consider that the potential for embodied and disembodied technical change should both be considered as part of the evidence base used to inform the OE challenge for RIIO-ED2. For example, we consider that cost savings that result from the employment of new inputs and through the introduction of new processes by which existing inputs are combined should both be considered.

However, the TFP estimates which result from our core EU KLEMS analysis are intended to capture disembodied technical change only. This finding is a result of the EU KLEMS methodology which makes use of quality-adjusted inputs which are intended to control for embodied technical change.[96] As such, TFP growth measured using the EU KLEMS database may underestimate the total potential for cost savings that can be achieved by network companies when quality improvements in the factor inputs are also considered.

This potential for EU KLEMS to underestimate the total level of productivity growth has been established in recent UK regulatory precedent. For example, Ofgem, Ofwat and the CMA have all considered the impact of embodied technical change on the level of productivity growth that can be achieved in the context of the PR19 and RIIO-T2/GD2 price controls. We note that the ENA's advisors have also agreed with the principle that TFP estimates based on the EU KLEMS database are intended to account for disembodied technical change only.[97]

Based on the above, to the extent that Ofgem relies on GO measures of TFP growth obtained from the EU KLEMS dataset, we consider that the potential for the TFP estimates developed using EU KLEMS data to underestimate the total level of productivity growth should be considered as a qualitative factor within our assessment of the growth accounting evidence from EU KLEMS. We consider that this view is consistent with the precedent set by the CMA in their review of the OE challenge set for PR19.

Relevance of time period constraints imposed by 2019 EU KLEMS dataset

Our growth accounting analysis of the 2019 EU KLEMS database already incorporates the effects of the slowdown by including post-GFC data. However, we do not consider that there is yet strong evidence to suggest that the slowdown in wider productivity growth since the GFC should fully impact on the potential for ongoing productivity gains in the electricity distribution sector. So, we include a range of sensitivities on EU KLEMS to understand the potential impact on the core EU KLEMS values of the sustained period of low productivity growth following the GFC.

This includes considering the trends in productivity growth over a longer period of time. We note that productivity growth over longer periods of time (including dating back to 1970) using the 2011 EU KLEMS database finds average annual TFP growth rates that are similar to or greater than the more recent estimates available from the 2019 EU KLEMS dataset.

[96] For example, the EU KLEMS methodology uses quality adjusted price deflators for capital inputs and a composition term for labour which captures factors such as changes in the workforce education level.

[97] However, NERA argues that data mismeasurement means that some effects of embodied technical change may inadvertently be captured within the TFP estimates developed using EU KLEMS data.

Recent UK regulatory precedent

Growth accounting analysis using EU KLEMS data has been widely used to inform recent regulatory decisions on the OE challenge in different network price controls – including for RIIO-GD1/T1 and RIIO-GD2/T2. The OE challenge in such decisions has been generally clustered around a value of 1% per annum.

Company proposals for OE

The network companies have made use of growth accounting analysis of historic productivity growth in the UK when presenting these OE proposals. They have also considered other sources of evidence such as:

- Consideration of the decisions made by the CMA in relation to ongoing efficiency for RIIO-T2/GD2 (particularly ENWL and UKPN).
- Short term productivity forecasts.
- Historic productivity growth achieved by the DNOs over RIIO-ED1 and DPCR5.

Based on this, the network companies have proposed a range of OE challenges for use in RIIO-ED2. NPg, SPEN, and WPD all include an ongoing efficiency challenge of 0.5% per annum. SSEN include a challenge of 0.7% per annum, while ENWL and UKPN both include a challenge of 1% per annum.[98] Holding all else equal, we consider that there should be similar scope for frontier efficiency gains in RIIO-ED2 across all the network companies. As such, Ofgem may wish to consider whether all the DNOs should be able to match the higher level of ambition shown by some of the companies.

Forward looking productivity forecasts

Section 3.5 discusses the latest available forecasts for LP (output per hour worked) available from the OBR and BoE. These are economy-wide forecasts and hence are most comparable to the weighted economy-wide sample in the EU KLEMS analysis, albeit our EU KLEMS analysis focuses on TFP measures.

These forecasts do not cover the whole RIIO-ED2 period (April 2023-March 2028). The BoE labour productivity forecast runs to 2024, while the OBR labour productivity forecasts runs to 2026. This raises the challenge of what assumptions to use for the latter years of the RIIO-ED2 period especially when there is a rising trend in the forecast over the period, which is the case for the forecasts from both the OBR and BoE.

More importantly, these forecasts are influenced by short-term macroeconomic factors including Brexit, Covid-19 and the ramifications of the Russian invasion of Ukraine. In our view the relevance of such factors to the potential for ongoing efficiency improvements in the electricity distribution sector over the ED2 period is limited, difficult to quantify, and likely to be outweighed by the stability of the price control framework and five-yearly control periods which provide the network companies with longer and more stable planning horizons than other, more competitive sectors of the economy, and enables them to drive continual innovation and efficiency improvements through their supply chains.

Using the historical productivity growth of the DNOs to adjust the OE challenge

Section 3.6 discusses historic productivity growth in the electricity distribution sector and its applicability to the forward-looking OE challenge in RIIO-ED2. The section focused on the evidence presented by the ENA and on independent research published by the University of Cambridge Energy Policy Research Group examining historical productivity growth in the electricity transmission and distribution sectors.

[98] UKPN states that it has adopted an ongoing efficiency assumption of 1.0% per annum (UKPN (Dec 2021) RIIO-ED2 Business Plan 2023–2028, p184). But calculated on a like-for-like CAGR basis with other network companies, it has adopted an average ongoing efficiency assumption of 1.4% per annum across the ED2 period (CEPA analysis of EPN, LPN and SPN Business Plan Data Templates). Likewise, SSEN states that it has adopted an ongoing efficiency assumption of 0.7% per annum (SSEN (Dec 2021) RIIO-ED2 Business Plan Annex 15.1, p17). But calculated on a like-for-like CAGR basis it has adopted an average ongoing efficiency assumption of 0.97% per annum (CEPA analysis of SSEH and SSES Business Plan Data Templates).

We consider that the OE challenge should primarily be informed by the level of frontier productivity growth that is achieved by competitive sectors in the wider economy. The objective of the growth accounting analysis of historic productivity growth is to provide an external benchmark from competitive sectors for the productivity improvements that could be achieved in the energy network sector.[99] Using any assessment of the level of productivity growth achieved by the DNOs in RIIO-ED1 would undermine this principle. It is for similar reasons that the energy and water sectors were omitted from the targeted comparator set used by Ofgem in the growth accounting assessment of historic productivity growth for RIIO-T2/GD2 and RIIO-T1/GD1.

Second, we consider that informing the OE challenge for RIIO-ED2 based on historic productivity growth achieved in the electricity sector may introduce distortionary incentives for the network companies in ED2. For example, the network companies' incentive to outperform their cost targets may be reduced.

Third, the evidence on historic productivity growth in the electricity distribution sector is highly variable and appears dependent on the assumptions and variables used. For example, the NERA finds that TFP growth in the electricity distribution sector between 2010/11 and 2019/20 ranges between -0.1% to 0.4% per annum while the University of Cambridge Energy Policy Research Group estimate that TFP growth over RIIO-ED1 ranges between -0.5% to 3.8% per annum. Given the range of reported results, if Ofgem intends to make further use of these studies then it will need to give further consideration as to how it will triangulate between the possible estimates of productivity growth and broadly equate this to the total efficiency challenge being set for ED2.

Overall, we do not see strong evidence for directly setting the forward-looking OE challenge based on the evidence of historical productivity growth in the electricity distribution sector that has been presented to date.

4.3. Setting the final OE challenge

Table 4.1 shows the TFP average growth rates for the core EU KLEMS analysis that has been carried out on the 2019 EU KLEMS database. Table 4.2 summarises the relevant factors for interpreting the EU KLEMS analysis.

Table 4.1: Average historic VA TFP growth based on the 2019 EU KLEMS database (to 1 d.p.)

Average TFP growth (%)	Full time series (1995-2016)		Business cycles (WEO data)	
	VA	GO	VA	GO
Unweighted average of narrow comparator set	0.8%[100]	0.4%	0.3 to 0.4%	0.2%
Unweighted average of expanded comparator set	1.2%	0.6%	0.9 to 1.0%	0.5 to 0.6%
Market economy (all industries excluding L, O, P, Q, T, and U)	0.8%	0.4%	0.7 to 0.8%	0.3 to 0.4%

Source: CEPA analysis of EU KLEMS

[99] For example, Ofgem have set a consistent regulatory precedent in RIIO-T2/GD2 and RIIO-T1/GD2 to exclude the energy and water sector from the targeted comparator set within the growth accounting assessment of historic productivity growth.

[100] The higher growth rate found for this industry sample across the full time period is driven by a high productivity growth rate in the 'Financial and Insurance Activities (K)' sector between 1997 and 1998. This time period is not included in any of the business cycle periods based on WEO data.

Table 4.2: Summary of relevant factors for interpreting the core EU KLEMS results

Factor	Implications for interpretation of core results
Recent UK regulatory precedent	Recent precedent of around 1.0%, generally focused on EU KLEMS analysis
Company proposals for OE	Stated range of 0.5% to 1.0%
Embodied technical change	Suggest the GO-based EU KLEMS values may underestimate the scope for productivity values in RIIO-ED2
RIIO-ED2 context	Supportive of more consideration of more dynamic, higher-productivity sectors in the expanded comparator set
Economy-wide productivity estimates	No definitive evidence to support additional qualitative adjustments from the core EU KLEMS values to reflect forward-looking productivity outlook
Impact of the time period limitations of the 2019 EU KLEMS dataset	Supportive of view that the importance of the post-GFC period in the 2019 EU KLEMS dataset may produce values below what could be a sustainable long-term trend
Historical productivity improvements by DNOs	No definitive evidence from analysis of recent historical productivity improvements by DNOs to support detailed calibration of the OE challenge

We suggest that Ofgem should consider three potential reference points for the OE challenge[101]:

- **0.5%,** which would be consistent with the OE challenge proposed by the least ambitious companies. This would represent a pessimistic outlook for the frontier efficiency achievements possible in RIIO-ED2; consistent with a view in which the wider slowdown in productivity since the global financial crisis acts as a brake on productivity improvements in the electricity distribution sector between 2023 and 2028. The pessimism of this view is represented by the fact that it is below the average OE challenge of 0.7% proposed by the companies.
- **1.0%,** which would be consistent with the OE challenge proposed by the most ambitious companies. This would represent a relatively stable outlook for the frontier efficiency achievements possible in RIIO-ED2. It is in line with recent regulatory decisions for the OE challenge in other regulated sectors, which have supported the view that EU KLEMS analysis does not fully capture the scope for efficiency improvements in regulated networks on top of what will be delivered through comparative benchmarking. In addition, in RIIO-ED1, Ofgem set company-specific OE challenges of between 0.8% and 1.1% per annum by adopting the challenge which was proposed by each of the slow-track companies.
- **1.2%,** which would represent a more stretching outlook for the frontier efficiency achievements possible in RIIO-ED2. This would suggest that the EU KLEMS values resulting from the 2019 dataset significantly underestimate the frontier efficiency improvements that can be achieved in ED-2, as a result of factors such as embodied technical change. This would also be consistent with a belief that in RIIO-ED2, the network companies will be able to achieve efficiencies closer to more dynamic competitive sectors, and that in the main such efficiencies will not be captured in the comparative benchmarking process that sets the 'catch-up' efficiency challenge.

[101] For the avoidance of doubt, none of these reference points should be seen as being equivalent to directly taking any single value from the set of core EU KLEMS analysis. Each of the reference points is based on a review of the set of core EU KLEMS values and the wider evidence base providing context for the interpretation of the core EU KLEMS values.

5. REAL PRICE EFFECTS

5.1. Overview of approach for ED2

Ofgem sets price control allowances which are linked to a general inflation measure (CPIH) and certain price indices that reflect the external pressures on companies' costs. Ofgem refers to the difference between CPIH and those price indices as Real Price Effects (RPEs). In its RIIO-ED2 Sector Methodology Decision, Ofgem confirmed its intention to use indexation to account for RPEs in place of the fixed ex-ante allowances set for RPEs in RIIO-1.[102]

Ofgem includes a notional RPE expenditure allowance to account for the forecast difference between changes in CPIH and changes in those price indices as part of each DNO's RIIO-ED2 Final Determination. The indexation mechanism means that the DNOs' expenditure allowances are later adjusted via within-period true-ups as part of Ofgem's Annual Iteration Process (AIP). A final true-up will occur at the end of RIIO-2 as part of the close-out process. This ensures that DNOs can recover costs related to actual changes in input prices that are beyond their control and, therefore, reduces the possibility of windfall gains / losses due to forecast error at the time of the price control review.

In this section, we set out the steps required to select the appropriate price indices on which the indexation mechanism will operate. We then propose a set of forecasts for RPEs for each index for use in setting forecast allowances at the start of the RIIO-2 period.

5.1.1. Approaches used in network companies' business plans

In producing this report, we have considered the submissions made by the network companies, the Energy Networks Association (ENA) and their advisors alongside the submission of company business plans in December 2021. All six network companies submitted supporting analysis in the form of two reports prepared by NERA on behalf of the ENA.[103] However, the network companies differ in the extent to which they adopted NERA's recommendations in their business plans across the following recommendations:

- **Selection of the indices** that should be used to calculated RPEs.[104]
- **Methodology used to forecast RPEs** for the purpose of setting the opening allowance for RIIO-ED2.[105]
- Adjustment to the RPEs forecast for what NERA characterises as the difference between a benchmark price index's growth rate over the past 10 years and the growth rate of DNOs' corresponding unit costs over the same period ('**mean adjustment**').[106]
- Application of a **constant RPE for general labour costs** where general labour cost allowances would be indexed to CPIH in addition to a fixed RPE set *ex-ante* based on the 20-year historical average growth in two benchmark price indices, followed by a true-up at the end of the RIIO-2 period based on outturn average long-term growth in the two benchmark indices.[107]

Table 5.1 summarises our understanding of the extent to which each network company's business plan applied the NERA recommendations listed above. We took care to ensure that we considered each company's RPE proposals

[102] Ofgem (2020) *RIIO-ED2 Sector Methodology Decision: Annex 2 Keeping bills low for customers.*

[103] NERA (8 June 2021) "Price Effects for the RIIO-ED2 Price Control Review" and NERA (29 November 2021) "Price Effects for the RIIO-ED2 Price Control Review – Addendum"

[104] NERA (29 November 2021) "Price Effects for the RIIO-ED2 Price Control Review – Addendum", p.6

[105] NERA (29 November 2021) "Price Effects for the RIIO-ED2 Price Control Review – Addendum", p.7-11

[106] NERA (29 November 2021) "Price Effects for the RIIO-ED2 Price Control Review – Addendum", p.12-13

[107] NERA (8 June 2021) "Price Effects for the RIIO-ED2 Price Control Review", p.41. The proposed benchmark price indices are: ONS AWE Private Sector (K54V) and ASHE Median Hourly Earnings for All Employees.

on their own merit. But where there was insufficient clarity provided in either the network company business plan submissions or via subsequent SQ correspondence, we assumed that the network companies adopted NERA's proposals (i.e. unless otherwise stated).

Table 5.1: Overview of network companies' approaches to RPEs in their business plans

	Index selection	Forecast methodology	Mean adjustment	Constant RPEs for general labour
ENWL[A]	Adopts NERA's recommendations	Adopts NERA's recommendations	Does not adopt NERA's recommendations in their BPDT	Adopts NERA's recommendations
SPEN[B]	Adopts NERA's recommendations	Adopts NERA's recommendations	Adopts NERA's recommendations	Adopts NERA's recommendations
SSEN[C]	Adopts NERA's recommendations	Adopts NERA's recommendations	Does not adopt NERA's recommendations in the BPDT, but refers to it in Business Plan	Adopts NERA's recommendations
WPD[D]	Adopts NERA's recommendations	Adopts NERA's recommendations	Does not adopt NERA's recommendations in the BPDT, but supports it in Business Plan	Adopts NERA's recommendations
NPg[E]	Adopts NERA's recommendations	Adopts NERA's recommendations	Adopts NERA's recommendations	Does not adopt NERA's recommendation but instead uses average of NERA's recommended indices
UKPN[F]	Adopts NERA's recommendations	Adopts NERA's recommendations	Does not adopt NERA's recommendation	Adopts NERA's recommendations

Source: CEPA review of DNO business plans and BPDTs. [A] ENWL (Dec 2021) Our plan to lead the North West to Net Zero: 2023-2028, Annex 20: Costing and benchmarking our plan. [B] SP Energy Networks (2021) RIIO-ED2 Business Plan, Annex 5D.4: Real Price Effects. [C] SSEN (2021) RIIO-ED2 Business Plan, Annex 15.1: Cost Efficiency Paper. [D] WPD (2021) RIIO-ED2 WPD Supplementary Annex 6 – Expenditure. [E] Northern Powergrid (2021) Our business plan for 2023-28, Annex 6.4: Real Price Effects and Ongoing Efficiency. [F] UKPN (2021 RIIO-ED2 Business Plan 2023-2028.

