RIIO-GD2 and T2: Cost Assessment – Frontier shift methodology paper

Ofgem

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EXECUTIVE SUMMARY

Frontier shift is the rate at which a company changes 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 other words, frontier shift is ongoing efficiency net of Real Price Effects (RPEs). For example, if an efficient company makes a 1% annual efficiency gain but its input prices were also rising at 1% a year, it would be expected to keep the cost of producing its outputs approximately constant over time – i.e. the net frontier shift would be zero.

This independent report discusses the issues faced by Ofgem in its assessment of frontier shift for the Draft Determinations for the RIIO-2 price control review period for the Gas Distribution Network (GDNs) and the gas and electricity transmission networks.

Ongoing efficiency

Setting a suitably stretching ongoing efficiency challenge is an important part of Ofgem's role in ensuring value for money for consumers through the RIIO-2 price control process. The report describes how a suggested range for the ongoing efficiency challenge can be constructed by considering different types of evidence:

- growth accounting analysis, based on a review of the EU KLEMS database, with a description of the efficiency ranges produced by different approaches;
- forward-looking productivity forecasts for the UK economy;
- historical performance of the companies; and
- sector-specific drivers of possible productivity improvements in the gas and electricity networks, e.g. as a result of innovation funding received by the network companies during RIIO-1.

We also review how these four types of evidence have been taken into account when determining suggested ongoing efficiency challenges for regulated businesses:

- by the GDNs and the transmission companies in their RIIO-2 submissions; and
- in other price controls, particularly RIIO-1 (Ofgem) and PR19 (Ofwat).

We identify reference ranges from the analysis of 2019 EU KLEMS data of:

- 0.6% to 1.0% for capex and repex (Total Factor Productivity); and
- 1.0% to 1.2% for opex (Labour Productivity at Constant Capital).

This is based on data on Value Added (VA) productivity improvements between the period of 1997-2016 of two sample groups (weighted average of all industries;[2] and unweighted average of four industries selected by Ofgem in RIIO-1 as being of particular relevance for the activities carried out by energy networks[3]).

We identify three further pieces of evidence that Ofgem should consider in deciding where to set the ongoing efficiency challenge in relation to the range from EU KLEMS analysis described above:

- **Giving some weight to the Gross Output (GO) measures from EU KLEMS,** which would support a lower bottom-end of the range for the ongoing efficiency challenge of 0.5%. This is calculated from the weighted average of all industries between 1997 and 2016.

[2] Excluding real estate, public admin, education, health and social services.

[3] Construction, Wholesale and retail trade: repair of motor vehicles and motorcycles, transportation and storage; financial and insurance activities.

- **Productivity forecasts from the OBR and BoE,** which would support a higher top-end of the range for the ongoing efficiency challenge for opex, and a lower value for capex/repex.
- **Ensuring a reasonable return for consumers from the innovation funding provided in RIIO-1,** which could support an upwards adjustment of up to 0.2% depending on the extent to which Ofgem believes that innovation benefits are already being delivered in the companies' RIIO-2 business plan proposals.

This would create a final range for Ofgem to consider of:

- 0.5% to 1.2%[4] for the ongoing efficiency challenge for capex and repex; and
- 0.5% to 1.4%[5] for the opex efficiency challenge.

This report describes alternative approaches that Ofgem may wish to consider as part of setting the ongoing efficiency challenge in the Final Determinations. In addition, at the time of writing, there is much uncertainty about the outlook for two atypical events that may affect economy-wide productivity over the RIIO-2 period. These events are the COVID-19 crisis, which may persist for an uncertain amount of time, and the conclusion of the transition period for the UK's exit from the EU at the end of 2020. At this stage, we have not included any adjustment in the ongoing efficiency challenge to reflect these events as it is unclear what the impact may be on economy-wide productivity over the next few years, and how this may translate into the productivity of energy network companies which operate in a regulated sector. More information on the possible impacts of these events may be available for Ofgem to consider as part of setting the Final Determinations.

Real Price Effects

In its RIIO-2 Sector-Specific Methodology Decision paper (SSMD),[6] Ofgem confirmed its intention to make use of indexation to account for RPEs. This will replace the fixed ex-ante allowances over the price control period set for RPEs in RIIO-1.

We report here the main findings of each of the five tasks required to set up the RPE indexation framework, as set out by Ofgem in its June 2019 consultation on RIIO-2 tools for cost assessment[7]:

- **Determination of cost structures.** Setting the indexation mechanism requires Ofgem to assess the share of totex by category (e.g. labour costs, materials, transport). We have assumed the same notional structure for all GDNs; and used a company-specific structure for the transmission companies, NGET, SHET, SPT, NGGT (TO) and NGGT (SO).
- **Materiality.** The SSMD set out Ofgem's decision to only apply RPE indexation to cost areas where there is strong evidence suggesting that the company's input prices (e.g. labour, materials) will **materially** track above or below general economy inflation (based on CPI or CPI(H)). The following cost areas passed the thresholds for materiality: labour, materials, and plant & equipment (SHET only).
- **Selection of the indices for each cost category**. We assessed the indices used for RIIO-1 against selection criteria agreed with Ofgem. The indices passed all the criteria, and hence have been retained for use in RIIO-2.
- **Developing forecasts for the indices**. To set the allowances for the RIIO-2 period at the start of the price control, Ofgem will use forecasts for the input cost areas that will be subject to indexation for the RIIO-2 time period. We have described a forecast for each index based on the approach used in RIIO-1, where long-term average was used for years that an external forecast was not available for. These forecasts were then combined to produce a forecast RPE for each cost area that had passed the materiality tests.

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[4] This is the top of EU KLEMS reference range combined with a value of 2% for the innovation efficiency challenge.

[5] This is the top of the EU KLEMS reference range combined with a value of 2% for the innovation efficiency challenge.

[6] Ofgem (2019) *RIIO-2 Sector-Specific Methodology – Core document.* Decision Paper.

[7] Ofgem (2019) *RIIO-2 tools for cost assessment.*

- **Treatment of cost areas not subject to RPE indexation.** We consider that on balance, Ofgem should continue to apply non-zero ongoing efficiency assumptions to non-indexed costs. It can consider any issues with this approach as one factor to inform its judgement in selecting the final ongoing efficiency challenge from the range of evidence available.

Table 1.1 shows the resulting totex-level RPE forecasts for each network. The same RPE forecasts apply to all GDNs because a common cost structure was assumed.

Table 1.1: Forecasts for Totex RPE (2 d.p.)