NERA's June 2021 report for the ENA also included a critique of the RPE indexation approach in general, stating a preference for setting *ex ante* RPE allowances as was the case in RIIO-ED1. In our view, NERA's critique does not introduce new material arguments that would not have been considered by Ofgem as part of the SSMC and SSMD process that led to its intention to use RPE indexation approach for RIIO-ED2. As such, we do not discuss those critiques further.

The rest of this section is structured as follows:

- First, we assess which cost categories are expected to represent a material share of DNOs' costs for RIIO-ED2.
- Second, we summarise our assessment of possible benchmark price indices that could be used to calculate RPEs for the material cost categories.

- Third, we present our current set of forecast RPEs that Ofgem could use for its RIIO-ED2 Draft Determinations.

Throughout the sub-sections that follow, we comment on the network companies' proposals where they are materially different from our own.

5.2. Materiality tests

Ofgem stated in the RIIO-ED2 SSMD that it would set a high materiality threshold and a high evidence bar for RPEs. The reason for the high materiality threshold is twofold:

- to reduce the complexity of the price control; and
- to reduce the resources needed to design and update the RPE indexation mechanism.

Therefore, Ofgem will apply RPE indexation to cost areas where there is strong evidence suggesting that the DNO's input prices will track materially above or below general economy-wide inflation based on the Consumer Prices Index including owner occupiers' housing costs (CPIH) over RIIO-ED2.[108]

Ofgem also stated that it will use materiality thresholds to determine which cost areas are material, but that the burden is on the network companies to demonstrate where RPEs are expected to be material. Consequently, the companies are required to provide robust evidence where and why they believe that CPIH is not a suitable proxy for input price inflation.

5.2.1. DNOs' approaches to materiality

All six network companies appear to have adopted NERA's recommendations with regard to materiality. NERA recommends applying RPEs to the DNOs' entire cost base (with the exception of 'other' costs, which it recommends are indexed to CPIH), specifically broken down into:

- General labour
- Specialised labour
- Materials used for capex, split into:
  - Poles
  - Cables
  - Transformers
  - Other
- Materials used for opex
- Plant and equipment
- Transport

NERA does not apply a materiality test to input cost categories in its analysis of RPEs. Instead, its approach is to presume that each category should be indexed and to then test whether the indices it has identified as being potentially relevant show a "sustained and material deviation" from CPIH.[109] The result of NERA's approach – reflected in the network companies' submissions – is that RPEs are calculated for each input cost category, despite the fact that some categories account for less than 2% of DNO costs (as shown in Figure 5.1).

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[108] Ofgem (2020) *RIIO-ED2 Sector Methodology Decision: Annex 2 Keeping bills low for customers,* p.29-32

[109] NERA (8 June 2021) "Price Effects for the RIIO-ED2 Price Control Review", p11.

5.2.2. CEPA's approach to materiality

By applying RPE indexation to each cost category (and four sub-categories of capex materials), NERA's approach is inconsistent with the aims Ofgem set out in SSMD for a high materiality threshold. NERA's approach would result in a more complex indexation mechanism that would substantially increase the resource required when compared to the indexation approaches Ofgem adopted for RIIO-GD2 and T2.

In contrast, following Ofgem's SSMD, we incorporated a materiality test into our approach to setting the RPE indexation approach. This is intended to help balance the reduction of the possibility of substantial windfall gains/losses with the objective of minimising the complexity of the indexation mechanism.

To be considered 'material', each input cost category must pass at least one of two materiality tests – these are the same tests as those we applied in our earlier advice to Ofgem ahead of RIIO-GD2/T2.[110]

- **Test 1: identifying cost categories that represent a relatively large share of totex (10% or more).** If the share of totex represented by the cost category is above the threshold of 10%, we assume that even small input price variations could result in a material change in DNO expenditure. If the cost category does not meet the totex share threshold, we then apply a second test.
- **Test 2: identifying cost categories that fall between 5% and 10% of totex where large input price variations could materially impact DNO expenditure**. We compared the simple average outturn values over the last ten years of the price indices used in RIIO-ED1 against the evolution of the CPIH. This gave an indication of the level of RPEs that would have occurred over that period if an indexation mechanism had been in place for this cost category. We then calculated the impact on totex of the estimated price volatility for this cost area. We use a threshold of 0.5% of totex over RIIO-2, which is consistent with what was used in RIIO-GD2/T2.

To conduct the materiality tests, we use the input cost structure provided in the *OERPE1 - RPEs and OE* tab in the final version of the Business Plan Data Templates (BPDTs), (re)submitted by the DNOs in March 2022. Information is provided in the following input cost categories:[111]

- General labour
- Specialised labour
- Materials
- Plant & equipment
- Transport
- Other

We conduct the materiality tests on a notional company cost structure by calculating the average cost structure across all network companies. This ensures that we avoid rewarding or penalising particular network companies for their individual cost structure or for inconsistent approaches between network companies with respect to cost allocation in the BPDTs.[112] We conducted the analysis based on total forecast expenditure across the RIIO-ED2 period, as this would reduce any possible impact of the investment cycle on spending in any particular category.

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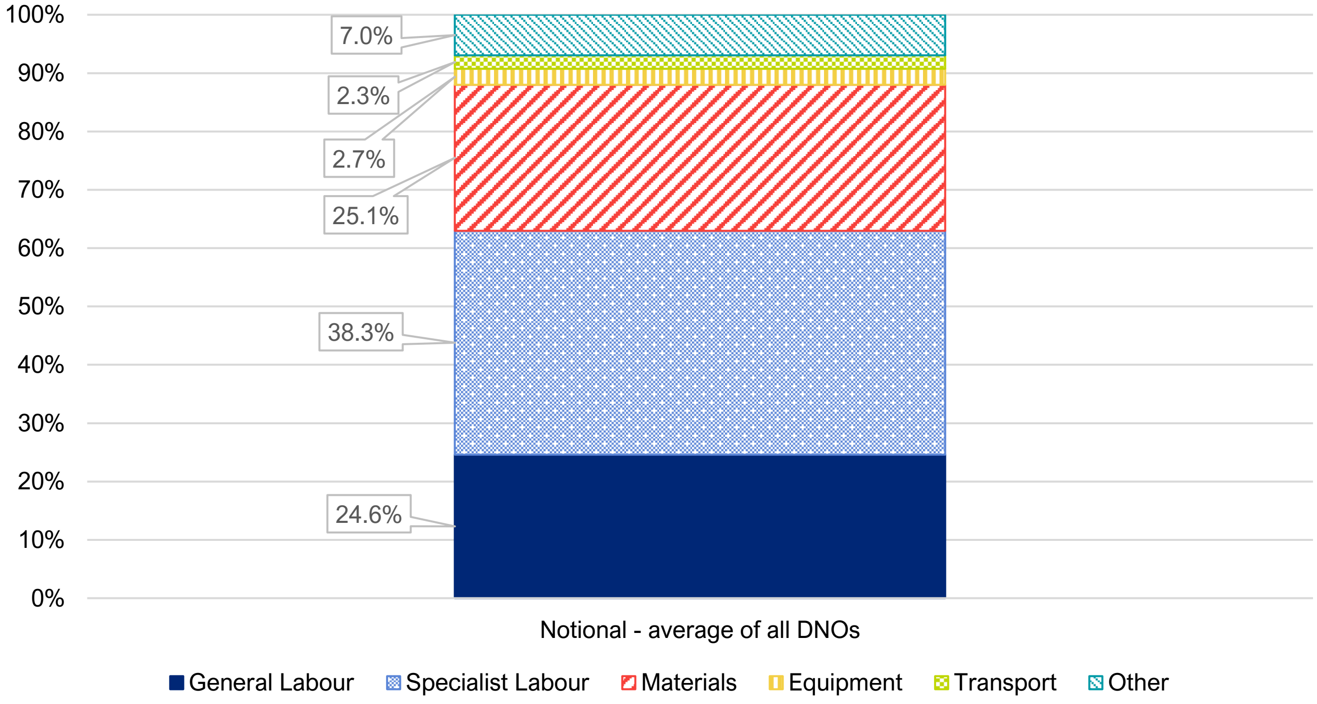
[110] CEPA (November 2020) "RIIO-GD2 and T2: Cost Assessment – Advice on Frontier Shift policy for Final Determinations", p37

[111] The only change from the cost categorisation used for RPE allowances in RIIO-ED1 is in the definition of the two labour cost categories – from Direct Labour and Contract Labour to General Labour and Specialised Labour.

[112] We did not review the robustness of the categorisation of costs by each company as that was not in scope of our work.

Figure 5.1 summarises the notional structure used in our RPE analysis compared to the individual cost structures for each of the 6 network companies. It shows that despite variation in input cost structures between the companies, all companies attribute at least 80% of input costs to labour and materials.

Figure 5.1: Notional and company-specific cost structures [REDACTED]



Source: CEPA analysis of March 2022 BPDTs

Alternative text: *Stacked bar chart of the average company cost structure by input cost as a % of total expenditure, indicating that around 88% of all DNO expenditure is on labour and materials costs.*

For the purposes of conducting the materiality tests, establishing an RPE indexation mechanism and associated RPE forecasts, we decided to combine general labour and specialist labour into a single labour category. We considered that this was likely to be a more robust approach because Figure 5.1 shows that there is significant variation across the industry with respect to the split between general labour and specialist labour costs. This variation suggests that the network companies may have applied inconsistent approaches to cost allocation. For example, ENWL's cost structure includes 46% general labour and 28% specialist labour, while WPD has 15% general labour and 51% specialist labour. When considering a combined labour category, we see greater convergence, with the share of labour being in the in the range between 60% to 74% of all input costs for all DNO groups, except SSE.[113]

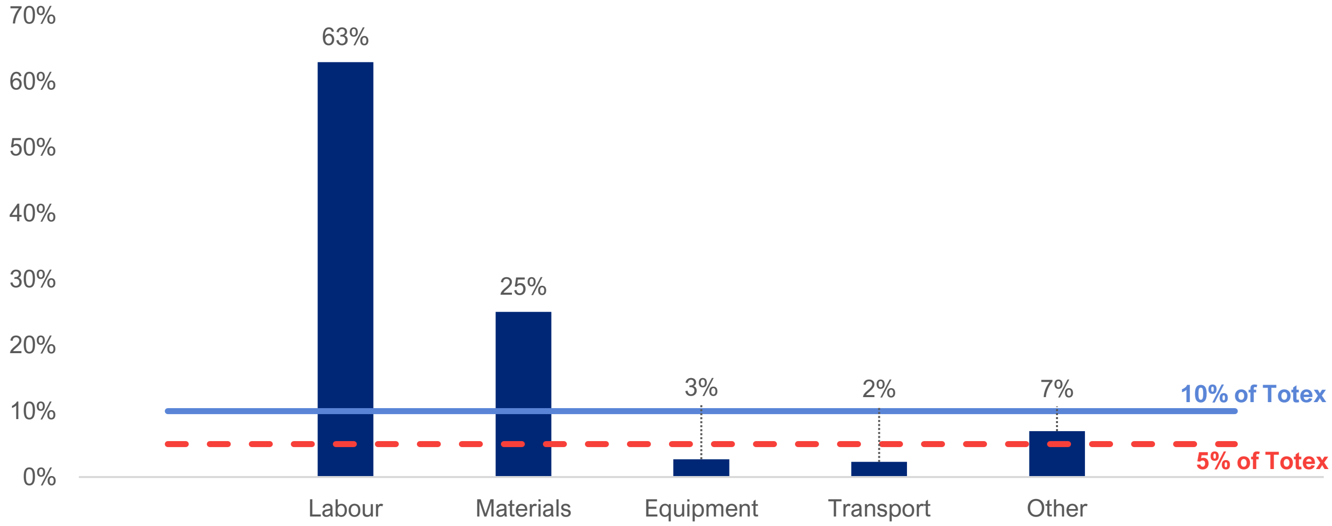
Figure 5.2 shows the results of the materiality tests as applied to the notional company cost structure. Only two cost categories passed the first materiality test by exceeding the 10% threshold: combined (general and specialist) labour expenditure; and materials expenditure.

One cost category fell between the 10% and 5% thresholds: this was the 'Other' category which represented 7% of DNO totex over RIIO-ED2. Although 7% as a share of totex is not insignificant, no price indices were used to forecast 'other costs' in ED1; therefore, we could not determine whether the impact on totex of input price volatility in the 'other cost' category would exceed the threshold of 0.5% of totex over RIIO-2. In line with the approach taken

[113] SSE appears to be an outlier, with a combined labour cost share of 47%. In contract, materials make up 37% of SSE's cost – compared to a range of 15% to 27% for all other DNOs. Before the Final Determination, Ofgem may want to clarify with SSE what may be driving this difference.

in RIIO-1 and GD2/T2, we assume that CPIH is an appropriate proxy for external input price pressures in this category and recommend that Ofgem does not set an RPE.[114]

Figure 5.2: Materiality test thresholds applied to notional DNO cost structure



Source: CEPA analysis of March 2022 BPDT submissions

Alternative text: *Bar chart of the average company cost structure by input cost as a % of total expenditure applied to the materiality test thresholds, indicating that labour and materials costs pass both of the materiality tests, and that 'other' costs pass the threshold of 5% of totex.*

Neither the Plant & Equipment (2.7% of DNO expenditure over the ED2 period) nor the Transport & Storage (2.3%) cost categories passed either materiality test. Therefore, neither are taken forward for RPE indexation. These input cost categories – alongside the 'other costs' category - are indexed to changes in general inflation (i.e. CPIH). Our analysis of company cost structure finds that these non-indexed costs represent no more than 17% of all costs for any individual network company.

5.3. Process for selecting indices for the indexation mechanism

In this section we set out the process for selecting the benchmark price indices suitable for tracking input costs within the cost categories that pass the materiality tests: i.e. labour (general and specialist combined) and materials.

We started with a long-list of indices, drawing from the indices used in RIIO-ED1, network company submissions (based on NERA's assessment) and our own review of publicly available series from the ONS and BCIS. We then applied the two-stage approach outlined in Figure 5.3, identical to that which was set out in CEPA's Frontier Shift paper published alongside the RIIO-GD2/T2 Final Determinations.[115]

There are two sets of assessment criteria for index selection:

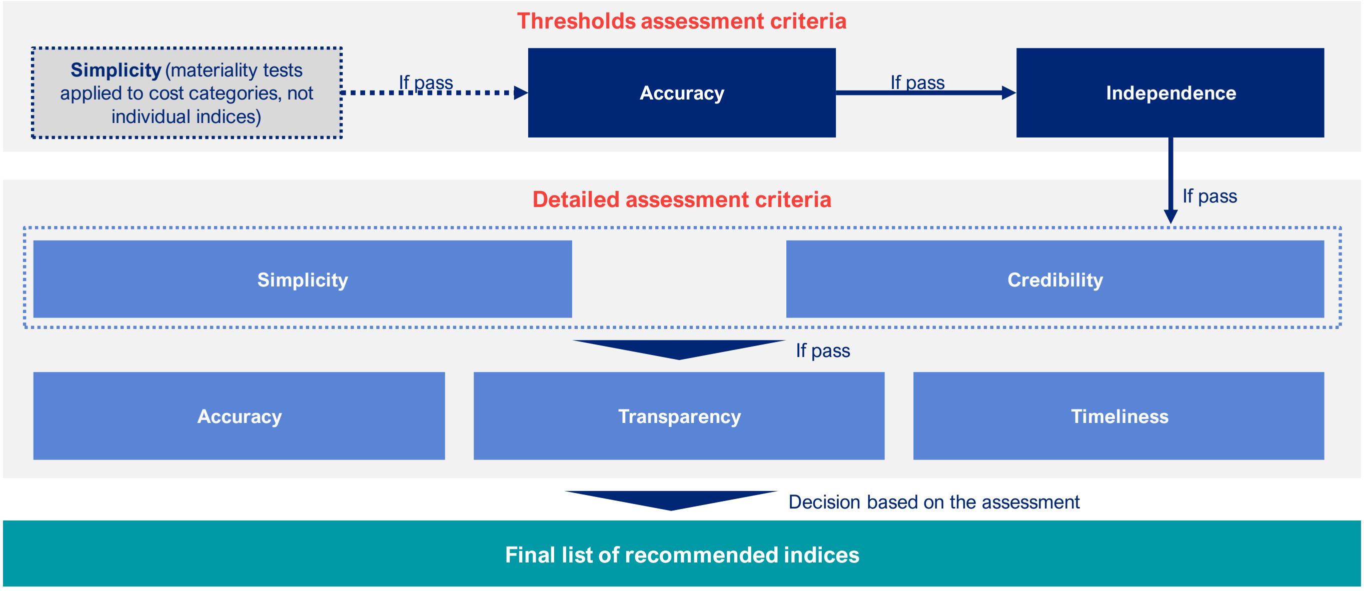
- **Thresholds assessment criteria**, covering accuracy and independence of the indices;[116] and
- **Detailed assessment criteria**, which covers simplicity, credibility, accuracy, transparency and the timeliness of publication and revisions.

[114] NERA reaches a similar conclusion in Section 3.4.6 of its June 2021 report.

[115] CEPA (November 2020) *RIIO-GD2 and T2 Final Determinations – Frontier Shift Annex,* p42.

[116] Materiality is assessed at the cost category level, as set out in section 5.2.

Figure 5.3: Process for selecting indices



Source: CEPA

5.3.1. Company views

In its June 2021 report, NERA sets out criteria for index selection which are different from those aligned above. We generally agree with the criteria used, including relevance to ED costs, data quality, volatility, regulatory precedent and feasibility. These elements are captured within our threshold and detailed assessment criteria.

However, we disagree with NERA's comment that it does not consider independence to be a relevant criteria for assessment. For some price indices, the DNOs may be the largest customers amongst a relatively small market, for example the BEAMA electricity distribution transformers price index. Such indices cannot be truly independent of the DNOs and might be influenced by their purchasing decisions. In other words, inclusion of indices with these characteristics could create issues of endogeneity, where DNOs have material influence on the direction and magnitude of the index's growth rate.

5.3.2. Findings of detailed assessment of indices

In this subsection we summarise the findings of index selection assessment, first for labour and then for materials – broken down against the four sub-categories in NERA's assessment: poles, cables, transformers and 'other' materials. We provide more details of our assessment and rationale in Appendix B.

Labour indices

Our assessment concluded that the following indices were most suitable for Labour RPEs indexation:

- **ONS AWE: Private Sector Index: Seasonally Adjusted Total Pay Excluding Arrears (K54V)**
- **BCIS 4/CE/01 Civil Engineering Labour; and**
- **BEAMA Electrical Engineering Labour**

The ONS index tracks general private sector wage inflation, including bonus pay. We consider that total pay to be appropriate for DNOs as they are private entities that pay their staff bonuses. We also find the seasonally adjusted index to be most appropriate due to the potential volatility that a non-seasonally adjusted series might introduce into the indexation and within-period true-ups.

The BCIS index tracks civil engineering labour costs. We consider this index to be appropriate for capturing trends in the type of specialist activities carried out by DNOs. We considered the inclusion of a construction labour index in place of civil engineering but deemed the activities of DNOs to be more specialised and less likely to be impacted by economic shocks than many construction firms. Additionally, the BCIS civil engineering was both used in ED1 and proposed by DNOs for ED2, whereas construction labour indices were not.

It is appropriate to include an electrical engineering labour index due to the nature of electricity distribution works. . The BEAMA index tracks electrical engineering labour. We considered additional electrical engineering labour indices from BCIS but decided that additional indices covering the same activities was not necessary and found no rationale for deviating from an index with regulatory precedent in ED1.

Table 5.2: Summary of index selection: labour

Provider	Index	Proposed by	Outcome	Main reasons for decision
Labour				
ONS	AWE: Private Sector Index: Seasonally Adjusted Total Pay Excluding Arrears (K54V)	ED1, DNOs	Accepted	Index is relevant to DNO labour costs and includes bonus pay and seasonal adjustments, which are appropriate for network companies and indexation. The index also has regulatory precedent.
BCIS	4/CE/01 Civil Engineering Labour	ED1, DNOs	Accepted	Index is relevant to DNO labour costs and uses the most recent BCIS index methodology. It also has regulatory precedent.
BEAMA	BEAMA Electrical engineering labour	ED1, DNOs	Accepted	Index is relevant to DNO labour costs and has regulatory precedent.
ONS	AWE: Private Sector Index: Seasonally Adjusted Regular Pay Excluding Arrears (K54M)	CEPA	Rejected	Index excludes bonus pay. Bonus pay is relevant for network companies, as they are private entities.
ONS	LNKY AEI Private Sector including bonus	ED1	Rejected	Index discontinued.
ONS	AWE: Private Sector Index: Non Seasonally Adjusted Regular Pay Including Arrears (KA5N)	CEPA	Rejected	Index is non-seasonally adjusted. It is appropriate to seasonally adjust indices to account for the effects of seasonal variation.
ONS	AWE: Private Sector Index: Non Seasonally Adjusted Total Pay Including Arrears (KA5W)	CEPA	Rejected	Index is non-seasonally adjusted. It is appropriate to seasonally adjust indices to account for the effects of seasonal variation.
ONS	AWE: Construction Seasonally Adjusted Total Pay (K553)	CEPA	Rejected	BCIS civil engineering index was both used in ED1 and proposed by DNOs for ED2 whereas this index was not. In addition, we consider the activities of DNOs to be more specialised and less likely to be impacted by economic shocks than most firms in the construction sector.

Provider	Index	Proposed by	Outcome	Main reasons for decision
ONS	ASHE: Median Hourly Earnings for All Employees (Gross Annual)	DNOs	Rejected	One labour index covering general wage inflation is sufficient, and the AWE index has regulatory precedent from ED1.
BCIS	70/ 1 Labour and Supervision in Civil Engineering	CEPA	Rejected	4/CE/01 has updated methodology and regulatory precedent for same cost subcategory
BCIS	90/ 1 Labour and Supervision in Civil Engineering	CEPA	Rejected	4/CE/01 has updated methodology and regulatory precedent for same cost subcategory
BCIS	2/E1 Electrical installations - cost of labour	DNOs	Rejected	Failed relevance and credibility criterion due to outdated series
BCIS	4/CE/EL/01 Electrical Engineering Labour	DNOs	Rejected	Relevant but unnecessary duplication of BEAMA index
BCIS	3/E1 PAFI Electrical - Labour	CEPA	Rejected	Relevant but unnecessary duplication of BEAMA index

Source: CEPA analysis

Materials indices

Our assessment concluded that the following indices were most suitable for Materials RPE indexation:

- **BCIS 3/58 PAFI Pipes and Accessories: Copper**
- **BCIS 3/59 PAFI Pipes and Accessories: Aluminium**
- **BCIS 3/S3 Structural Steelwork - Materials: Civil Engineering Work**
- **BCIS FOCOS Resource Cost Index of Infrastructure: Materials**

Our approach to index selection for materials tries to identify 'accurate' benchmark price indices that reflect the most significant components of materials expenditure based on the information presented in NERA's June 2021 report and its subsequent response to a clarificatory question from Ofgem.[117] In summary, NERA used DNO unit costs representing transformers, wood poles, cables and other residual materials costs to select benchmark price indices.[118] However, our selection of indices ultimately depended on identifying indices that passed the selection process set out in Figure 5.3.

In respect of materials used to construct wood poles, the data provided by NERA shows that these inputs make up only [✂]% of materials costs [✂]. Therefore, we concluded that the wood and timber indices in Table 5.3 below are unlikely to support the overall accuracy of an RPE index for materials.

[117] [✂].

[118] [✂].

Table 5.3: Summary of index selection: poles materials

Provider	Index	Proposed by	Outcome	Main reason for decision
Materials				
Poles				
ONS	ONS Wood; Sawn and Planed for Domestic Market (MM22)	DNOs	Rejected	Failed accuracy criterion because NERA's SQ response suggests that wood poles account for a relatively small percentage of DNO materials costs ([✂]).
ONS	ONS Wood, Sawn and Planed (JU89)	DNOs	Rejected	Failed credibility and accuracy criteria due to being discontinued.
BCIS	4/CE/21 BCIS PAFI Timber	CEPA	Rejected	Failed accuracy criterion due to coverage of raw materials.
BCIS	70/10 BCIS PAFI Timber	CEPA	Rejected	Failed accuracy criterion due to coverage of raw materials.

Source: CEPA analysis

In respect of cables, we noted that the data provided by NERA suggests that wires and cables are likely to be around [✂]% of network company materials costs. Therefore, we concluded that an accurate RPE would reflect indices that act as a reasonable benchmark for the price of electricity distribution cables. We include price indices for copper and aluminium pipes as electricity distribution cables consist of copper and aluminium wires. The components of our selected cables indices are mostly made up of the relevant resources but also consist of approximately 35% labour components. Where possible, it is most appropriate to avoid conflating labour and materials indices, but we have not been able to identify alternative indices that only contain materials components that are as relevant to electricity distribution cable materials as these two indices for pipes and accessories.

Table 5.4: Summary of index selection: cables materials

Provider	Index	Proposed by	Outcome	Main reason for decision
Materials				
Cables				
BCIS	3/58 Pipes and Accessories: Copper	ED1, DNOs	Accepted	Components mostly relevant to electricity distribution cable materials costs.
BCIS	3/59 BCIS PAFI Pipes and Accessories: Aluminium	ED1, DNOs	Accepted	Components mostly relevant to electricity distribution cable materials costs.
BCIS	4/CE/25 BCIS aluminium products	DNOs	Rejected	Already contained within 3/59, which is more targeted to cable components.
BCIS	2/33 Copper Tubes, Fittings And Cylinders	CEPA	Rejected	Failed credibility criterion, due to outdated series.
BCIS	4/CE/EL/03 Electrical Cables	CEPA	Rejected	Rejected due to suitable alternatives. Cost relevancy unclear, as may refer to retail electrical cables.

Source: CEPA analysis

In respect of transformers, we noted that the data provided by NERA suggests that transformers and switchgear are likely to be around [✂]% - [✂]% of network company materials costs. We therefore concluded that an accurate RPE would reflect benchmark price indices that act as a reasonable proxy for transformers. The BCIS 3/S3 Structural Steelwork – Materials: Civil Engineering Work index contains components that are relevant to transformer materials costs, including: steel sections, plate and flats, and structural hollow sections. We opted for the Series 3 index over the Series 4 alternative (4/CE/ST/02 Structural Steelwork Materials index) as the latter had a different component weighting, which we deemed not to be appropriate for transformers materials costs.[119]

Table 5.5: Summary of index selection: transformers materials

Provider	Index	Proposed by	Outcome	Main reason for decision
Materials				
Transformers				
BCIS	3/S3 Structural Steelwork - Materials: Civil Engineering Work	ED1, DNOs	Accepted	Components relevant to transformer materials costs and has regulatory precedent.
BCIS	4/CE/EL/02 Electrical Engineering Materials	CEPA	Rejected	Failed accuracy criterion, due to non-relevant index components.
BCIS	2/27 Steelwork	CEPA	Rejected	Failed credibility criterion, due to outdated series.
BCIS	2/S2 Steelwork - Cost Of Materials	CEPA	Rejected	Failed credibility criterion, due to outdated series.
BCIS	4/CE/ST/02 Structural Steelwork Materials	CEPA	Rejected	Cost relevant but 3/S3 component weighting is more appropriate for transformers.
BCIS	3/E2 BCIS Electrical – materials	DNOs	Rejected	Failed accuracy criterion, due to non-relevant index components.
BCIS	3/56 BCIS PAFI Pipes and Accessories: Steel	CEPA	Rejected	Failed accuracy criterion, due to non-relevant index components.
BCIS	2/33 Copper Tubes, Fittings And Cylinders	DNOs	Rejected	Failed credibility criterion, due to outdated series.
BCIS	4/CE/23 BCIS PAFI Steel Pipes	CEPA	Rejected	Failed accuracy criterion, due to non-relevant index components.
BCIS	2/E2 Electrical Installations - Cost Of Materials	CEPA	Rejected	Failed credibility criterion, due to outdated series.
BCIS	4/CE/26 Metal Structures	CEPA	Rejected	Failed accuracy criterion, due to non-relevant index components.

Source: CEPA analysis

In our view, it is also appropriate to include an index for other materials costs that are not captured by the indices selected to reflect cables and transformers, based on the expectation that these costs might evolve at a materially different rate to the CPIH. The FOCOS Resource Cost Index of Infrastructure: Materials is a well-established index of infrastructure materials, which was used in ED-1, and is made up of a range of materials resources. We deem this index to be suitable for covering other materials costs.[120]

[119] NERA had similarly selected the Series 3 index for transformers.

[120] NERA had similarly selected this index for ‘other’ capex materials and for opex materials.

Table 5.6: Summary of index selection: other materials

Provider	Index	Proposed by	Outcome	Main reason for decision
Materials				
Other				
BCIS	FOCOS Resource Cost Index of Infrastructure: Materials	ED1, DNOs	Accepted	Well-established index of infrastructure materials so is suitable for covering Other materials costs.
BCIS	FOCOS Resource Cost Index of Infrastructure: Labour and Plant	CEPA	Rejected	Failed accuracy criterion, due to labour and plant components.

Source: CEPA analysis

5.3.3. Recommended indices

The table below summarises our recommended indices for RPE indexation with respect to the cost categories that passed the materiality tests.

Table 5.7: Recommended indices for RPEs indexation

Cost category and indices
Labour
AWE: Private Sector Index: Seasonally Adjusted Total Pay Excluding Arrears (K54V)
4/CE/01 Civil Engineering Labour
BEAMA Electrical engineering labour
Materials
3/58 Pipes and Accessories: Copper
3/59 BCIS PAFI Pipes and Accessories: Aluminium
3/S3 Structural Steelwork - Materials: Civil Engineering Work
FOCOS Resource Cost Index of Infrastructure: Materials

Source: CEPA analysis

5.4. Forecasts for input prices subject to RPEs

In this subsection we consider NERA's proposed approach to forecasting RPEs (submitted by the network companies in support of their business plans); describe our approach to setting the RPE forecast for each expenditure category subject to RPE indexation; and explain how we set the overall totex-level RPE forecast that will be applied in the Draft Determinations.

5.4.1. NERA / Network company proposals

NERA proposes that RPEs should be forecast using the average historical RPE of each proposed price index. This differs from Ofgem's approach in RIIO-GD2/T2 which (for most indices where there was no independent price index forecast) was to calculate the difference between historical average annual price index growth and forecast annual growth in the CPIH. NERA argues that at the time of the network company final business plan submissions, CPIH was forecast to be higher than average over recent decades, and so it also expects other indices to grow faster than historical averages. Therefore, it argues that setting RPEs using forecast CPIH and historical average change in the individual price indices is likely to result in an RPE forecast that is too low and will systematically under-forecast DNO allowances.

NERA recognises that "*the level forecast does not determine the amount that consumers ultimately pay, but merely facilitates the planning of expenditure under the price control*" but argues that "*the benefits of avoiding a systematic downward bias are likely to outweigh the potential benefits of being able to forecast annual variations in RPEs*".[121]

NERA then calculates a long-run average RPE for each index as follows:

$$RPE_i = \frac{1}{N_T}\sum_{t \in T}\left(\frac{1 + IPI_{it}}{1 + CPIH_t} - 1\right)$$

$$IPI_{it} = \text{annual percentage growth in index } i \text{ for year } t$$

$$CPIH_t = \text{annual percentage growth in CPIH for year } t$$

$$RPE_i = \text{long run average RPE for the benchmark index } i$$

$$N_t = \text{number of years in set } T$$

The long run average RPE for each benchmark index is calculated over the period 2000 to 2021. Each RPE is then aggregated within each cost category to determine a constant RPE growth forecast for that cost category.

With regard to general labour, however, NERA proposes that indexation is not applied. It suggests that Ofgem's true-up at the end of ED2 should not be for the movements in the labour indices during ED2, but rather for the 20-year average of the labour indices (excluding years deemed distortionary, such as 2010, 2011 and 2021).