Network	2019/20	2020/21	2021/22	2022/23 – 25/26
GDNs	0.89%	1.38%	1.20%	1.22%
NGGT (TO)	-0.19%	1.50%	1.31%	1.28%
NGGT (SO)	0.32%	1.28%	1.11%	1.11%
NGET	0.64%	1.64%	1.44%	1.34%
SHET	0.46%	1.52%	1.29%	1.16%
SPT	0.32%	1.45%	1.28%	1.18%

Source: CEPA analysis

In RIIO-2, Ofgem will use indexation rather than ex-ante allowances to account for RPEs. Therefore, there will be a true-up once the relevant index/indices areas are published each year, and a final true-up will occur at the end of RIIO-2 as part of the close-out process.

1. INTRODUCTION

Ofgem commissioned a partnership of CEPA, AFRY Management Consulting (AFRY) and Economic Consulting Associates (ECA) to provide economic advice for RIIO-2. This independent report has been prepared by CEPA under this Economic Strategic Partner contract for RIIO. It discusses the issues faced by Ofgem in its assessment of frontier shift for the Draft Determinations for the RIIO-2 price control review period for the Gas Distribution Network (GDNs) and the gas and electricity transmission networks.

This report considers evidence that pre-dates the COVID-19 crisis. We have not attempted to draw inferences about the impact that the COVID-19 crisis might have on the scope for ongoing productivity improvements in energy networks and on Real Price Effects (RPEs) in RIIO-2.

1.1. DEFINITION OF FRONTIER SHIFT

Frontier shift is the rate at which a company changes 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 other words, frontier shift is ongoing efficiency net of RPEs. For example, if an efficient company makes a 1% annual efficiency gain but its input prices were also rising at 1% a year, it would be expected to keep the cost of producing its outputs approximately constant over time – frontier shift would be zero.

1.2. SCOPE OF OUR WORK ON ONGOING EFFICIENCIES

This report considers the outlook for improvements in frontier efficiency and does not cover catch-up efficiency, which is covered separately in the cost assessment process carried out by Ofgem (e.g. through benchmarking). This report does not explore how the ongoing efficiency challenge should be practically implemented within the totex allowance calculation process to ensure consistency with the overall approach to cost assessment as a whole. In addition, the level of frontier shift to be applied in the ESO price control is out of scope of this report.

In line with the approach set out in Ofgem's RIIO-2 Sector-Specific Methodology Decision paper (SSMD),[8] we have focused on analysing the EU KLEMS dataset to identify relevant benchmarks for the companies. In addition, we have reviewed wider evidence of the scope for efficiency improvements in RIIO-2. This includes credible sources of forward-looking productivity estimates, such as the Bank of England (BoE) and the Office for Budget Responsibility (OBR), as well as considering the possible impact of RIIO-1 innovation funding.

We have also reviewed the companies' RIIO-2 submissions to understand their proposed rationale and estimates of their scope to achieve ongoing efficiencies, and how they have proposed to apply their estimates to their businesses.

1.3. SCOPE OF OUR WORK ON REAL PRICE EFFECTS

To date, the GDNs have been broadly supportive of the introduction of an indexation mechanism. In contrast the transmission companies have suggested that an indexation mechanism should not be adopted for their sector and have proposed alternative approaches, such as a fixed allowance for some or all costs, or indexing all costs to the CPIH combined with a zero ongoing efficiency challenge.

Whilst we have noted these positions, reviewing the Ofgem decision to introduce indexation for RPEs in RIIO-2, including for the transmission sector, is not in the scope of this report.

As agreed with Ofgem, the following assumptions have underpinned our work on RPEs:

- Ofgem will apply the same indexation approach to RPEs for the transmission companies as to the GDNs.

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[8] Ofgem (2019) *RIIO-2 Sector-Specific Methodology – Core document.* Decision Paper.

- The notional cost structure will follow the RIIO-1 approach, which used an unweighted average for the gas distribution (GD) sector, and company-specific structures for gas transmission (GT) and electricity transmission (ET). To produce the notional cost structure, we used the cost structure information provided to us by Ofgem. We did not review the robustness of the categorisation of costs by each company as that was not in scope of our work.
- Ofgem's assessment of the materiality of input cost areas is based on two tests – one is on the share of totex represented by the cost category and the other is on the impact of totex of volatility in the input prices for the cost category.

The focus of this report is on setting the framework for RPEs at the start of the price control process. Therefore, this report does not cover:

- licence drafting for the implementation of the proposed framework;
- how the RPE forecasts should be practically implemented within the totex allowance calculation process to ensure consistency with the overall approach to cost assessment as a whole; and
- ongoing governance of the RPE process during RIIO-2 – e.g. the operation of the true-up mechanism, and any changes to indices during RIIO-2.

1.4. STRUCTURE OF THE REPORT

The rest of this report is structured as follows:

- Section 3 discusses the different pieces of evidence for Ofgem to consider in setting the ongoing efficiency challenge for the network companies to achieve over the RIIO-2 period;
- Section 3 describes a reference range for Ofgem to consider in setting the ongoing efficiency challenge, based on the evidence presented in Section 2; and
- Section 4 sets out the different steps in the analysis to develop the RPE indexation mechanism for the companies.

The appendices include more detailed information on the use of the EU KLEMS data set in RIIO-1 and in this report (Appendix A) as well as expanding on the description of innovation funding schemes in other sectors (Appendix B).

2. EVIDENCE TO INFORM ONGOING EFFICIENCY CHALLENGE

Setting a suitably stretching ongoing efficiency challenge is an important part of Ofgem's role in ensuring value for money for consumers through the RIIO-2 price control process. This section of the report describes the following different types of evidence that can be used to inform the range for an ongoing efficiency challenge:

- growth accounting analysis, based on a review of the EU KLEMS database, with a description of the efficiency values produced by different approaches;
- forward-looking productivity forecasts for the UK economy;
- historical performance of the companies, including the potential to make use of the companies' historical data, using techniques such as Data Envelopment Analysis (DEA); and
- sector-specific drivers of possible productivity improvements in the gas and electricity networks, e.g. as a result of innovation funding received by the network companies during RIIO-1.

The first two elements consider historical and forward-looking evidence from the wider economy, whereas the latter two examine historical and forward-looking evidence specifically related to regulated energy networks.

We then discuss how these four types of evidence have been taken into account when determining suggested ongoing efficiency challenges for regulated businesses:

- by the GDNs and the transmission companies in their RIIO-2 submissions; and
- in other price controls, particularly RIIO-1 (Ofgem) and PR19 (Ofwat).