NERA proposed uplift for "mean adjustment"

NERA also proposes that an 'uplift' adjustment should be made for the *historical* difference between the selected benchmark price indices and the unit costs that DNOs faced for the corresponding cost category, without which it is argued that RPEs would systematically undercompensate the DNOs for the evolution of their costs.[122] NERA suggests that this adjustment is required because the indices selected may not be directly comparable to the costs they are used to index: e.g. "In the case of "BCIS electrical – materials (3/E2)", for example, it would reflect that the growth rate of transformer prices is persistently above the growth rate of electrical materials more broadly".[123]

For each benchmark price index, NERA calculates a mean adjustment reflecting the difference between the average growth in an index and the average growth of the associated DNO unit cost. Each mean adjustment is calculated as follows:

$$Aic = \frac{1 + DNOc}{1 + TYAi} - 1$$

$$DNO\text{c} = \text{10yr average annual percentage change in the DNO unit cost c}$$

$$TYAi = \text{10yr average annual percentage change in benchmark index } i$$

$$Aic = \text{resulting adjustment for price index } i \text{ and unit cost } c$$

NERA then applies the mean adjustment to each index via the Fisher formula:

$$RPE\ A_{ict} = (1 + RPE_{it})\ \times (1 + A_{ic}) - 1$$

$$RPE\ A_{ict} = \text{mean adjusted RPE of index } i \text{ at year } t, \text{for cost category } c$$

$$RPE_{it} = \text{unadjusted RPE index } i \text{ at year } t$$

[121] NERA (29 November 2021) "Price Effects for the RIIO-ED2 Price Control Review – Addendum", p7.

[122] NERA (8 June 2021) "Price Effects for the RIIO-ED2 Price Control Review", p. 14

[123] NERA (8 June 2021) "Price Effects for the RIIO-ED2 Price Control Review", p. 46

If Ofgem were to implement NERA's proposals, then it would need to calculate its own ex-ante mean adjustments.[124]

We have several concerns with the proposed means adjustment mechanism:

- One of the principles of RPEs is that they should reflect changes in input prices which are independent of and therefore beyond the control of the network companies. By linking RPE allowances to DNO unit costs, NERA's proposals are inconsistent with that principle.
- The mean adjustments approach is inconsistent with Ofgem's aim for introducing RPE indexation – namely that Ofgem sought to reduce the forecasting risk involved in setting RPEs. NERA's approach introduces a new source of ex ante forecasting risk since the growth rate of DNO unit costs and their corresponding index may evolve differently during ED2 to its past evolution.
- NERA only had unit cost data from [✂] of the six network companies and provided insufficient information to give us confidence that that unit costs had been compiled and calculated consistently across companies. Therefore, we cannot conclude that NERA's estimated mean adjustments are not biased.
- NERA did not provide any evidence to demonstrate that the DNO costs to which it had access were efficient.
- We identified inconsistencies in NERA's proposed application of the mean adjustment. Some cost categories – opex materials, transport, plant and equipment – are not subject to a means adjustment as NERA says it did not have unit costs for these categories. This raises the question of how representative the proposed mean adjustments are for network companies' entire cost base.[125]

Based on the NERA report, four network companies[126] raised a concern that the RPE indexation approach would systematically undercompensate them; and proposed significant changes to the indexation approach that (they argue) would make it more reflective of their actual long run unit cost growth. However, we note that neither ENWL nor UKPN adopted the mean adjusted 'uplift' approach to RPEs.

Different approach to general labour RPEs

NERA argues that there is a negative correlation in the year-on-year movements between its proposed general labour benchmark price indices and DNO unit costs but that the proposed general labour indices are more reflective of long-run DNO unit cost growth than CPIH alone. It suggests that the negative correlation is due to the essential nature of electricity distribution activities, such that the economy-wide general labour indices are more prone to fluctuations than DNO labour costs. Their statistical tests indicate that the indices better track DNO costs than CPIH as the long-run mean of indices is closer to DNO unit labour cost growth than CPIH.

Therefore, NERA proposes to index general labour to CPIH and set a forecast RPE, where the forecast RPE is set based on the long-term average RPEs of ONS AWE Private Sector and ASHE Median Hourly Earnings for All Employees.[127] NERA proposes to add a true-up at the end of RIIO-2 based on outturn growth in the benchmark indices for general labour to mitigate concerns about forecasting risk associated with ex-ante RPE allowances. This

[124] We note that NERA did not provide complete information on DNO unit costs that would enable Ofgem to calculate any such adjustment to all the indices that it selects for the RPE indexation mechanism. NERA's response to clarificatory questions from Ofgem suggests to us that [✂].

[125] [✂].

[126] NPg and SPEN adopt the 'mean adjustment' uplifts. SSEN and WPD highlight concern in their business plan submissions but do not adopt the uplifts in their BPDTs.

[127] In its analysis, NERA defines the long-term as financial years from 2000-2020, excluding 2010 and 2011 because of the financial crisis, and 2021 because of COVID-19.

approach would create a constant RPE forecast but, unlike the other cost categories subject to indexation, the RPE indexation true-up process would be moved to the end of the RIIO-ED2 period.

5.4.2. CEPA response

Where possible, we would continue to use independent forecasts of annual growth rates for prices indices that are consistent with the OBR's latest forecasts set out in its economic and fiscal outlook. This is on the basis that these forecasts account for expected inflationary outcomes at the time of Ofgem's Draft Determinations – as was the approach in RIIO-GD2 and T2.

However, independent forecasts of annual growth rates for the selected price indices are not generally available, with the exception of the OBR's forecast of average earnings growth. So, where independent forecasts of the price index are not available, we have forecast RPEs based on the long term historical average RPE (2000 – 2020) in line with the approach proposed by NERA.[128]

We do not agree with NERA's assertion that the latest OBR forecast (March 2022) for CPI over the ED2 period is materially higher than long-run historical average CPI growth. In fact, our analysis finds that CPI is forecast to grow by ~2% p.a. on average over the ED2 period. But we recognise that an approach based on the historical average RPE may support smaller annual true-ups on average over the ED2 period.[129]

We do not apply a mean adjustment 'uplift' to our selected benchmark price indices for the reasons set out in Section 5.4.1. above. Nor do we propose to treat general labour costs differently from other input categories, because:

- We think it would be more appropriate to consider general labour and specialist labour costs as a combined labour category given the variation in cost structures across the network companies (see Section 5.2.2. above);
- Setting *ex-ante* RPEs would go against Ofgem's position as set out in the ED2 SSMD. The aim of within period true-ups is to protect consumers and companies against the risk of inaccurate forecasting. Reducing the frequency of adjustments increases the likelihood and potential scale of forecasting error.
- In our view, the data underlying NERA's statistical analysis is insufficiently complete to be representative of DNO unit costs.

In summary, we forecast the RPE indices as follows:

- **AWE Private Sector Index: Seasonally Adjusted Total Pay Excluding Arrears:** the difference between the OBR's average earnings growth forecast and its forecast of CPI[130] up to 2026 and 1.0% thereafter based on the long term average RPEs for the AWE private sector index (over a period consistent with the approach to other benchmark price indices).
- **All other benchmark price indices:** long term historical average RPE (2000 – 2020) calculated as the difference between average historical difference between the annual growth in each price index and CPIH. This results in an RPE forecast that is constant across the RIIO-ED2 period.[131]

[128] NERA (November 2021) "Price Effects for the RIIO-ED2 Price Control Review – Addendum", p7.

[129] We excluded data from 2009/10, 2010/11 and 2020/21 from this calculation because we are concerned that years affected by the financial crisis and the COVID-19 could generate an RPE forecast that is less reflective of long-term trends.

[130] In line with other areas of the price control, Ofgem uses a financial year CPI forecast that is calculated by giving 75% weight to the OBR's calendar year CPI forecast for year *t* and 25% weight to the forecast for year *t+1*.

[131] Excluding RPEs from 2009/10, 2010/11 and 2020/21 as above.

Table 5.8: RPE forecasts – Financial Years Ending – 2022 to 2028

Index	2022	2023	2024	2025	2026	2027	2028
CPI[132]	3.8%	6.6%	3.4%	1.6%	1.9%	2.0%	2.0%
Labour							
ONS AWE Private Sector Index	2.1%	-1.8%	-0.6%	1.1%	1.1%	1.0%	1.0%
BCIS Civil Engineering	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
BEAMA Electrical Engineering Labour	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
Materials							
BCIS Pipes & Accessories: Aluminium	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
BCIS Pipes & Accessories: Copper	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
BCIS Structural Steelwork – Materials	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
FOCOS Resource Cost Index	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%

Source: CEPA analysis of OBR, BCIS, BEAMA and FOCOS data

We applied an unweighted average to the RPE forecasts for the indices in each category to produce a composite RPE forecast for each cost category.[133] These category-level RPEs are then weighted by the notional company cost structure (as outlined in Section 5.2) to produce a totex-level RPE forecast. Table 5.9 summarises the RPE forecasts by cost category and at a totex level.

The totex-level RPE forecast is that which will be used in Ofgem's cost modelling.

Table 5.9: RPE forecasts for RIIO-ED2 by cost category and totex

Category	Weighting	2022	2023	2024	2025	2026	2027	2028
Labour	63%	1.3%	0.1%	0.4%	1.0%	1.0%	1.0%	1.0%
Materials	25%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Totex[134]	**-**	**1.3%**	**0.4%**	**0.7%**	**1.0%**	**1.0%**	**1.0%**	**1.0%**

Source: CEPA analysis

132 Ofgem's CPI forecast is not directly reported from the OBR's forecast. Our approach is consistent with Ofgem's overall approach to setting CPI forecasts in the price review – and with the approach used in RIIO-GD2 and T2 – where financial year CPI forecasts are calculated by applying a 75% weight to the OBR's forecast for the first calendar year and a 25% weight to the OBR's forecast to the second calendar year.

133 We consider an unweighted approach to be proportionate to the goals of RPE indexation, because if we developed more granular cost categorisations and weightings these would be prone to concerns about spurious accuracy and may not be reflective of general network company costs.

134 For completeness, the other 12% of the weighting represents costs which are not subject to RPE indexation.

Appendix A APPROACH TO GROWTH ACCOUNTING

The EU KLEMS database provides a series of updates of data on a wide range of historical productivity metrics for industry groups. However, using the data to produce historical productivity estimates to inform the OE challenge requires key methodological choices to be made across the following elements:

- the dataset to be used as different updates vary in terms of revised data, time period covered and definitions of industry groups;
- the time period;
- the productivity metrics; and
- the comparator industries.

A.1. ELEMENTS OF THE APPROACH TO EU KLEMS ANALYSIS

An overview of each element is set out in the following sub-sections below.

A.1.1. EU KLEMS dataset

We considered two separate EU KLEMS datasets, which vary in time period, included metrics and industry classification:

- The 2011 release of the EU KLEMS database uses the NACE 1.1 industry classification, contains data covering the period between 1970 to 2007 and productivity data based on GO and VA output measures.
- The 2019 release of the EU KLEMS database uses the NACE 2 industry classification, covers 1997 to 2016 and productivity data based on VA output measures. This dataset covers the GFC and the period of lower productivity growth that has been subsequently recorded in the UK.

We consider that the core analysis should account for the most recently available evidence on UK productivity growth.[135] As such, we base the core analysis on the evidence from the 2019 EU KLEMS dataset only.

A.1.2. Time period

Productivity measures typically move pro-cyclically over the business (economic) cycle. In other words, productivity growth tends to accelerate during periods of economic expansion and decelerate during periods of economic contraction.[136] Therefore, it is standard practice in growth accounting to consider average productivity growth over complete business cycles. If the sample includes an incomplete business cycle, it may result in an upwardly or downwardly biased estimate.

A challenge with this approach is that it requires an accurate judgement around when the business cycle starts and end. In practice, there is often little consensus on precise dates, in part because different definitions of the business cycle can produce different start and end dates. A business cycle is often defined with reference to trends in GDP growth or the output gap.[137] However, the lack of consensus around the business cycle can introduce a degree of subjectivity around selecting any one defined time period and can lead to accusations of analytical cherry-picking.

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135 We note that an updated EU KLEMS database that includes data on the period between 1995 and 2018 was published by the Luiss University in 2022 (Release 2021). This dataset was subject to data revision at the time of drafting and has not been included in our analysis for this paper. A further EU KLEMS database (Release 2022) was published by the Vienna Institute for Economic Studies in 2022. This dataset does not include data for the UK.

136 OECD (2003) *Measurement of aggregate and industry level productivity growth,* page 119, available on oecd.org.

137 The output gap is defined as the difference between the actual output of an economy and the maximum potential output of an economy. Business cycles defined on the output gap typically refer the period between one point of zero output gap to another point of zero output gap, where that period includes periods where the output gap is both negative and positive.

An alternative approach to considering average productivity growth over a complete business cycle is to consider average productivity growth over a longer period of time. For example, assessing productivity growth over the entire time period available through the EU KLEMS database may reduce the degree of subjectivity involved with selecting a sample time period. While this approach may result in incomplete cycles being included in the analysis, a longer sample period will help reduce the overall impact of any one individual cycle.

A.1.3. Productivity metrics

When undertaking growth accounting analysis, regulators face a choice between two different measures of output:

- **Gross output (GO)** measures aggregate output by one or more companies. The inputs used to make gross output are capital, labour and intermediate inputs (energy, materials, services). In simple terms, GO assumes that intermediate inputs (i.e., materials, contractors, etc) are a factor in production, along with labour and capital.
- **Value added (VA)** is equivalent to gross output minus the value of intermediate inputs required to produce the final output. Value added inputs are therefore labour and capital only. This means that productivity changes resulting from variations in the use of intermediate inputs should not be captured in VA measures.

The following approximation can be used to estimate GO TFP growth from VA TFP growth:[138]

$$\Delta TFP_{GO} = \frac{VA}{GO} \times \Delta TFP_{VA}$$

Because VA measures of output are lower in magnitude than GO measures, by definition (i.e. VA/GO will be less than one), this mathematical relationship between the two measures means that the rate of change in VA productivity will be greater in absolute terms that than the rate of change in GO measures. Recent regulatory precedent has typically considered both measures to inform the OE challenge. This is consistent with Ofgem's approach in RIIO-1 and RIIO-GD2/T2 and with Ofwat's approach in PR19.

There are also different measures of productivity which are available to regulators, such as:

- total factor productivity (covering labour, capital, and intermediate inputs):
- labour productivity; and
- labour and intermediate inputs productivity.

Total factor productivity (TFP) measures how productively the combined factors of production are used to generate output. TFP measures of productivity are typically seen as being more relevant to activities which require significant inputs of both labour and capital, such as network companies' totex.

Partial factor productivity (PFP) measures such as labour productivity can be used to show how productively labour is used to generate output over time. For example, regulators have informed the OE challenge for more labour-intensive costs (such as opex) using labour productivity growth measures. This can be informative for regulators interested in the efficiency of a particular factor of production over time. The growth in labour productivity reflects the joint influence of changes in the other factors of production, technical, organisational and efficiency change, as well as capital substitution.

Summary of productivity metrics included in this report

Using the data available in both EU KLEMS database, we include the following productivity measures in this report:

- **VA TFP growth**: We calculate this measure using the 2011 EU KLEMS database as a residual using Törnqvist indices and Divisia weights based on underlying data on the factors of production and value

[138] OECD (2003) *Measuring Productivity – Measurement of Aggregate and Industry-Level Productivity Growth*, available on oecd.org

added output. This approach however is not appropriate when using the 2019 EU KLEMS database due to limitations with the published data.[139] As such, we calculate VA TFP growth using the 2019 EU KLEMS database based on the year-on-year change in the VATFP_I index which is published in that database.

- **GO TFP growth**: We calculate this measure using the 2011 EU KLEMS database as a residual using Törnqvist indices and Divisia weights based on underlying data on the factors of production (including intermediate inputs) and gross output. The data required for this approach is not available in the 2019 EU KLEMS database. As such, we calculate GO TFP growth by converting VA TFP growth (based on the VATFP_I index) using the fixed conversion outlined in Section A.1.3.

A.1.4. Comparator industries

The EU KLEMS database includes a range of comparator sectors which can be used to inform a growth accounting estimation of historic productivity growth. The range of comparator sectors raises two questions:

- Which (sub-)industries should be included in the sample used to calculate the historical productivity estimates to inform potential efficiency improvements for energy network companies?
- Should sample averages be unweighted (i.e., equal weight to each industry), or weighted (e.g., economic contribution)?

The main approaches to sampling sectors are either (a) to take as a wide a sample as possible to reduce sensitivity to volatility in one particular sector, or (b) to focus on sectors that undertake relatively similar activities in relation to the cost area being examined.

A further consideration when determining which sectors to use is that the different releases of the EU KLEMS database use different industry classifications:

- The 2011 release of the EU KLEMS database uses the NACE 1.1 industry classification system. This database contains information on over 16 different industries. If sub-industries are included, then there are over 35 potential comparators to be considered.
- The EU KLEMS database uses the NACE 2 industry classification system. This database contains information on over 20 different industries. If sub-industries are included, then there are over 40 potential comparators to be considered.

The choice of EU KLEMS dataset will determine which industry classification system must be used.

A.2. Summary results

A.2.1. VA

Table A1 and Table A2 shows the full set of VA TFP average growth rates that we have calculated based on the 2019 and 2011 EU KLEMS database.

[139] As part of CEPA's support for Ofgem on RIIO-GD2 and RIIO-T2, we identified issues with the 2019 EU KLEMS database which means that productivity growth cannot be directly calculated as a residual using the underlying data on capital, labour, and output. The Vienna Institute for International Economic Studies (WIIW) – the academic institute responsible for managing the 2019 EU KLEMS dataset – informed us that they have used a Laspeyres formulation to calculate the published labour and capital services indicates. Neither of these indices enter directly into the calculations used by WIIW to produce their productivity indices. This approach by the WIIW means that it is not possible to calculate the underlying productivity growth rates using the standard growth accounting approach.

Table A.1: Average historic VA TFP growth based on the 2019 EU KLEMS database (to 1 d.p.)

Average VA TFP growth (%)	Full sample	Business cycles based on WEO data				Time periods since GFC		
	1995-2016	1998-2015	1998-2016	1999-2015	1999-2016	2008-2016	2009-2016	2010-2016
Unweighted average of narrow comparator set	0.8%	0.4%	0.3%	0.4%	0.3%	-0.5%	0.4%	0.0%
Unweighted average of expanded comparator set	1.2%	1.0%	1.0%	1.0%	0.9%	0.0%	0.9%	0.5%
Market economy (all industries excluding L, O, P, Q, T, and U)	0.8%	0.8%	0.8%	0.8%	0.7%	-0.2%	0.5%	0.2%

Source: CEPA analysis

Table A2: Average historic VA TFP growth based on the 2011 EU KLEMS database (to 1 d.p.)

Average VA TFP growth (%)	Full sample	Business cycles based on WEO data	
	1970-2007	1990-2007	1991-2007
Unweighted average of narrow comparator set	1.1%	1.7%	1.8%
Unweighted average of expanded comparator set	1.2%	2.1%	2.3%
Weighted average of market Economy (all industries excluding K, L, M, N, and O)	1.0%	1.0%	1.3%

Source: CEPA analysis

A.2.2. GO

Table A3 and Table A4 shows the full set of GO TFP average growth rates that we have calculated based on the 2019 and 2011 EU KLEMS database.

Table A3: Average historic GO TFP growth based on the 2019 EU KLEMS database (to 1 d.p.)

Average GO TFP growth (%)	Full sample	Business cycles				Since GFC		
	1995-2016	1998-2015	1998-2016	1999-2015	1999-2016	2008-2016	2009-2016	2010-2016
Unweighted average of narrow comparator set	0.4%	0.2%	0.2%	0.2%	0.2%	-0.2%	0.2%	0.1%
Unweighted average of expanded comparator set	0.6%	0.5%	0.5%	0.5%	0.5%	0.0%	0.5%	0.3%
Weighted average of market Economy (all industries excluding L, O, P, Q, T, and U)	0.4%	0.4%	0.4%	0.4%	0.3%	-0.1%	0.2%	0.1%

Source: CEPA analysis

Table A4: Average historic GO TFP growth based on the 2011 EU KLEMS database (to 1 d.p.)

Average GO TFP growth (%)	Full sample	Business cycles based on WEO data	
	1970-2007	1990-2007	1991-2007
Unweighted average of narrow comparator set	0.5%	0.8%	0.8%
Unweighted average of expanded comparator set	0.6%	1.1%	1.2%
Weighted average of market Economy (all industries excluding K, L, M, N, and O)	0.4%	0.5%	0.6%

Source: CEPA analysis

A.3. Companies' Submissions on growth accounting

In support of their proposed OE challenges, the network companies submitted reports by their advisors on growth accounting and the use of EU KLEMS data to inform the OE challenge for RIIO-ED2. All of the network companies refer to a report prepared by NERA for the Energy Networks Association (ENA).[140] SSEN also provided a report that it had commissioned from Oxera on the use of growth accounting to inform the OE challenge for RIIO-ED2.[141]

The following sub-sections outlines the key methodological choices proposed in these advisors' reports across each of the elements outlined in Section A.1.

In addition to the quantitative analysis of EU KLEMS, which is outlined below, the report for the ENA also set out a view on the relevance of embodied technical change in interpreting the estimates which can be derived from an analysis of the EU KLEMS dataset. We discuss this in more detail in Section 3.2.

[140] NERA (April 2021) *Ongoing Efficiency Improvement at RIIO-ED2*. Prepared for the Energy Networks Association, available online at ssenfuture.co.uk.

[141] Oxera (November 2021) "Establishing an appropriate efficiency challenge" available online.

A.3.1. NERA report for the Energy Networks Association

In its report for the ENA, NERA estimates a productivity growth range of between 0.3% and 0.8% per annum based on its assessment of the 2011 release of the EU KLEMS database. [142] The range is informed by the following choices:

- **Time period**: A sample covering the time period from 1970 to 2007 is chosen, on the basis that a growth accounting assessment of productivity growth should be based on the longest available period of time, so as to: (a) minimise the effect of short term volatility; (b) avoid the subjectivity of pinpointing business cycles; (c) mitigate problems with measurement error; and (d) reduce the impact of catch-up productivity improvements. Consequently, the ENA's advisors choose to use the EU KLEMS database which was released in 2011, with its relatively longer sample period of 1970 to 2007.
- **Productivity metrics:**
    - **TFP vs. PFP**: NERA propose that TFP measures provide the best reflection of the DNOs' totex cost base. The paper argues that any use of PFP growth estimates to inform the OE challenge will systematically bias the OE challenge up or down unless it is applied symmetrically across all costs.
    - **GO vs. VA:** NERA choose to use GO measures of productivity only. They argue that VA productivity will systematically overestimate productivity growth rates if it is applied to a cost base which includes intermediate inputs (such as totex).[143]
- **Comparator sectors:** The report makes use of a range of different comparator sets based on NERA's review of DPCR5, RIIO-T2/GD2, and a recent decision by the Dutch regulator on the price control for the electricity transmission network in the Netherlands.[144] A broad group of comparator sectors are chosen on the basis that a wide group: (a) mitigates the effect of measurement error; (b) eliminates subjectivity in the choice of sectors; and (c) reduces reliance on individual sector estimates.

The full range of results are shown in Table A5 below.

Table A5: Results from ENA's advisors' growth accounting analysis

Comparator set	Weighting	Average TFP GO growth 1970-2007 (% p.a.)
Whole economy (excluding non-market sectors)	Unweighted	0.4
Whole economy (excluding non-market sectors)	Weighted	0.3
DPCR5	Unweighted	0.8
T2/GD2	Unweighted	0.5
ACM	Weighted	0.5
Mean and median		**0.5**
Range		**0.3 to 0.8**

Source: NERA (2021)

As shown in the table above, NERA calculate a set of average GO TFP growth estimates that vary between 0.3% and 0.8% per annum for the period of 1970-2007. Based on the mean and median of the range of estimates

[142] NERA (April 2021) *Ongoing Efficiency Improvement at RIIO-ED2*. Prepared for the Energy Networks Association, available online at ssenfuture.co.uk.

[143] The ENA's advisors argue that if VA productivity measures are to be used, then they should be applied to primary costs (i.e. excluding intermediate inputs) only. NERA (April 2021) *Ongoing Efficiency Improvement at RIIO-ED2*. Prepared for the Energy Networks Association, p.43. Available online at ssenfuture.co.uk.

[144] In order to replicate the sectors used by Ofgem for RIIO-T2/GD2 and by the ACM, the report says that the closest equivalent NACE 1.1 industries have been used.

produced, the report concludes that the historical productivity improvements in the chosen comparator sectors has been 0.5% per annum.[145] We note that based on the choices outlined in this section, we have been unable to replicate the results presented by NERA in Table A5.

A.3.2. Oxera report for SSEN

Scottish and Southern Electricity Networks (SSEN) commissioned a separate piece of analysis on the use of growth accounting to inform the OE challenge for RIIO-ED2.[146] SSEN's advisors (Oxera) developed a base OE estimate of 0.4% per annum based on a growth accounting assessment of the 2019 release of the EU KLEMS database.

Oxera's analysis is based on the following analytical considerations:

- **Time period**: Oxera calculate the productivity growth rate based on the sample period from 2007 to 2016, using the most recent 2019 release of the EU KLEMS database. Oxera argue that the pro-cyclicality of productivity should be taken into account and that the time period should reflect a full business cycle. Oxera analyse trend-adjusted VA growth and suggest that this period covers a complete business cycle. They also argue that 2007-2016 is more likely to be representative of conditions over ED2, as forecasts suggest that the recent slowdown in UK productivity growth will persist in the medium term.
- **Productivity metrics:**
  - **TFP vs. PFP**: Based on similar points to those raised in the report for the ENA, Oxera choose to place all weight on TFP.
  - **GO vs. VA:** Based on similar concerns to those raised in the report for the ENA, Oxera place all weight on GO measures of productivity. They argue that VA measures will systematically overestimate productivity growth if applied to a cost base which includes intermediate inputs.[147] Oxera argue that if VA productivity measures are to be used, then they should be applied to a more narrowly defined cost base which excludes intermediary inputs.
- **Comparator sectors:** Oxera differ from the report for the ENA by selecting a narrower range of comparator sectors. Oxera argue that economy-wide TFP estimates may be biased by sectors that share not common activities with DNOs. Oxera also differ from the approach which has been used by Ofgem to weighting comparator sectors in the past. Oxer state that a weighted average measure based on DNOs' cost structure is more 'complete'. They use SSEH's cost structure to calculate the weights as they assess SSEH to be a broadly efficient company. They use equal weighting within capex and opex as a simplification. Oxera map comparator sectors to capex and opex costs within the DNO's cost structure. The capex and opex categories are weighted by the share of opex and capex which is assumed within the SSEH cost structure.[148] Each comparator sector is given an equal weighting within the opex and capex categories.[149]

Oxera then use the choices set out above to calculate estimates of average GO TFP growth for 2007-2016 for the selected sectors. These estimates are then averaged to give an overall headline estimate GO TFP growth of 0.4% per annum between 2007 and 2016. The results are shown in Table A6 below.

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[145] NERA calculates a weighted and unweighted GO TFP growth rate of 0.3% and 0.4% per annum between 1970 and 2007. These figures do not match the corresponding figure of 0.5% calculated by Ofgem as part of its decision for RIIO-T1/GD1.

[146] Oxera (2021) *Establishing an appropriate efficiency challenge*, available on ssenfuture.co.uk

[147] SSEN's advisors note that GO measures may be problematic when economy-wide data is used due to measurement errors related to the flow of intermediary products across industries

[148] A weighting of 37% capex and 63% opex is assumed in the analysis.

[149] This differs from the approach which has been followed by Ofgem in previous determinations by weighting comparator sectors by their relative importance in the economy (e.g. weighting each comparator sector by its share of output within the industry sample).

Table A6: Main results from SSEN's advisors' growth accounting analysis

Sector / cost category	Average TFP GO growth, 2007-2016 (%)
Capex (unweighted average)	**0.2%**
Construction	0.2%
Other manufacturing; repair and installation of machinery and equipment	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 (2021).

Oxera also conduct sensitivity analysis to test the robustness of the estimates to their methodological choices. The results of the sensitivity analysis are shown in Table A7: . In addition, Oxera also investigated the sensitivity of the result to VA based productivity estimates. Based on otherwise unchanged assumptions, Oxera calculate a higher average VA TFP growth rate of 0.7% per annum between 2007[150] and 2016. However, Oxera argue that this rate can only be applied to a share of totex which excludes intermediate inputs. After making this adjustment, Oxera develop a productivity growth rate based on VA TFP adjusted for the share of intermediate inputs of between 0.3% and 0.6% per annum between 2007 and 2016.

Table A7: Results from sensitivity analysis conducted by SSEN's advisors

Methdological choice	Main analysis	Sensitivity test	Estimate (% p.a.)
Time period	2007-2016	2006-2016	0.4%
Productivity metrics	GO TFP	VA TFP, adjusted for share of non-intermediates	0.3 - 0.6%
		VA TFP, unadjusted	0.7%
Comparator sectors	See Table A6	Also include repair of motor vehicles and motorcycles	0.4%
		Also include financial and insurance activities	0.3%
Weighting	37% capex, 63% opex	44% capex, 56% opex	0.4%

Source: Oxera (2021)

CEPA assessment of Oxera's growth accounting analysis for SSEN

Having reviewed the analysis developed by Oxera for SSEN, it appears that Oxera has calculated TFP using Törnqvist indices and Divisia weights based on the underlying EU KLEMS data on output, capital, and labour, rather than using the final productivity values published by EU KLEMS. While this approach is in line with OECD

150 We note that Oxera appear to define the start of this period as the growth in productivity from 2006 to 2007.

recommendations for estimating productivity growth,[151] it suffers from several issues due to the construction of the 2019 EU KLEMS dataset.[152]

As a sense-check, we have recreated Oxera's analysis using the TFP growth rates which are published directly in the 2019 EU KLEMS database. As a further sensitivity, we have also recreated Oxera's choice of comparator weightings using the time periods outlined in Section 2.1.2 of this report. Both sensitivities are shown in Table A.7.

Table A8: Sensitivity analysis of Oxera assessment of EU KLEMS for SSEN

Average GO TFP growth (%)	Oxera	CEPA replication	Time periods based on CEPA analysis				
	2007-2016	2006-2016[153]	1995-2016	1998-2015	1998-2016	1999-2015	1999-2016
Capex (unweighted average)	**0.2%**	**0.0%**	**0.4%**	**0.5%**	**0.4%**	**0.4%**	**0.3%**
Construction	0.2%	0.0%	0.2%	0.2%	0.1%	0.1%	0.1%
Other manufacturing; repair & installation of mach & equip't	0.9%	0.8%	0.6%	1.0%	0.9%	0.9%	0.8%
Transportation and storage	-0.6%	-0.6%	0.2%	0.1%	-0.1%	0.0%	-0.2%
Total manufacturing – electrical equipment	0.3%	0.0%	0.5%	0.6%	0.6%	0.6%	0.6%
Opex (unweighted average)	**0.5%**	**0.4%**	**1.1%**	**1.3%**	**1.2%**	**1.1%**	**1.0%**
Transportation and storage	-0.6%	-0.6%	0.2%	0.1%	-0.1%	0.0%	-0.2%
Telecommunications	0.9%	0.8%	0.8%	0.8%	0.7%	0.8%	0.7%
IT and other information services	0.9%	0.8%	3.1%	3.4%	3.1%	2.9%	2.6%
Professional, scientific, technical, admin and support	0.9%	0.8%	0.5%	0.7%	0.9%	0.8%	0.9%
Weighted average (37% capex, 63% opex)	**0.4%**	**0.3%**	**0.9%**	**1.0%**	**0.9%**	**0.8%**	**0.8%**

Source: CEPA analysis of Oxera (2021).

As shown in Table A8, replicating Oxera's choice of comparators using the data on historic TFP growth that is directly available from the EU KLEMS database results in a small decrease in the weighted average productivity

[151] OECD (2003) *Measuring Productivity – Measurement of Aggregate and Industry-Level Productivity Growth*, available on oecd.org

[152] These issues were elaborated on as part of CEPA's advice on ongoing efficiency to Ofgem for RIIO-GD2 and RIIO-T2. The Vienna Institute for International Economic Studies (WIIW) – the academic institute responsible for managing the 2019 EU KLEMS dataset – informed us that they have used a Laspeyres formulation to calculate the published labour and capital services indicates. Neither of these indices enter directly into the calculations used by WIIW to produce their productivity indices. This means that it is not possible to replicate the productivity growth rates published by published by EU KLEMS by applying the EU KLEMS methodology to the published labour and capital indices. The use of the Laspeyres formulation in this way is not set out in any of the published EU KLEMS documentation.