2.1. GROWTH ACCOUNTING ANALYSIS

There is a well-established methodology for using growth accounting analysis of historical productivity improvements to inform the ongoing efficiency challenge. For example, this was the basis of the ongoing efficiency challenge that Ofgem set for RIIO-GD1/T1. Our Frontier Shift paper[9] published alongside Ofgem's June 2019 consultation on tools for cost assessment[10] identified the EU KLEMS dataset as the preferred dataset for growth accounting analysis. That approach had been supported by respondents to the Ofgem's Sector Specific Methodology Consultation (SSMC) [11] for RIIO-T2/GD2, who all favoured the continued use of the EU KLEMS data set to inform the ongoing efficiency challenge.

The EU KLEMS data set provides multiple choices for the determination of long-term averages for productivity levels across different industry groups. Essentially, deciding on the preferred range involves a choice about elements such as:

- the time period;
- the productivity metrics; and
- the comparator industries, considering factors such as comparability, competitiveness, and avoiding volatility or atypical changes.

As discussed in our 2019 Frontier Shift paper, there is value in exploring the impact of making different assumptions about comparators, time periods and productivity metrics. This analysis can be used to produce a

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[9] CEPA (2019) *RIIO-GD2 cost assessment – frontier shift.*

[10] Ofgem (2019) *RIIO-2 tools for cost assessment.*

[11] Ofgem (2018) *RIIO-2 Sector-Specific Methodology.* Consultation Paper.

final ongoing efficiency estimate reflecting a mix of different sets of assumptions, addressing the lack of expert consensus on the 'correct' approach to take. This is the approach that was adopted by Ofgem in RIIO-1.

Time Period

Productivity measures may co-move (pro-cyclically) over the business/economic cycle. In general, productivity growth tends to accelerate during periods of economic expansion and decelerate during periods of recession.[12] Therefore, it is standard practice to consider productivity growth over complete cycles, which are defined with reference to either trends in GDP growth or the output gap. If the sample includes an incomplete business cycle, it may result in a biased estimate of the expected conditions for the upcoming price control period.

A challenge for this approach, however, is that it relies on the accuracy of judgements about when business cycles start and end. There are some standard time periods that regulators and companies have used, but this is not a simple decision, and so can lead to accusations of cherry-picking.

Based on the Office of Budgetary Responsibility's (OBR) data on the output gap,[13,14] we consider the following to be complete business cycles since 1972:[15]:

- 1972 – 1978.
- 1978 – 1986.
- 1986 – 1997.
- 1997 – 2006.
- 2006 – 2016.

Productivity metrics

Regulators face a choice between different measures of productivity, such as:

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

Total factor productivity is typically seen as being more relevant to capex.

Partial factor productivity measures (e.g. labour productivity, and labour and intermediate inputs productivity) are typically seen as being more relevant to activities with a large labour share, such as network companies' opex. Partial factor productivity growth may include the effect of capital substitution (i.e. where growth of capital exceeds the growth of variable factor inputs such as labour and intermediate inputs, thereby increasing partial factor productivity compared to total factor productivity), which is sometimes distortionary. Regulators may, therefore, choose to hold capital constant to strip out the impact of capital substitution.

There are also two common measures of output used to measure productivity:

- Gross output (GO) is the simple aggregate of 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 are a factor in production (I.e., materials, contractors, etc) and therefore business will make decisions on production if prices change for intermediate inputs.

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[12] OECD (2001) *Measurement of aggregate and industry level productivity growth.* Page 119.

[13] OBR (2011) *Estimating the UK's historical output* gap. Working paper 1.

[14] OBR (2019) Potential output and the output gap.

[15] Defined as a point of zero output gap to another point of zero output gap.

- 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.

There has been a long-standing debate over which definition of output is more relevant for measuring ongoing efficiency. The mathematical relationship between the two measures means that the rate of change in VA measures will be greater in absolute terms that than the rate of change in GO measures.

As each measure has advantages and disadvantages, no consistent expert view has emerged on which one should be preferred. This means that there is not one prevailing approach used consistently in regulatory determinations. For example, in a report for NGN prepared as part of the RIIO-1 discussions, First Economics use the VA measure to calculate the TFP for GDNs.[16] However, Reckon use GO to calculate the TFP in work for the Dutch regulator (NMa) on the price control for gas transmission.[17]

One argument made in favour of the GO measure is that by identifying intermediate inputs as a controllable factor of production, it better reflects the business decisions taken by companies. However, producing consistent sets of GO measures across industries requires careful treatment of intra-industry flows of intermediate products, which may be difficult empirically.

An advantage of the VA approach for labour productivity measures is that is far less sensitive than GO labour productivity measures to changes in the vertical structure of different firms in the sample set – for example, if a firm uses outsourcing to replace labour with intermediate inputs. This is because such a substitution between labour and intermediate inputs will cause a fall in both value-added output measure and in the labour used. These changes have opposite impact on estimated labour productivity, hence making the VA measure less sensitive to outsourcing than GO measure (as GO will not change necessarily because of outsourcing). The opposite is true for total factor productivity measures.

This means it is typically seen as good regulatory practice to consider the information provided by both methods when developing a range for ongoing efficiency estimates. This is consistent with Ofgem's approach in RIIO-1 and with Ofwat's approach in PR19.

Comparator sectors

The 2019 EU KLEMS database contains information on over 20 different industries. If sub-industries are included, then there are over 40 potential comparators to be considered. This then raises two questions:

- Which samples of (sub)industries should be used to create the historical productivity estimates to inform estimates of potential efficiency improvements for energy network companies?
- Whether sample averages should be unweighted (e.g. equal weight to each industry) in the sample, or weighted?

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

2.1.1. Approach to the analysis of the 2019 EU KLEMS database

Table 2.1 describes the different samples of comparator sectors in the 2019 EU KLEMS database that we have considered in this report.

Table 2.1: Elements of the EU KLEMS 2019 database used to inform the ongoing efficiency challenge for RIIO-2

Element	Considered in this report
Time Period	• 1997-2016, which represent the longest data set covering complete business cycles in the 2019 EU KLEMS database.

[16] First Economics (2011) *The Scope for Future Productivity Growth: A report prepared for Northern Gas Networks.*

[17] Reckon (2011), *Productivity growth of GTS.* Report prepared for NMa.