[153] CEPA define the start of this time period as the growth in productivity between 2006 and 2007. Based on our assessment of Oxera's analysis, we consider that this aligns with the Oxera's definition of the time period from 2007 to 2016.

growth rate from 0.4% to 0.3%. But extending Oxera's choice of comparators and weighting to the time periods reviewed in Section 2.1.2 of this report results in a significantly higher estimate of average productivity growth.

Summary

TableA9 provides a high-level comparison of our approach to growth accounting analysis to that of NERA and Oxera in the advisory reports submitted by the electricity distribution networks.

Table A9: Comparison of methodological choices to inform the growth accounting assessment for RIIO-ED2.

Evidence considered	CEPA	ENA's advisors (NERA)	SSEN's advisors (Oxera)
Time period			
Time period	• 1995-2016 • 1998-2015 • 1998-2016 • 1999-2015 • 1999-2016 • *2007-2016 (sensitivity)* • *2008-2016 (sensitivity)* • *2009-2016 (sensitivity)* • *1970-2007 (sensitivity)* • *1990-2007 (sensitivity)* • *1991-2007 (sensitivity)*	1970-2007	2007-2016 *2006-2016 (sensitivity)*
Productivity metrics			
TFP measures	✓	✓	✓
GO measures	✓	✓	✓
VA measures	✓	✗	✓ (sensitivity)
Comparator industries			
All industry sample	✓	✓	✗
Targeted samples of selected industries	✓	✓	✓

Source: CEPA analysis of the DNO's business plans.

An outline of the industries we have used in the expanded comparator set is outlined in Table A10 below. This is compared against the comparator industries proposed by Oxera who also use the 2019 dataset.

Table A10: Comparison of comparator industries used by CEPA and Oxera in the 2019 EU KLEMS database

2019 EU KLEMS Industries	CEPA (targeted)	Oxera (for opex)	Oxera (for capex)
Manufacturing: Electrical equipment (C27)			✓
Other manufacturing, repair and installation of machinery and equipment (C31-C33)			✓
Construction (F)	✓		✓
Wholesale and retail trade, repair of motor vehicles and motorcycles (G)	✓		
Transportation and Storage (H)	✓	✓	✓
Information and communication (J)	✓*		
Telecommunications (J61)		✓	
IT and other Information services (J62-63)		✓	
Financial and insurance activities (K)	✓		
Professional, Scientific, Technical, Administrative and Support Service Activities (M_N)	✓*	✓	

** Sectors included in CEPA's RIIO-ED2 expanded comparator set*

Source: CEPA analysis of Oxera (2021)

The 2011 EU KLEMS dataset contains a different set of sectors based on a NACE 1.1 industry classification system. An outline of industries that we have used in the targeted comparator sets based on the 2011 EU KLEMS dataset is outlined in the table below. This is compared against the comparator industries proposed by NERA who also use the 2011 dataset.

Table A11: Comparison of industries used by CEPA and NERA in the 2019 EU KLEMS database

2011 EU KLEMS Industries	CEPA (targeted)	NERA (for capex)
Manufacture of Electrical and Optical Equipment (C27)		✓
Manufacture of Machinery and Equipment N.E.C. (C28)		✓
Manufacture of Transport Equipment (C29-C30)		✓
Manufacture of Chemicals and Chemical Products (D24)		✓
Electricity, Gas and Water Supply (E)		✓
Construction (F)	✓	✓
Sale, Maintenance & Repair of Motor Vehicles/Motorcycles, Retail Sale of Fuel (G50)	✓	✓
Transport & Storage (I60-I63)	✓	✓
Post and Telecommunications (I64)	✓*	✓
Financial Intermediation (J)	✓	✓
Renting of Machinery and Equipment and other business activities (K71-K74)	✓*	✓

** Sectors included in the RIIO-ED2 alternative expanded comparator set*

Source: CEPA analysis of NERA (2021)

Appendix B DETAILED PROCESS FOR RPE INDEX SELECTION

This annex provides further detail on the index selection process we follow to inform the recommendations presented in Section 5.3.

B.1. SELECTION CRITERIA

We followed the selection process set out in CEPA's June 2019 Frontier Shift methodology report for Ofgem.[154] This consisted of an initial 'threshold assessment' of a long list of indices, followed by a detailed assessment of the short-listed indices.

The threshold criteria are described in the table below.

Table B.1: Threshold assessment criteria for selection of input price indices

Criteria	Rationale for criteria	Substantiation
A. Simplicity		
The index represents a material cost or identifiable portion thereof	Proportion of cost covered by the given index	Share of sector totex and mapping to cost categories (>10%, or >5% and passes the criterion below)
Movements in the index are likely to have a material impact on totex	Estimated impact on totex of movements in the index	As above or evidence from company submissions clearly demonstrating a material impact on totex (>0.5%)
B. Accuracy		
Reflects movements in the respective input cost category (or a distinct portion thereof) for a notional efficiency company in the sector	The index must reflect movements for a notional efficient company	Comparison of drivers of changes in the index and changes in input costs for companies in the sector
C. Independence		
The index has a low or no chance of being manipulated by actions of companies in the sector	Companies in the sector should not be able to manipulate the data series for financial gain	An assessment of the source of information used to create the data to consider the risk that the companies exert material influence over the index

Source: CEPA

The detailed assessment criteria are described in the table below.

BCIS has indicated that Series 2 indices have generally been superseded by new indices, from Series 3 or Series 4. Therefore, where available, we have used indices from Series 3 or Series 4. We have taken this approach to ensure that the indices we recommend for RIIO-2 are the most current set of relevant indices.

[154] CEPA (2019), RIIO-GD2 cost assessment – frontier shift

Table B.2: Detailed assessment criteria for selection of input price indices

Criteria	Rationale for criteria	Substantiation	Grading
1. Simplicity			
1a. Series does not capture ongoing efficiency	Avoidance of the need to adjust ongoing efficiency	Series represents the cost of an input for companies in the sector	True / false
2. Credibility			
2a. Data provider has provided indices for Ofgem/other regulators and/or is an established provider of statistical data	It will be important for the legitimacy of the mechanism and provides confidence that the series will be maintained in line with statistical best practice	Data provided by the organisation has been used or considered by a regulatory authority for the analysis of RPEs in the UK within the last ten years (or comparable recent reliance by a public body in a similar area)	Pass / fail
2b. Series has no known statistical or methodological flaws	Measurement error risk should be minimised	Analysis of index methodology, if available	True / false
2c. Number of years available	Mature indices are less likely to be discontinued or have methodological changes and assist with producing up-front forecasts	Verification of availability	Years
3. Accuracy			
3a. Level of confidence that use of the index will provide a more accurate reflection than the default approach to RPEs	The index must be at least as good as the default approach to RPEs (i.e. CPI/ CPIH indexation)	As above plus comparison with drivers of the value of the default approach to RPEs (e.g. economy-wide factors affecting CPI-based measures), and analysis of forecast deviations from CPI-based measures and relative volatility	Red / amber / green
3b. Large historical movements in the index can be explained	For a good index that is not affected by measurement error, it will be possible to understand the drivers of the magnitude and volatility of movements over time	Targeted analysis of historic values and press search	Red / amber / green
4. Transparency			
4a. Series is publicly available	Allow stakeholders to understand how the series has been calculated. Minimises costs of the process.	Verification of steps required to access data	Free / paid / false
4b. A forecast comparable to the index is available from a credible source	This makes it simpler for stakeholders to understand the potential	Verification of availability	Yes, or available but from alternative credible source / no

Criteria	Rationale for criteria	Substantiation	Grading
	future behaviour of the mechanism		
5. Timeliness			
5a. Time lag for provisional values to be published	A longer lag may lead to delays in adjustments for RPEs	Verification of data provider schedule for releasing updates to forecasts	Months
5b. Time lag for revised values to be provided	As above	As above	Months

Source: CEPA

B.2. Assessment against threshold criteria

The first threshold criterion relates to simplicity. This is informed by the materiality test discussed in section 5.2. It ensures that indexation is applied only to material cost categories. This assessment takes place at the level of cost categories, rather than published indices.

The outcome of that step is to apply indexation only to:

- Labour cost areas for all companies.
- Materials cost areas for all companies.

The other two threshold criteria relate to accuracy and independence. These assessments take place at the level of indices. Below, we go through the assessment of individual indices for each cost category.

Labour costs

We rejected one general labour index during the initial assessment:

- **LNKY AEI private sector including bonus**: This index was discontinued.

All other general labour indices passed the initial assessment and were passed on to the detailed assessment. Our assessment is summarised below.

Table B.3: Initial assessment – general labour

Indices	Simplicity	Accuracy	Independence
AWE: Private Sector Index: Seasonally Adjusted Total Pay Excluding Arrears	Pass	Pass	Pass
LNKY AEI private sector including bonus	Discontinued	Discontinued	Discontinued
AWE: Private Sector Index: Seasonally Adjusted Regular Pay Excluding Arrears	Pass	Pass	Pass
AWE: Private Sector Index: Non Seasonally Adjusted Regular Pay Including Arrears	Pass	Pass	Pass
AWE: Private Sector Index: Non Seasonally Adjusted Total Pay Including Arrears	Pass	Pass	Pass
ASHE: Median Hourly Earnings for All Employees (Gross Annual)	Pass	Pass	Pass

Source: CEPA Analysis

We rejected one specialist labour index during the initial assessment:

- **BCIS 90/ 1 Labour and Supervision**: This index failed the Accuracy criterion. The 70/ 1 Labour and Supervision in Civil Engineering index was deemed more accurate based on relevance.

The remaining specialist labour indices passed the initial assessment and were passed on to the detailed assessment. Our assessment is summarised below:

Table B.4: Initial assessment – specialist labour

Indices	Simplicity	Accuracy	Independence
BCIS 4/CE/01 Civil Engineering Labour	Pass	Pass	Pass
BCIS 70/ 1 Labour and Supervision in Civil Engineering	Pass	Pass	Pass
BCIS 90/ 1 Labour and Supervision	Pass	Fail	Pass
BEAMA Electrical engineering labour	Pass	Pass	Pass
BCIS Electrical installations - cost of labour (2/E1)	Pass	Pass	Pass
BCIS Electrical Engineering Labour (4/CE/EL/01)	Pass	Pass	Pass
BCIS PAFI Electrical - Labour (3/E1)	Pass	Pass	Pass

Source: CEPA Analysis

Materials costs

As discussed in Section 5.3.2, we carried out further analysis of the potential materiality of sub-categories of material costs. As a result of that analysis, we concluded that the inclusion of wood and timber indices to attempt to capture movements in the costs of poles was unlikely to support the overall accuracy of an RPE index for materials.

We rejected five more materials indices during the initial assessment. For each index, we explain below why it did not pass the initial assessment.

- **BCIS 4/CE/EL/03 Electrical Cables**: This index failed the Accuracy criterion because the Electrical Engineering Materials (4/CE/EL/02) index includes electrical cables and it would be unnecessary to include 4/CE/EI/03 as a separate index.
- **BCIS 4/CE/26 Metal Structures**: This index failed the Accuracy criterion. This index tracks steel costs for uses such as bridge constructions and is therefore not relevant to transformers costs.
- **BCIS PAFI Pipes and Accessories: Steel (3/56)**: This index failed the Accuracy criterion. Labour makes up 40% of this index. The index does not accurately reflect materials cost only. Furthermore, the structural steelwork indices are more reflective of DNO costs.
- **BCIS PAFI Steel Pipes (4/CE/23)**: This index failed the accuracy criterion. The structural steelwork indices are more reflective of DNO costs.
- **FOCOS Resource Cost Index of Infrastructure: Labour and Plant**: This index failed the Accuracy criterion. Labour makes up 21% of this index. The index does not accurately reflect materials cost only.

Our assessment of the material indices is summarised below.

Table B.5: Initial assessment - materials

Indices	Simplicity	Accuracy	Independence
BCIS 3/58 Pipes and Accessories: Copper	Pass	Pass	Pass
BCIS PAFI Pipes and Accessories: Aluminium (3/59)	Pass	Pass	Pass
BCIS aluminium products	Pass	Pass	Pass
BCIS 2/33 Copper Tubes, Fittings And Cylinders	Pass	Pass	Pass
BCIS 4/CE/EL/03 Electrical Cables	Pass	Fail	Pass
BCIS 4/CE/EL/02 Electrical Engineering Materials	Pass	Pass	Pass

Indices	Simplicity	Accuracy	Independence
BCIS 3/S3 Structural Steelwork - Materials: Civil Engineering Work	Pass	Pass	Pass
BCIS 2/27 Steelwork	Pass	Pass	Pass
BCIS 2/S2 Steelwork - Cost Of Materials	Pass	Pass	Pass
BCIS 4/CE/ST/02 Structural Steelwork Materials	Pass	Pass	Pass
BCIS Electrical - materials (3/E2)	Pass	Pass	Pass
BCIS PAFI Pipes and Accessories: Steel (3/56)	Pass	Fail	Pass
BCIS PAFI Steel Pipes (4/CE/23)	Pass	Fail	Pass
BCIS 2/E2 Electrical Installations - Cost Of Materials	Pass	Pass	Pass
BCIS 4/CE/26 Metal Structures	Pass	Fail	Pass
FOCOS Resource Cost Index of Infrastructure: Materials FOCOS	Pass	Pass	Pass
FOCOS Resource Cost Index of Infrastructure: Labour and Plant	Pass	Fail	Pass

Source: CEPA Analysis

B.3. Assessment against detailed criteria

The indices that passed the initial assessment were subsequently assessed against the detailed criteria, as summarised below.

Table B.6: Detailed assessment of shortlisted criteria

Assessment criteria	Description of criteria	Assessment
Simplicity	(a) Series does not capture ongoing efficiency	Y/N
Credibility	(a) Data provider has provided indices for Ofgem / other regulators and / or is an established provider of statistical data	Y/N
	(b) Series has no known statistical or methodological flaws	RAG
	(c) Number of years available	# of years
Accuracy*	(a) Level of confidence that use of the index will provide a more accurate reflection than the default approach to RPEs (CPIH or other existing index in use)	RAG
	(b) Large historical movements in the index can be explained	RAG
Transparency*	(a) Series is publicly available	Y/Y (fee)/N
	(b) A forecast comparable to the index is available from a credible source	Y/N
Timeliness*	(a) Time lag for provisional values to be published	Weeks
	(b) Time lag for revised values to be provided	Weeks

** An index that does not pass the simplicity or credibility criteria is rejected and not assessed further.*

Labour

We identified shortcomings with four of the general labour indices in the detailed assessment.

- **AWE: Private Sector index: Seasonally Adjusted Regular Pay Excluding Arrears**: Total pay is more accurate than regular pay, as regular pay does not include bonuses.
- **AWE: Private Sector Index: Non Seasonally Adjusted Pay Regular Excluding Arrears**: Total pay is more accurate than regular pay, as regular pay does not include bonuses. Furthermore, seasonally adjusted pay is more accurate than non-seasonally adjusted pay, as the former accounts for seasonal variation, while the latter does not.
- **AWE: Private Sector Index: Non Seasonally Adjusted Total Pay Including Arrears**: Seasonally adjusted pay is more accurate than non-seasonally adjusted pay, as the former accounts for seasonal variation, while the latter does not.
- **ASHE: Median Hourly Earnings for All Employees (Gross Annual)**: ASHE includes both private and public sector. Public sector pay restraints do not apply to the DNOs.

Our assessment is summarised in Table B.7.