	• 2006-2016, which is used to show the impact of only considering the most recent complete business cycle available in the EU KLEMS database.
Productivity metrics	• Total Factor Productivity (TFP), and Partial Factor Productivity (PFP: Labour, and labour and intermediate outputs). • Value added (VA) for both TFP and PFP measures. • Implied figures for Gross Output (GO) for both TFP and PFP measures.
Comparators	• Construction. • Unweighted average of selected industries. (Manufacture of Chemicals & Chemical Products; Manufacture of Computer, Electronic and Optical products, Manufacture of Electrical Equipment, Manufacture of Transport Equipment; Construction; Wholesale and Retail Trade: Repair of Motor Vehicles and Motorcycles; Transportation and Storage; Financial and Insurance Activities). • Unweighted average selected industries excluding manufacturing. (Construction; Wholesale and Retail Trade: Repair of Motor Vehicles and Motorcycles; Transportation and Storage; Financial and Insurance Activities). • Unweighted average all industries[18]. (excluding real estate, public admin, education, health and social services). • Weighted average of all industries. (excluding real estate, public admin, education, health and social services).

Source: CEPA Analysis

The list of sample comparators in Table 2.1 is similar to the samples that Ofgem considered in RIIO-1 (as shown in Appendix A), with three main differences being in relation to:

- the length of the overall time period;
- number of different time periods tested; and
- approach to calculation of GO productivity measures.

We have considered a shorter overall time period than Ofgem did in RIIO-1 because the 2019 EU KLEMS dataset only includes sufficient data to present productivity estimates for the period from 1995 to 2016. In line with the approach of considering complete business cycles, we have therefore considered the 2019 EU KLEMS data between 1997 and 2016. This spans two complete business cycles based on our analysis of the output gap in the OBR data.

We have tested the impact on estimated productivity of using a time period covering only the most recent business cycle (2006-2016). This would be consistent with seeing the slow productivity growth since the global financial crisis as representing a structural break in the economy-wide potential for productivity improvements. Under this view, more weight should be put on the most recent business cycle information and less on previous business cycles – whereas using the full time period of 1997-2016 puts equal weight on the last two business cycles. Putting more weight on productivity growth in recent years was put forward by network companies in their RIIO-2 submissions. Oxera used a similar time period (2007-2016) in the analysis that it provided to support WWU's business plan, stating that it represents a full economic cycle.[19]

The 2019 EU KLEMS database does not include all of the data traditionally required to reproduce GO TFP estimates.[20] Therefore, we have applied the following approximation to convert VA TFP to GO terms:[21]

[18] This sample follows the definition of the 'market economy' group of industries in the EU KLEMS database.

[19] Oxera (2019) *Establishing an appropriate efficiency challenge.* Prepared for Wales & West Utilities Limited.

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

[21] This relationship is set out in: OECD (2001) M*easuring Productivity: OECD Manual*, available here.

$$gTFP_{VA} = \frac{gTFP_{GO}}{\frac{VA}{GO}}$$

The formula states that TFP growth in VA terms is equal to TFP growth in GO terms divided by the share of VA in GO. This approach is also followed by Ofwat's consultants for PR19, Europe Economics, to generate GO measures of TFP growth.

Using the formula above, we have been able to use the data that is available in the 2019 EU KLEMS dataset to produce implied estimates of GO TFP growth for the period between 1997 and 2016. In addition, we have been able to use this to produce an estimate of GO labour and intermediate inputs (LEMS) productivity (at constant capital). This metric was also used by Ofgem when setting the ongoing efficiency challenge in RIIO-1.[22]

We used the same industry comparators used in RIIO-1 to the extent that the data is available. Where the industry classifications in the 2019 EU KLEMS database do not match those used by Ofgem in RIIO-1, we have selected the most appropriate available industry substitutes.[23]

In line with what Ofgem did in RIIO-1, we have calculated any weightings on the basis of the proportion of VA at current basic prices or the proportion of GO at current basic prices, dependent on the productivity metric being used. The resulting weights are listed in Appendix A.

We used RPI to remove the impacts of inflation from the productivity metrics calculated in the EU KLEMS models. Although Ofgem's wider RIIO-2 policy is to use CPIH, this index was only introduced in 1996. There is therefore not enough historical coverage for this measure of inflation to be used for all of the time periods within the 2009 EU KLEMS release which we have used to compare to the results from the 2019 EU KLEMS database. As we felt that it is important to have consistency between the inflation measures used in the EU KLEMS releases, we used RPI throughout. We expect this to have very little impact on the productivity figures that are produced; and if anything, the impact will be to produce figures that may be slightly lower than if CPI had been used.

2.1.2. Findings from the analysis of the 2019 EU KLEMS database

The tables below presents the estimated annual improvements in productivity for the time periods and industry samples listed in Table 2.1.[24] Table 2.2 shows the figures for VA, which are calculated directly from the EU KLEMS database. Table 2.3 shows the figures for GO, which have been estimated from the EU KLEMS database using the approach described above.

These tables provide a wide range of historic efficiency estimates depending on time period, productivity measure, and sampling approach. Therefore, narrowing down the range requires consideration of how much weight should be placed on different combinations of these elements.

[22] Ofgem (2012) *RIIO-T1/GD1: Real price effects and ongoing efficiency appendix*, available here.

[23] For the selected industries measures, the data for the Retail Sale of Fuel is not presented in the 2019 EU KLEMS database. Therefore, the number presented is based on the other eight industries: Manufacture of Chemicals & Chemical Products; Manufacture of Transport Equipment; Construction; Wholesale and Retail Trade: Repair of Motor Vehicles and Motorcycles; Transportation and Storage; Financial and Insurance Activities.

[24] All the productivity measures are presented in real terms.

Table 2.2: EU KLEMS data for VA efficiency benchmarks for RIIO-2 (to 1 d.p.)

Sample	TFP VA 1997 – 2016	TFP VA 2006 – 2016	LP VA at constant capital 1997 – 2016	LP VA at constant capital 2006 – 2016
Construction	0.3%	0.4%	0.4%	0.3%
Unweighted average selected industries	1.6%	0.9%	2.2%	1.2%
Unweighted average selected industries (exc. manufacturing)	0.6%	-0.3%	1.0%	-0.6%
Unweighted average all industries (exc. real estate, public admin, education, health and social services)	0.3%	-0.8%	-0.4%	-3.0%
Weighted average all industries (exc. real estate, public admin, education, health and social services)	1.0%	0.2%	1.2%	-0.2%

Source: CEPA analysis of EU KLEMS data

Table 2.3: EU KLEMS data for GO efficiency benchmarks for RIIO-2 (to 1 d.p.)

Sample	TFP GO 1997 – 2016	TFP GO 2006 – 2016	LEMS GO at constant capital 1997 – 2016	LEMS GO at constant capital 2006 – 2016
Construction	0.1%	0.2%	0.1%	0.1%
Unweighted average selected industries	0.5%	0.3%	0.6%	0.3%
Unweighted average selected industries (exc. manufacturing)	0.3%	-0.1%	0.4%	-0.2%
Unweighted average all industries (exc. real estate, public admin, education, health and social services)	0.2%	-0.3%	0.1%	-0.6%
Weighted average all industries (exc. real estate, public admin, education, health and social services)	0.5%	0.1%	0.5%	0.1%

Source: CEPA analysis of EU KLEMS data

2.2. FORWARD-LOOKING PRODUCTIVITY ESTIMATES

The use of growth accounting analysis to inform Ofgem's ongoing efficiency challenge involves the extrapolation of historical productivity improvements in different sample industry groupings to form the basis for estimates for future efficiency gains. An alternative source of evidence is to explore forward-looking estimates of productivity improvements in the UK economy. In this section, we consider productivity forecasts and supporting commentary from the OBR and the BoE. Ofgem's SSMD noted that several respondents to the SSMC had suggested that Ofgem also use BoE and OBR forecasts as comparators with the EU KLEMS forecast.

The impact of the ongoing COVID-19 pandemic has not been taken into account within the forward-looking productivity estimates presented in this section. There is a degree of uncertainty surrounding any medium-term or structural impact that COVID-19 will have on future ongoing efficiency for the wider economy, or for regulated energy network companies in particular.

Since the global financial crisis in 2008-2009, productivity growth in the UK has been below its long-term trends. 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.[25] Labour productivity is the productivity metric commonly associated with opex.

A number of explanations have been put forward to explain this 'productivity puzzle' including measurement issues, lower investment, compositional effects, labour market factors and impaired financial markets.[26] Another explanation is that low UK productivity growth is driven by a number of major industry sectors, including retail and wholesale, where UK companies may have pursued a more labour-intensive business model than is the case in other advanced economies.[27] The BoE also found that the fall in UK productivity since the financial crisis is attributable to the performance of four sectors which together accounted for one-third of total output: manufacturing, finance, ICT and professional services[28]. Manufacturing and finance together accounted for three-quarters of the productivity fall.

However, as shown in Table 2.4, the OBR's and the BoE's recent labour productivity forecasts do not assume that the recent pattern of weak productivity growth driven by a small number of sectors will persist indefinitely.

Table 2.4: Economy-wide productivity forecasts (labour productivity)

	2020	2021	2022	2023	2024
Bank of England	0.0%	0.75%	1.25%		
Office for Budget Responsibility	0.8%	1.00%	1.10%	1.20%	1.30%

Source: Office for Budget Responsibility[29] and Bank of England[30]

The OBR assume that hourly productivity growth will rise gradually over the forecast period, reaching 1.2% in 2024 and steadily rising towards 1.5% over the long term.

In making these forecasts, the OBR stress that the outlook for productivity growth remains uncertain, with the path it takes likely to be shaped by factors such as:

- **Tightening labour market.** The OBR expect an increase in trend productivity growth due to a tighter labour market exerting pressure on firms to extract more output from workforce. A wider COVID-19 slowdown could affect this. That, however, may not affect specialist labour as much as it may affect more generalist roles.
- **Brexit uncertainty.** Reduced uncertainty around transition arrangements and future trading arrangements could support business investment and lead to a stronger-than-expected pickup in productivity growth. At the time of the OBR report (March 2020), uncertainty around these areas was having a dampening effect on business investment.

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

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

[27] PwC (Nov 2019) *UK Economic Outlook.*

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

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

[30] Bank of England (January 2020) *Monetary Policy Report.*

- **Global growth.** Productivity in the UK could increase should global productivity increase more than expected. This is in addition to if there is a global upswing in trade and investment into the UK.
- **Structural break.** With such a period of weak productivity growth, it could be argued that there has been a structural break in productivity and that we are in a new period of lower productivity growth.

TFP is the measure used to produce capex and repex ongoing efficiency estimates in the growth accounting analysis. In its January 2020 Monetary Policy Report, the BoE forecast annual TFP growth of 0.1% between 2020 and Q1 2023. This is lower than the annual forecast of 0.3% for TFP growth included in the BoE's Inflation Report in February 2019[31] which is cited in some companies' RIIO-2 submissions. Interestingly, the estimated historical TFP changed significantly between the two reports; for example, the estimated annual TFP gain between 1998 and 2007 rose from 1.0% to 1.6%. This seems to be driven by ONS revisions to estimates of capital stocks and gross fixed capital formation estimates as a result of changes set out in the 2019 Blue Book.[32] This illustrates the uncertainty around the TFP value which is calculated as a residual. The OBR makes a similar point when discussing the sensitivities of TFP and Capital Deepening when calculating productivity growth:

"business investment data and the implied path for the capital stock are prone to significant revisions, which can have a substantial impact on this type of decomposition."[33]

2.3. HISTORICAL PERFORMANCE OF THE NETWORK COMPANIES

We have considered the potential to use the historical performance of the companies to directly inform the efficiency target for RIIO-2. This analysis can then inform how Ofgem addresses concerns raised in the enhanced stakeholder engagement process – e.g. the RIIO-2 Challenge Group report on the December 2019 business plans.[34] This report stated that the ongoing efficiency improvements proposed by the companies were not stretching enough, especially in the light of the high level of totex underspends in RIIO-1.

Care needs to be taken when attributing historical out-performance of allowances simply to ongoing efficiencies because there are multiple other reasons why the companies may outperform allowances. This includes:

- lower volume of activity than forecast;
- lower RPEs than forecast; and
- faster catch-up efficiency improvement than forecast.

This means econometric techniques such as Data Envelopment Analysis (DEA) are often used to try to decompose the drivers of historical differences between expenditure and allowances.

We considered the productivity estimates presented in Ajayi et al (2018).[35] Ajayi et al (2018) uses data collected from Ofgem to estimate historical productivity growth for each of the four regulated sectors – electricity distribution, gas distribution, electricity transmission and gas transmission.[36] At a high level, the authors used the data to

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[31] Bank of England (February 2019) *Inflation Report*. The Inflation Report was subsequently renamed as the Monetary Policy Report.

[32] Office for National Statistics (October 2019) *Multi-factor productivity estimates: Experimental estimates April to June 2019.*

[33] Office for Budget Responsibility (March 2018) *Economic and fiscal outlook*

[34] RIIO-2 Challenge Group (January 2020) *Independent report for Ofgem on RIIO-2 Business Plans.*

[35] Ajayi, V., Anaya, K., and Pollitt, M., (Ajayi et al, 2018) *Productivity growth in electricity and gas networks since 1990*. A report prepared for Ofgem.