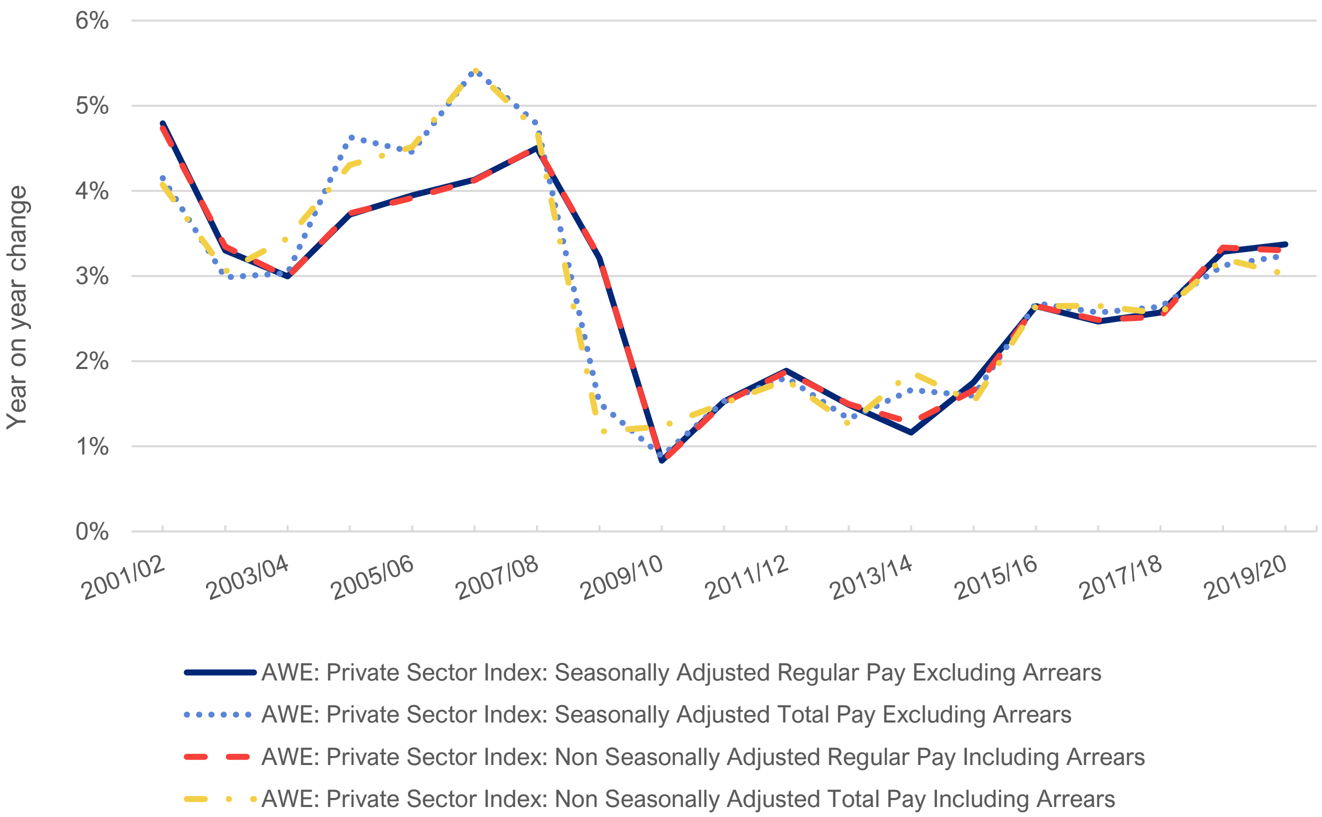
Table B.7: Detailed assessment – general labour

Index	Simplicity	Credibility			Accuracy		Transparency		Timeliness	
		(a)	(b)	(c)	(a)	(b)	(a)	(b)	(a)	(b)
AWE: Private Sector Index: Seasonally Adjusted Regular Pay Excluding Arrears	Y	Y	G	20	A	G	Free	No	6-7 weeks	10-11 weeks
AWE: Private Sector Index: Seasonally Adjusted Total Pay Excluding Arrears	Y	Y	G	20	G	G	Free	No	6-7 weeks	10-11 weeks
AWE: Private Sector Index: Non Seasonally Adjusted Regular Pay Including Arrears	Y	Y	G	20	A	G	Free	No	6-7 weeks	10-11 weeks
AWE: Private Sector Index: Non Seasonally Adjusted Total Pay Including Arrears	Y	Y	G	20	A	G	Free	No	6-7 weeks	10-11 weeks
ASHE: Median Hourly Earnings for All Employees (Gross Annual)	Y	Y	G	20	A	G	Free	No	1 Year	1 Year

Source: CEPA analysis

The four AWE indices have very similar historical movements, as shown in Figure B.1 below. Including more than one AWE index would introduce duplication and reduce the simplicity of the RPE indexation mechanism. Our preference is to rely on AWE: Private Sector Index: Seasonally Adjusted Total Pay Excluding Arrears (K54V), which scored best in the assessment shown in Table B.7. This reflects company cost pressures most accurately, as it accounts for the effects of seasonal variation, and, being Total Pay, it includes bonus pay. Furthermore, this index has regulatory precedent, being used both in ED1 and GD2/T2. Therefore, out of the four AWE indices, only AWE: Private Sector Index: Seasonally Adjusted Total Pay Excluding Arrears (K54V) passes this stage of the assessment.

Figure B.1: Trend analysis of AWE indices



Source: CEPA analysis of ONS data

Alternative text: *Line chart of the year-on-year change in four AWE private sector pay indices between 2001/02 and 2019/20, indicating that the four indices have very similar historical movements.*

We deem one general labour index as sufficient. Including more than one general labour index would introduce duplication and reduce the simplicity of the RPE indexation mechanism. AWE has regulatory precedent, while ASHE does not. Furthermore, AWE is a private sector index, while ASHE includes both private and public sector. AWE does not reflect public sector pay restraints which don't apply to the DNOs, while ASHE does. Therefore, we prefer AWE to ASHE; and so AWE therefore becomes the only general labour index.

We identified shortcomings with one specialist labour index. In this case, the concerns were so great, that the index is rejected outright:

- **BCIS Electrical installations – cost of labour (2/E1)**: Series 2 indices have generally been superseded by new indices, from Series 3 or Series 4. Therefore, we rejected this index.

Table B.8: Detailed assessment – specialist labour

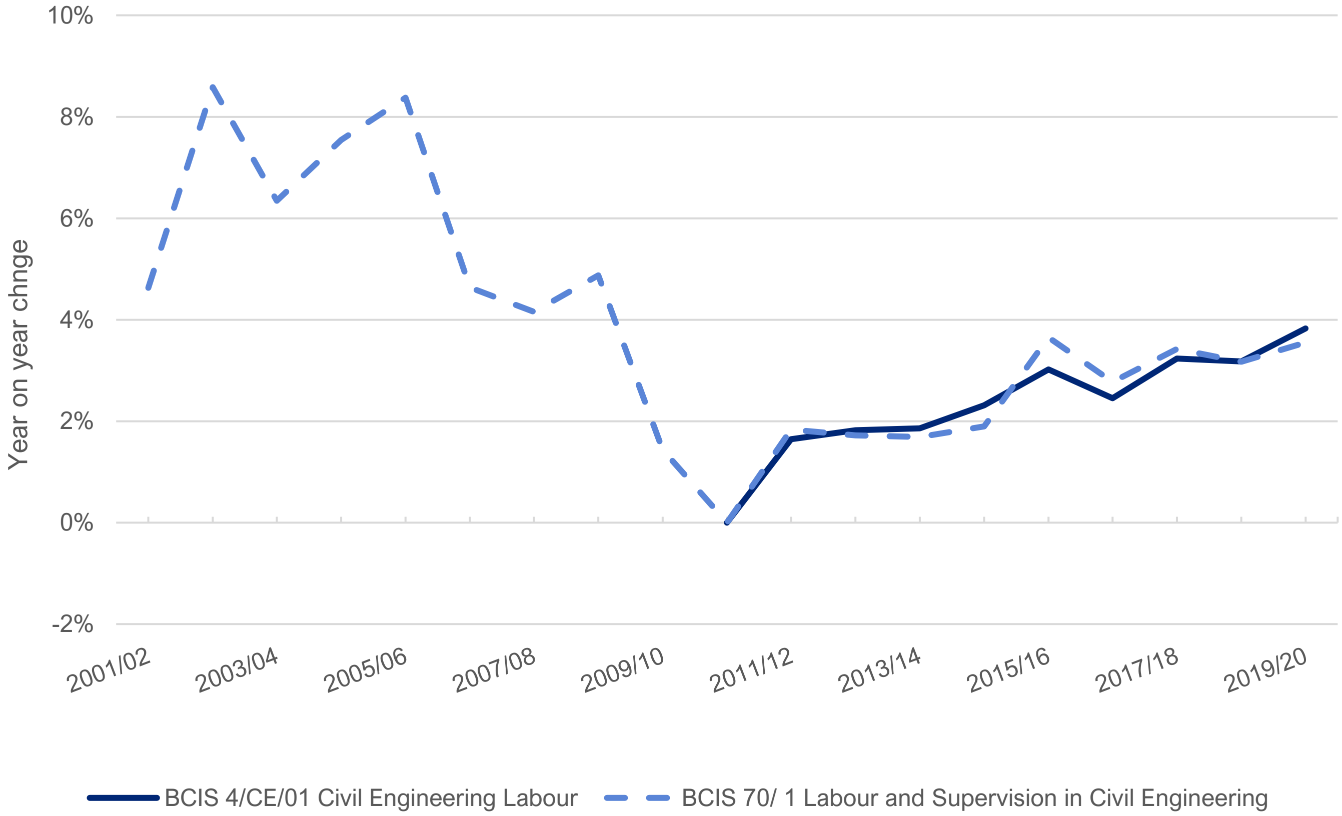
Index	Simplicity	Credibility			Accuracy		Transparency		Timeliness	
		(a)	(b)	(c)	(a)	(b)	(a)	(b)	(a)	(b)
BCIS 4/CE/01 Civil Engineering Labour	Y	Y	G	11	G	G	Paid	No	1 month	3 months
BCIS 70/ 1 Labour and Supervision in Civil Engineering	Y	Y	G	21	G	G	Paid	No	1 month	3 months
BEAMA Electrical engineering labour	Y	Y	G	21	G	G	Paid	Yes	1 month	Not available
BCIS Electrical installations - cost of labour (2/E1)	Y	Y	R	21	G	G	Paid	No	1 month	3 months

Index	Simplicity	Credibility			Accuracy		Transparency		Timeliness	
		(a)	(b)	(c)	(a)	(b)	(a)	(b)	(a)	(b)
BCIS Electrical Engineering Labour (4/CE/EL/01)	Y	Y	G	11	G	G	Paid	No	1 month	3 months
BCIS PAFI Electrical - Labour (3/E1)	Y	Y	G	21	G	G	Paid	No	1 month	3 months

Source: CEPA analysis

The two civil engineering labour indices, BCIS 4/CE/01 and BCIS 70/1, have very similar historical movements, as shown in Figure B.2. Therefore, we deem one civil engineering labour index as sufficient. Including more than one civil engineering labour index would introduce duplication and reduce the simplicity of the RPE indexation mechanism. BCIS 4/CE/01 has regulatory precedent, as it was used in ED1 and GD2/T2, while BCIS 70/1 does not. Therefore, we prefer BCIS 4/CE/01 to 70/1.

Figure B.2: Trend analysis of civil engineering indices

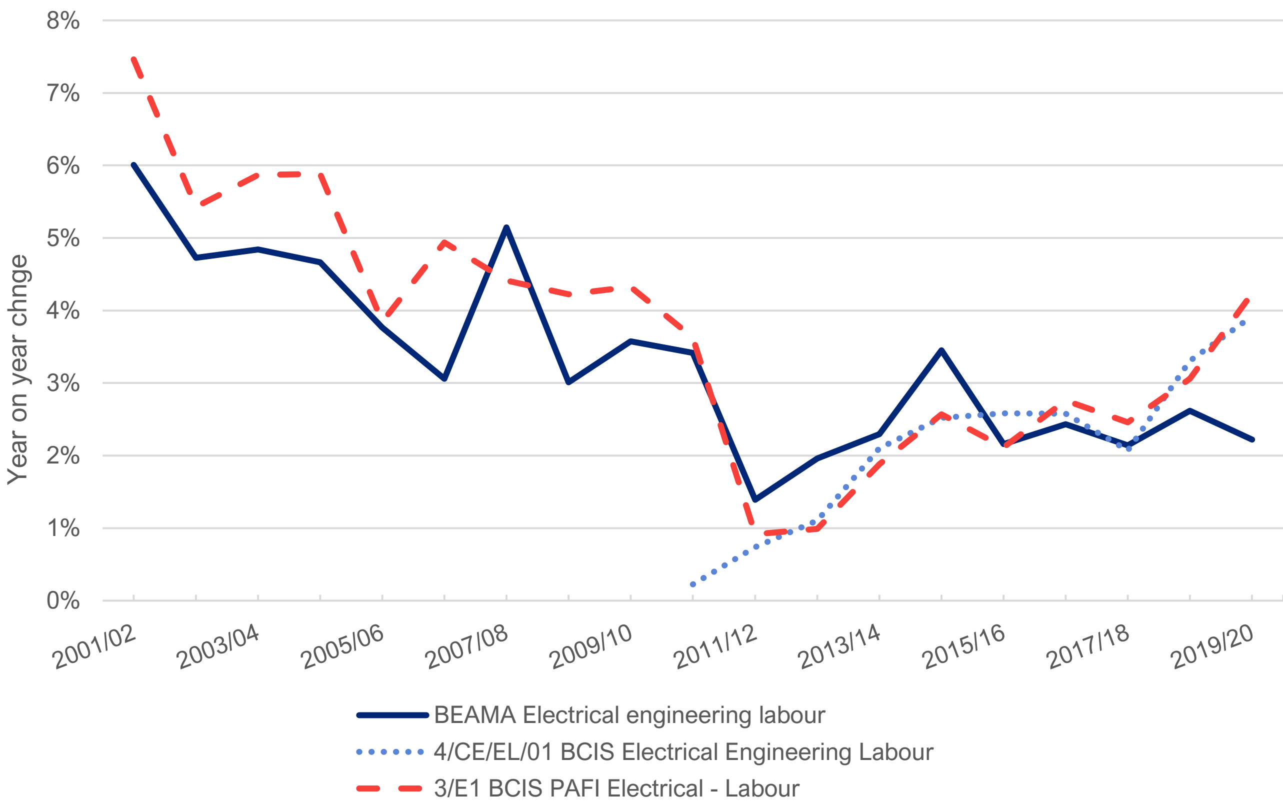


Source: CEPA analysis of BCIS data

Alternative text: *Line chart of the year-on-year change in two civil engineering pay indices between 2001/02 and 2019/20, indicating that the two indices have very similar historical movements since 2010/11.*

The three electrical engineering labour indices, BEAMA, BCIS 4/CE/EL/01 and BCIS 3/E1, have very similar historical movements, as shown in Figure B.3. We deem one electrical engineering labour index as sufficient. Including more than one electrical engineering labour index would introduce duplication and reduce the simplicity of the RPE indexation mechanism. BEAMA Electrical engineering labour has regulatory precedent, as it was used in ED1 and GD2/T2, while BCIS 4/CE/EL/01 and 3/E1 do not have regulatory precedent. Therefore, we prefer BEAMA Electrical engineering labour.

Figure B.3: Trend analysis of electrical engineering indices



Source: CEPA Analysis of BEAMA and BCIS data

Alternative text: *Line chart of the year-on-year change in three electrical engineering pay indices between 2001/02 and 2019/20, indicating that the three indices have very similar historical movements since 2010/11.*

Materials – cables

We identified shortcomings with two cables indices in the detailed assessment:

- **BCIS 2/33 Copper Tubes, Fittings and Cylinders**: Series 2 indices have generally been superseded by new indices, from Series 3 or Series 4. Therefore, we rejected this index.
- **BCIS 4/CE/25 Aluminium Products**: 3/59 is less volatile than 4/CE/25. 3/59 has a standard deviation of 4.1% over the last 10 years, while 4/CE/25 has a standard deviation of 6.8%.