[36] For electricity distribution, the data used by the authors covered the period 1990/91 to 2016/17, but some specifications used a much shorter period. For gas distribution, the data used covered the period 2008/09 to 2016/17. For gas transmission the data covered the period 2006/07 to 2016/17 period. For electricity transmission the data covered the period 2000/01 to 2016/17.

construct DEA Malmquist TFP. Unlike the econometric modelling typically adopted by Ofgem, DEA is a 'linear' programming approach to estimating the efficiency of different business units. The 'Malmquist' part is a way of decomposing efficiency gains into catch-up and ongoing efficiency.

Ajayi et al's approach is largely in line with the academic literature and models adopted by some regulators internationally. However, we have some concerns of whether their approach can be used to quantify historical efficiency improvements that can robustly and definitively produce quantitative inputs into the ongoing efficiency challenge.

Ajayi et al (2018) uses capex instead of the flow of capital services, which can cause issues in the measurement of output. The capital that should be used in a productivity analysis is the 'flow' of capital services, or how much of the capital services are consumed each year rather than the annual capex. Annual capex can be lumpy and may contain a mix of very long-lived assets and short-lived assets. This does not give a good indication of the capital flow consumed by the companies in providing their services each year. Using annual capex can lead to large shifts in the annual measures of productivity change. This is clearly articulated as an issue in Ajayi et al (2018) with multiple references to capex changes driving the results.[37]

Their use of RPI for deflation means that any changes in input price inflation that differs from RPI over time is not captured. This is related to the issues around Real Price Effects discussed in Section 4. For example, wage price inflation may differ from the RPI; therefore changes over time in input costs may not reflect pure volume movements.

In addition, the authors have used a relatively short period of data, particularly for transmission and for gas distribution for which the period covered is a maximum of 11 years. While this may not be an issue if the data covers a full 'business cycle', the authors have not identified whether this is the case.

Furthermore, the authors' remit was simply to measure historical productivity. Therefore, unsurprisingly, they have not detailed the applicability of their research for use in forecasting the scope for future productivity gains. We also note that using the historical productivity performance of regulated companies' risks embedding this performance into future targets.

Thus overall, while Ajayi et al (2018) provides an indication of the historical productivity of the regulated companies, we do not consider that in its current form it is suitable for use alongside EU KLEMS data to inform the ongoing efficiency challenge. To make use of the DEA approach it would be necessary to commission a new study to address the issues with applicability identified above.

2.4. FORWARD-LOOKING EVIDENCE ON PRODUCTIVITY FROM THE ENERGY SECTOR

This section discusses factors specific to the energy sector that may change the expectations of the scope of future improvements in frontier efficiency during RIIO-GD2 and RIIO-T2. These factors include:

- Innovation funding provided by consumers to network companies during RIIO-1 – e.g. through the Network Innovation Allowance.
- Opportunities for efficiency gains during transformational periods for network companies. Such periods are typified by a step increase in funding that allows new opportunities for economies of scale and scope and optimisation of internal business processes and operations.

[37] See, for example, pages 64 and 65 of the conclusions section of Ajayi et al (2018).

- The extent to which meeting the suite of reputational incentives proposed by the companies without baseline funding attached will effectively erode some of the cost savings achieved through improved efficiency.[38]

The second and third issues are not discussed further in this report as they are something that Ofgem would need to consider at a sector or company level once it has taken a position on the cost allowances it proposes to set for RIIO-2 in comparison to RIIO-1.

2.4.1. Innovation funding

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 result in cost reductions and increase in productivity. This type of regulated funding for innovation is not available to industries in competitive markets considered in the EU KLEMS analysis.

In this section, we explore whether there is any evidence from previous energy price controls or from other regulated sectors to inform a robust quantification of how the innovation funding could be expected to result in sector-level efficiency improvements.

We considered the following key questions to inform this assessment:

- What innovation funding has there been in previous Ofgem price controls?
- What evidence is there from the GB energy network sector on how innovation funding has changed the scope for ongoing efficiency improvements?
- What evidence is available from outside the GB energy network sector on the link between innovation spending and ongoing efficiency improvements that can be achieved?

Our review identified the challenges of establishing a firm relationship between the level of innovation funding and the expected efficiency improvements that could result from the funding.

One way of looking at the innovation funding is to consider it as consumers providing the network companies with upfront allowances. Therefore, we considered the issue from a different perspective – in terms of what consumers may reasonably expect to receive during RIIO-2 in return for the innovation funding they have provided to the network companies in RIIO-1.

What innovation funding has there been in previous Ofgem price controls?

Ofgem looked in detail at the framework for innovation in energy networks in its RPI-X@20 review.[39] Since privatisation, the focus of energy network companies on innovations was in the areas where they were incentivised to improve performance; with particular emphasis on achieving cost reductions, especially in opex. However, a lot of R&D progressed by academics and other groups were not being trialled on the networks.

The introduction of various incentives in the price controls prior to RIIO helped increase innovation. Ofgem introduced the Innovation Funding Incentive (IFI) as part of DPCR4 (2005-2010) where R&D spending in the UK electricity distribution sector increased from c. £1m to over £11m over three years.[40] Gas distribution, gas transmission and electricity transmission companies have also had access to innovation stimulus funds since the

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[38] For example, this point was noted with respect to Cadent in the January 2020 RIIO-2 Challenge Group report. "*These plans [Cadent] are backed up by a series of specific reputational incentive commitments…..Cadent estimates the costs of these initiatives as c£16m over the RIIO-2 period. However, it says it has not increased the baseline to allow for these but will effectively take them as an additional efficiency challenge over the period.*"

[39] Ofgem (2009) *Regulating energy networks for the future: RPI-X@20*., Working paper 2, Innovation in energy networks: Is more needed and how can this be stimulated?

[40] Ofgem (2009) *Regulating energy networks for the future: RPI-X@20.* Working paper 2, Innovation in energy networks: Is more needed and how can this be stimulated?

introduction of the IFI in 2007. The IFI evolved into the Low Carbon Networks Fund (LCNF) in DPCR5 which provided approximately £250m of funding to DNOs to trial new technologies.

In RIIO-1, Ofgem introduced three innovation mechanisms to help enable the transition to a low carbon economy as well as minimise networks' environmental impact: the Innovation Roll-Out Mechanism (IRM), the Network Innovation Allowance (NIA) and the Network Innovation Competition (NIC).

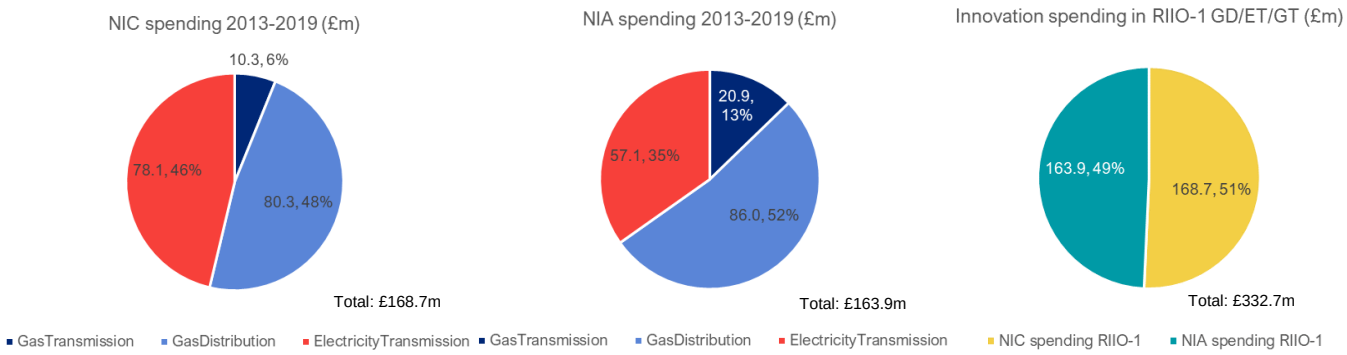
Ofgem tends to adopt a case-by-case process for any innovation project to be funded through the NIA or the NIC. For innovation projects to be approved by Ofgem, network companies must provide detailed evidence on how their proposed projects will accelerate the development of a low carbon energy sector and whether the projects have the potential to deliver net financial benefits to existing and/or future customers.

In RIIO-1 there were approximately 700 NIA projects and 20 NIC projects across gas distribution, gas transmission and electricity transmission. Innovation spending across both mechanisms was over £330m[41], with Figure 2.1 showing the breakdown of spending by sector.

The types of projects that network companies received innovation funding include:

- demonstration plants;
- initiatives to help meet decarbonisation targets;
- initiatives making use of real-time data for a more flexible network in the future; and
- initiatives enabling operational efficiencies such as remotely repair leaking joints.

Figure 2.1: NIC and NIA spending in RIIO-1 (year-to-date) for GD, GT and ET (excluding ESO)



Source: CEPA analysis of Ofgem data

Table 2.5 shows that the NIA allowances in RIIO-1 represented between 0.5-0.7% of base revenue across the GDNs and the transmission companies.

[41] The total innovation spending in the sector was much greater as network companies also rely on external funding for their innovation projects.

Table 2.5: Summary of NIA allowances for RIIO-1 (GD, GT and ET)

Company	RIIO-1 NIA p.a. (£m)	RIIO-1 NIA % base revenue
Cadent	11.6	0.7%
NGN	2.6	0.7%
SGN	4.8	0.5%
WWU	1.9	0.5%
SPT	1.9	0.5%
SHET	1.8	0.7%
NGET	9.9	0.7%[42]
NGGT	4.5	0.7%

Source: CEPA analysis of Ofgem data

In its SSMD, Ofgem confirmed the following changes to the innovation framework for RIIO-2:

- the retention of the NIA;
- introduction of a new innovation funding pot in place of the existing NIC to refocus innovation funding on the energy system transition; and
- the removal of the IRM.

What evidence is there from the GB energy network sector on how innovation funding has changed the scope for ongoing efficiency improvements?

At the end of DPCR5, Ofgem commissioned Pöyry to perform a review of the LCNF. The review concluded that the mechanism had encouraged DNOs to include innovation as core business, with encouraging signs of transfer to business as usual (BAU) activities – although this remained a work in progress. Pöyry estimated that the potential future benefit from the LCNF projects ranged from 4.5 to 6.5 times the cost of funding the scheme.[43]

We are aware of evidence that specific items of innovation spending by network companies have proven beneficial for the industry and end-consumers. Examples include:

- demonstration projects on the feasibility of substituting natural gas with hydrogen in PE pipes;
- the use of robotics to reduce the time required for maintenance and repairs;
- the injection of biomethane into the grid; and
- innovative approaches for the reduction of carbon emissions.

However, despite the increased focus on innovation spending in RIIO-1, the link between the increased innovation spend and the overall level of potential efficiencies to be achieved in RIIO-2 remains unclear. Since innovation funding has been a feature of price controls for over a decade, we would expect companies to be able to clearly articulate the impact that past innovation funding has had on forecast costs for RIIO-2.

In 2017, Ofgem commissioned CEPA to review the RIIO framework and RIIO-1 performance.[44] As part of the scope of work, CEPA explored whether the learnings from innovation projects have been incorporated as BAU activities by network companies and considered whether separate innovation mechanisms were required for future price controls. CEPA noted that DNOs were able to provide more evidence in response to these questions than the

[42] 0.5% post separation of the ESO from NGET.

[43] Pöyry and Ricardo (2016) *An Independent Evaluation of the LCNF.* A report to Ofgem

[44] CEPA (2018) *Review of the RIIO Framework and RIIO-1 Performance.*

GDNs and TOs which perhaps reflects DNOs having had access to innovation mechanisms earlier than GDNs and TOs in previous price controls.

We reviewed GDNs and TOs RIIO-2 business plans to see if companies have been able to provide evidence of the impact of innovation spending in RIIO-1 and planned innovation spend for RIIO-2 on realised ongoing efficiencies in RIIO-1 and forecast frontier efficiency improvements in RIIO-2. However, discussion of this relationship in this business plans is limited and mainly qualitative in nature.

This is consistent with the comments from the Customer Engagement Groups, User Groups and the Challenge Group on the treatment of innovation in the RIIO-2 business plans submitted by the GDNs. These groups noted the overall lack of ambition on innovation shown in the business plans. The Challenge Group felt that GDNs should show more ambition to take forward previous innovation projects in RIIO-2. The Customer Engagement Groups of some GDNs were concerned that there was a lack of ambition in efficiency target for BAU innovation.

These stakeholder groups expressed similar views on the submission by the transmission companies. Some of the electricity transmission companies had linked their RIIO-1 innovation spending to their RIIO-2 business plans, but it was still unclear how previous innovations would result in ongoing efficiencies in RIIO-2. Most transmission companies did not articulate well enough the innovation savings they were able to achieve in RIIO-1.