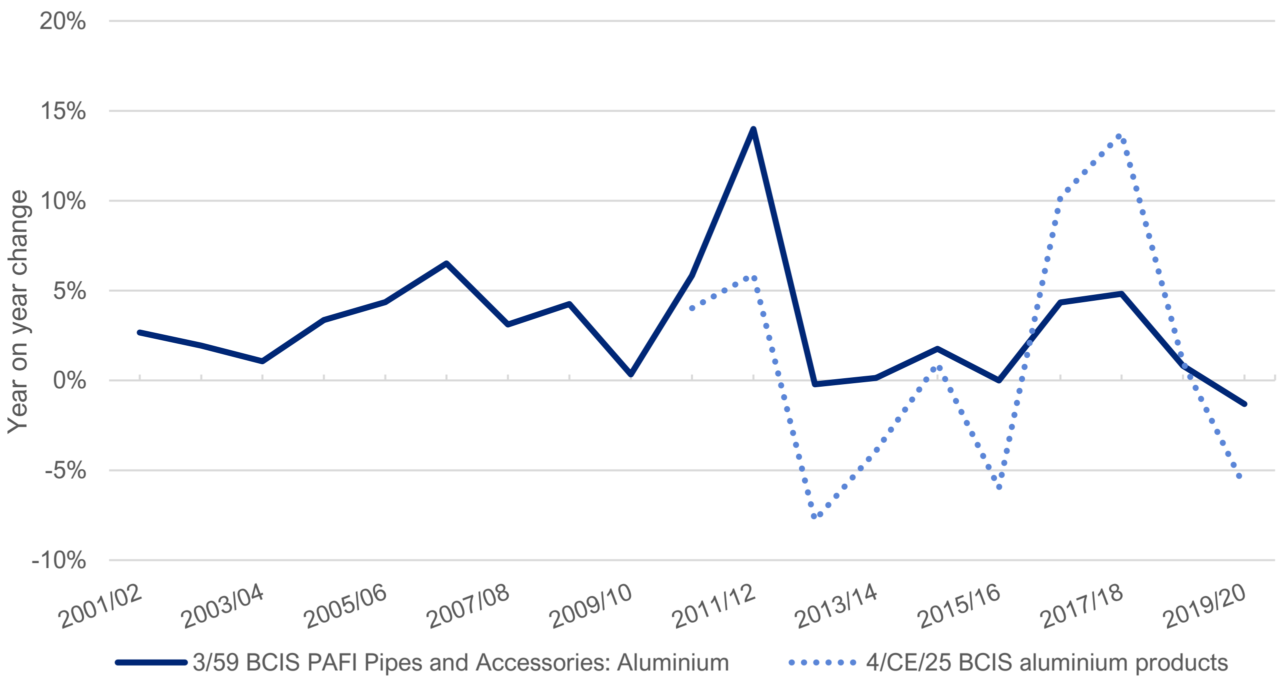
Table B.9: Detailed assessment - Cables

Index	Simplicity	Credibility			Accuracy		Transparency		Timeliness	
		(a)	(b)	(c)	(a)	(b)	(a)	(b)	(a)	(b)
3/58 Pipes and Accessories: Copper	Y	Y	G	21	G	G	Paid	No	1 month	3 months
2/33 Copper Tubes, Fittings And Cylinders	Y	Y	R	21	A	G	Paid	No	1 month	3 months
BCIS aluminium products (4/CE/25)	Y	Y	G	11	A	G	Paid	No	1 month	3 months
BCIS PAFI Pipes and Accessories: Aluminium (3/59)	Y	Y	G	21	G	G	Paid	No	1 month	3 months
BCIS 4/CE/EL/03 Electrical Cables		Y	R	21	A	G	Paid	No	1 month	3 months

Source: CEPA analysis

Including more than one aluminium index would introduce duplication and reduce the simplicity of the RPE indexation mechanism. Our preference is to rely on 3/59 BCIS PAFI Pipes and Accessories: Aluminium, which scored best in the assessment shown in Table B.9. This index is less volatile, as shown in Figure B.4 below. Therefore, we accept only 3/59 BCIS PAFI Pipes and Accessories: Aluminium out of the two aluminium indices.

Figure B.4: Trend analysis of aluminium indices



Source: CEPA analysis of BCIS data

Alternative text: *Line chart of the year-on-year change in two aluminium materials indices between 2001/02 and 2019/20, indicating that since 2010/11 the BCIS 3/59 PAFI Pipes and Accessories: Aluminium index is less volatile than the BCIS 4/CE/25 aluminium products index.*

Materials – transformers

Concerns were highlighted with four transformers indices in the detailed assessment.

- **BCIS 2/33 Copper Tubes, Fittings and Cylinders**: Series 2 indices have been superseded by Series 3 and Series 4 indices.
- **BCIS 2/27 Steelwork**: Series 2 indices have been superseded by Series 3 and Series 4 indices.
- **BCIS 2/S2 Steelwork – Cost of Materials**: Series 2 indices have been superseded by Series 3 and Series 4 indices.
- **BCIS 2/E2 Electrical Installations – Cost of Materials**: Series 2 indices have been superseded by Series 3 and Series 4 indices.

Table B.10: Detailed assessment - Transformers

Index	Simplicity	Credibility			Accuracy		Transparency		Timeliness	
		(a)	(b)	(c)	(a)	(b)	(a)	(b)	(a)	(b)
BCIS 2/33 Copper Tubes, Fittings And Cylinders	Y	Y	R	21	G	G	Paid	No	1 month	3 months
BCIS 3/58 Pipes and Accessories: Copper	Y	Y	G	21	G	G	Paid	No	1 month	3 months
BCIS 2/27 Steelwork	Y	Y	R	21	G	G	Paid	No	1 month	3 months

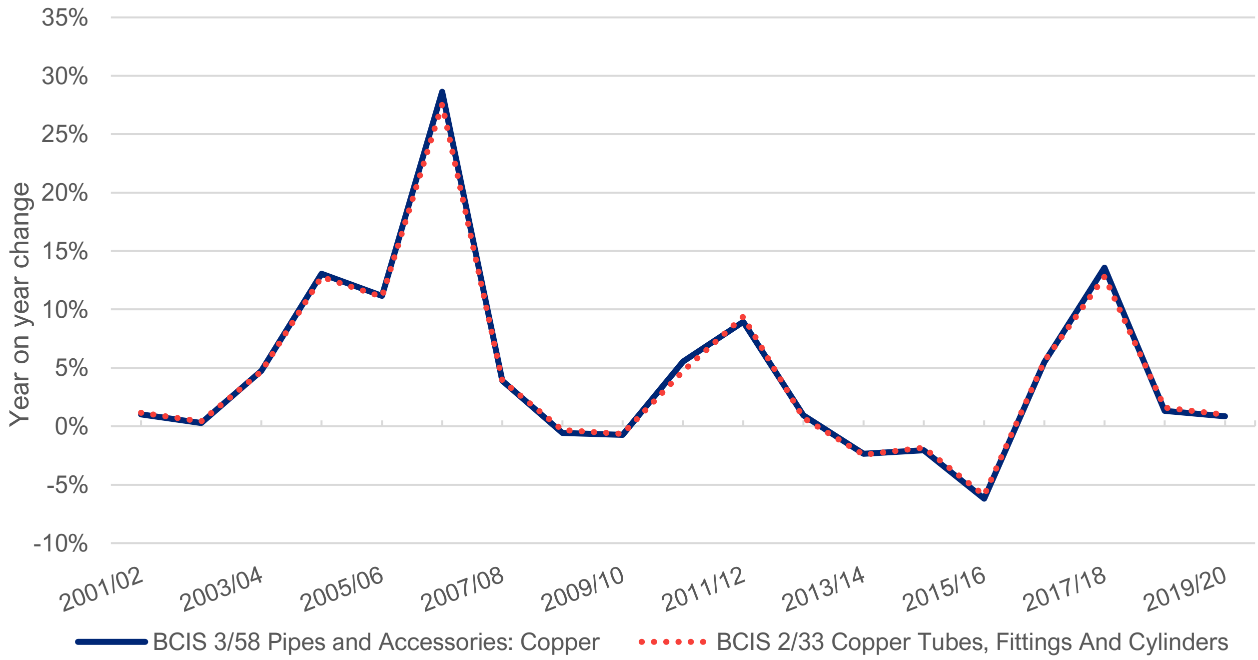
Index	Simplicity	Credibility			Accuracy		Transparency		Timeliness	
		(a)	(b)	(c)	(a)	(b)	(a)	(b)	(a)	(b)
BCIS 2/S2 Steelwork - Cost Of Materials	Y	Y	R	21	G	G	Paid	No	1 month	3 months
BCIS Electrical - materials (3/E2)	Y	Y	G	21	G	G	Paid	No	1 month	3 months
BCIS 2/E2 Electrical Installations - Cost Of Materials	Y	Y	R	21	G	G	Paid	No	1 month	3 months
BCIS 4/CE/EL/02 Electrical Engineering Materials	Y	Y	G	11	G	G	Paid	No	1 month	3 months
BCIS 3/S3 Structural Steelwork – Materials: Civil Engineering Work	Y	Y	G	21	G	G	Paid	No	1 month	3 months
BCIS 4/CE/ST/02 Structural Steelwork Materials	Y	Y	G	11	G	G	Paid	No	1 month	3 months

Source: CEPA analysis

The two copper indices, BCIS 2/33 and 3/58, have very similar historical movements, as shown in Figure B.5 below. Including more than one copper index would introduce duplication and reduce the simplicity of the RPE indexation mechanism. Our preference is to rely on BCIS 3/58 Pipes and Accessories: Copper, which scored best in the assessment shown in

Table B.10. Index 2/33 is a Series 2 index, which has been superseded by Series 3 and Series 4 indices. Therefore, we only use 3/58 as a copper index.

Figure B.5: Trend analysis of copper indices

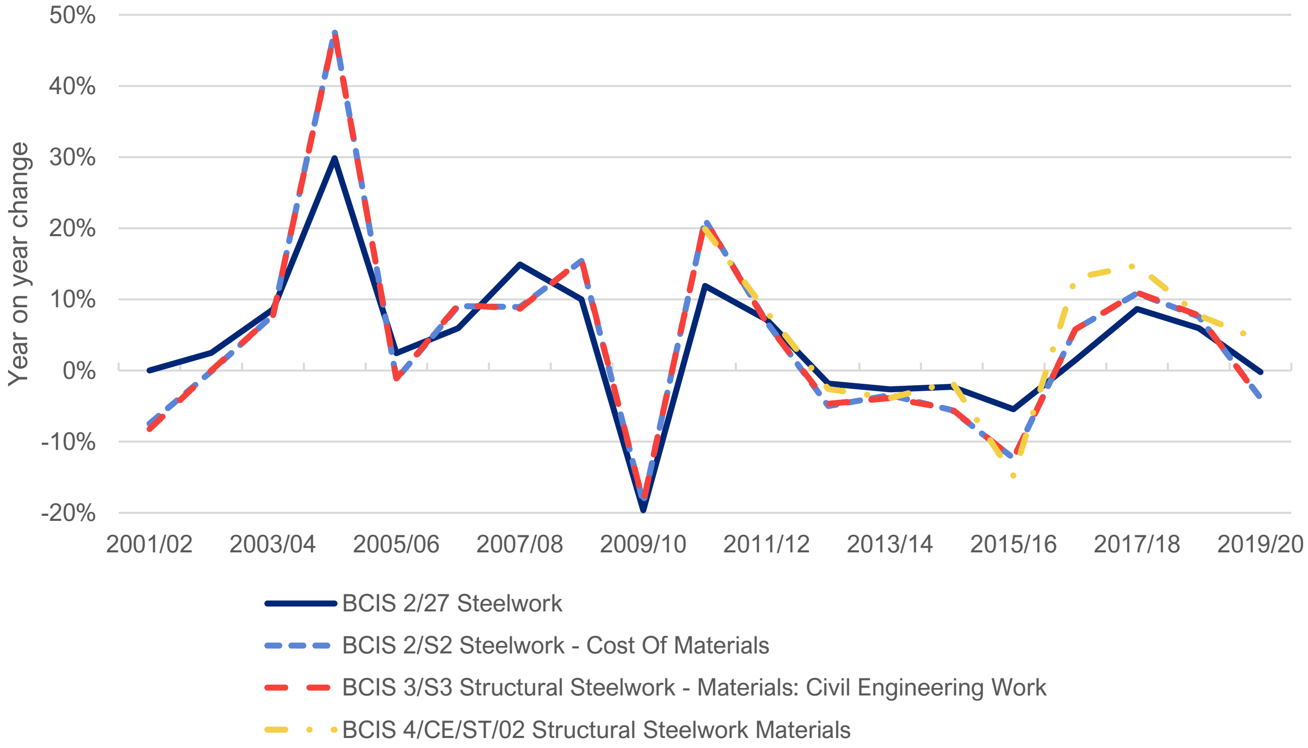


Source: CEPA analysis of BCIS data

Alternative text: *Line chart of the year-on-year change in two copper materials indices between 2001/02 and 2019/20, indicating that both indices have very similar historical movements.*

We deem one steel index as sufficient. Including more than one steel index would introduce duplication and reduce the simplicity of the RPE indexation mechanism. BCIS 3/S3 Structural Steelwork – Materials: Civil Engineering Work has regulatory precedent, as it was used in ED1 and GD2/T2, while BCIS 2/27, 2/S2 and 4/CE/ST/02 do not have regulatory precedent. Furthermore, 2/27 and 2/S2 are series 2 indices, and, as explained above, series 3 and 4 indices have preference over series 2 indices. Lastly, all four indices have very similar historical movements, as shown in Figure B.6. Therefore, we prefer BCIS 3/S3.

Figure B.6: Trend analysis of steel indices

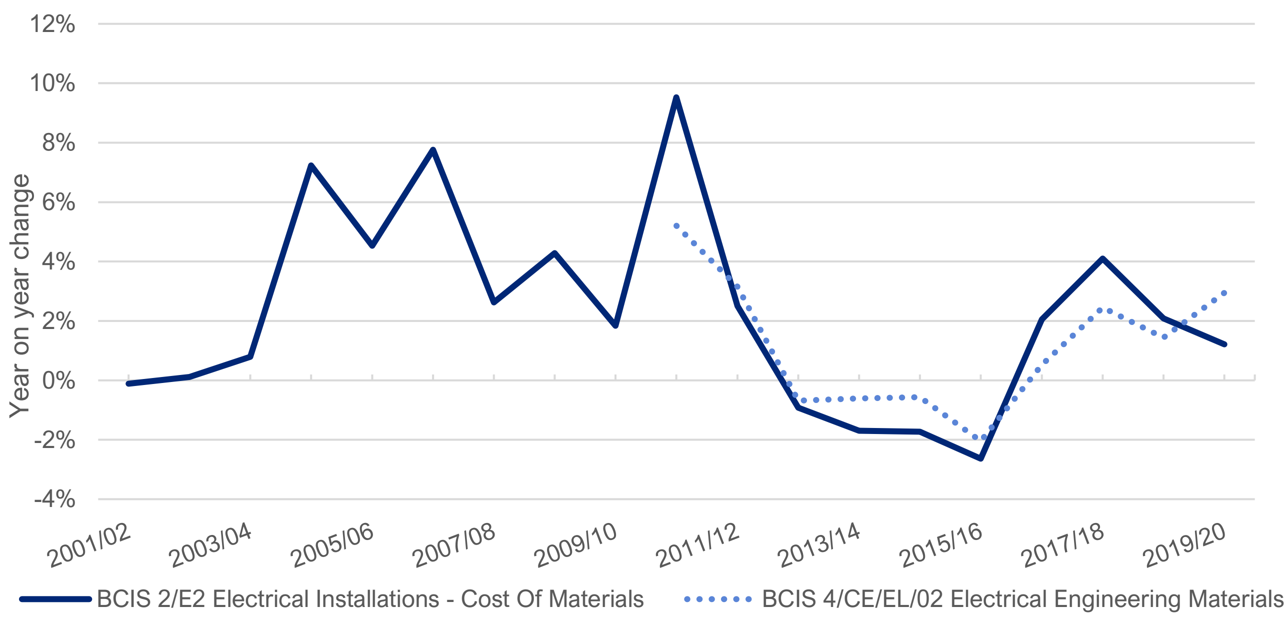


Source: CEPA analysis of BCIS data

Alternative text: *Line chart of the year-on-year change in four steel materials indices between 2001/02 and 2019/20, indicating that since 2010/11 all four indices have had very similar historical movements.*

We deem one electrical engineering materials index as sufficient. Including more than one electrical engineering materials index would introduce duplication and reduce the simplicity of the RPE indexation mechanism. BCIS 4/CE/EL/02 Electrical Engineering Materials has regulatory precedent, as it was used in T2, while BCIS 2/E2 does not have regulatory precedent. Furthermore, 2/E2 is a series 2 indices, and, as explained above, series 3 and 4 indices have preference over series 2 indices. Lastly, both indices have very similar historical movements, as shown in Figure B.7. Therefore, we prefer BCIS 4/CE/EL/02.

Figure B.7: Trend analysis of electrical engineering materials indices



Source: CEPA analysis of BCIS data

Alternative text: *Line chart of the year-on-year change in two electrical engineering materials indices between 2001/02 and 2019/20, indicating that since 2010/11 both indices have very similar historical movements.*

Materials – others

No concerns were highlighted in the detailed assessment of indices proposed for other materials costs.

Table B.11: Detailed assessment - other

Index	Simplicity	Credibility			Accuracy		Transparency		Timeliness	
		(a)	(b)	(c)	(a)	(b)	(a)	(b)	(a)	(b)
FOCOS Resource Cost Index of Infrastructure: Materials FOCOS	Y	Y	G	21	G	G	Paid	No	3 months	

Source: CEPA analysis

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