What evidence is available from outside the GB energy network sector on the link between innovation spending and ongoing efficiency improvements that can be achieved?

We have reviewed innovation mechanisms that are in place in other regulated sectors in GB and elsewhere. A summary of this review is included in Appendix B. However, we have not been able to identify any quantitative evidence on the impact of innovation funding on ongoing frontier efficiency improvements in the sector. Therefore, we have explored evidence from the wider economy (i.e. outside regulated sectors) on the link between ongoing efficiency and productivity.

The link between R&D and productivity for large UK establishments with substantial R&D activities is discussed in Bond & Guceri (2016)[45]. The authors used ONS data for large UK establishments in the production industries in the period 1997-2008[46] to:
"study the relationship between their productivity and the presence of substantial R&D activities, either at the production unit itself, or at other UK reporting units owned by the same enterprise group."

The authors estimate a positive relationship between R&D activity and productivity. Specifically, they estimate that total factor (revenue) productivity is on average about 14% higher at the establishments which have substantial R&D themselves, compared to those with no R&D activity. Among the establishments with no R&D themselves, they estimate that productivity is on average about 9% higher at those which belong to enterprise groups which do have substantial R&D elsewhere in the UK in the same sub-sector.

The findings of Bond & Guceri (2016) are insightful and are consistent with the theory that a company that invests in R&D or innovation should become more productive in the near future. However, for the reasons set out below, we see a need for caution in directly quantitatively applying the rate of productivity gains findings in Bond & Guceri (2016) to the regulated energy networks.

The EU KLEMS dataset will already take into account some of the productivity growth captured in Bond & Guceri (2016). Therefore, there may be some scope for double-counting if the full relationship between innovation and productivity was used to estimate an innovation-related top-up to the ongoing efficiency estimates produced by EU KLEMS analysis.

The Bond & Guceri (2016) study measures TFP revenue gains at the level of individual firms. This is because companies in the competitive sector tend to use private R&D funding and patent any innovation to ensure the

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[45] Bond & Guceri (2016) *R&D and productivity: Evidence from large UK establishments with substantial R&D activities. Economics of Innovation and New Technology, 26:1-2, 108-120, DOI: 10.1080/10438599.2016.1203525*

[46] This period before the financial crisis is just longer than the business cycle of 1997-2006 identified in our analysis of the output gap in OBR data, as reported in Section 2.1.

benefits of such innovation stay within the company. This will then affect the measured return to the innovation in revenue terms, as one of the benefits may to be able to increase prices and/or take market share from other companies in the sector. Neither of these impacts would be expected in the energy network sector because of its regulated nature. Indeed, the requirements of the RIIO innovation mechanisms for the network companies to publicly share the results of innovation projects means that the benefits of innovation are disseminated rather than kept within the private company. This would increase the productivity of the whole sector as all network companies can embed learnings from the innovation carried out by others.

The study looks at productivity growth before the 2008-2009 global financial crisis. Productivity growth has been slower since that crisis, even if there is an ongoing debate about the long-term impact on productivity growth. Therefore, it is not clear how the findings of the Bond & Guceri (2016) study would change if it considered the period since the financial crisis.

Bond & Guceri (2016) uses OECD definitions of R&D in production industries.[47] The OECD definitions provide a very systematic way of identifying and defining R&D and its components based on a set of criteria covering a specific set of activities. Furthermore, the definitions differentiate between activities that are part of the innovation process but that do not satisfy the criteria required to be classified as R&D as such. However, these definitions do not directly map to the types of activities contained in the energy sector innovation spending in the energy sector. Innovation under the RIIO mechanisms is defined more broadly than in the OECD definitions; with more of a focus on practical application rather than primary innovation. Therefore, innovation projects undertaken by the network companies would not necessarily always meet the OECD definitions of R&D.

The utilities sector was excluded from Bond & Guceri (2016). Potential sectoral differences between the production industries and the utilities sector will affect the quantitative application of the findings to the energy network sector; for example, it may be expected that the high technology sector might experience greater productivity improvements from R&D than energy network companies. In addition, Bond & Guceri (2016) assumes a one-year lag for their static estimation. We would expect a longer lag in the energy network sector. This is consistent with subsequent discussions with Dr.Guceri that there will be heterogeneity in lags across sectors.

Impact of innovation funding on ongoing efficiency assumption

Both theory and the available evidence suggest that that some degree of causality (in terms of direction) can be expected between innovation funding and ongoing efficiency improvements in the energy network sector. This is supported by the academic evidence of a quantitative relationship between R&D spending and productivity improvements in production industries. In their RIIO-2 business plans, some network companies provided specific examples of areas in which RIIO-1 innovation spending will result in efficiency improvements in RIIO-2 – although the plans didn't describe the overall impact on frontier efficiency.

However, we have not yet identified robust evidence for establishing a firm quantitative relationship between innovation funding in RIIO-1 and the scope for frontier efficiency improvements in the energy network sector.

Through the innovation funding, consumers have provided the network companies with upfront allowances. Therefore, we have considered the issue from a different perspective – what would different assumptions on ongoing efficiency driven by innovation mean for the return effectively received by consumers on the innovation funding they provided to companies in RIIO-1. This can be seen as being akin to treating consumers as investors.

Consideration of how the benefits of innovation are shared between different stakeholders is consistent with the attitude to innovation seen in other regulated sectors. For example, for its innovation competition to run between 2020 and 2025, Ofwat has set out within the competition's guiding principles that innovation fostered through the competition must provide public value for all customers in England and Wales. The Network Rail price control framework for 2014-2019 (CP5) included a mechanism for encouraging innovation through collaboration – the Route-level Efficiency Benefit Sharing (REBS) mechanism. Train operators, if they opted in, could receive a capped share of Network Rail's outperformance or underperformance payments. This mechanism was intended to encourage a train operator to work with Network Rail to drive down industry costs.

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[47] OECD (2015) *Frascati Manual. Guidelines for Collecting and Reporting Data on Research and Experimental Development*.

We have estimated a baseline for what cost savings to consumers would be required in order to make providing the innovation allowances seem a reasonable investment. We recognise that the implied efficiency gains could well be below the savings that companies can actually make, and hence the companies will retain some benefit from the cost efficiencies driven by innovation. However, at this stage, we have not identified a robust way to estimate that upside captured by the network companies.

Estimating the baseline for cost savings from innovation required to provide a reasonable return for consumers involves judgements being made in multiple areas – therefore, to avoid spurious accuracy, we have tried to keep the analysis simple and have tested the robustness of the overall conclusion to different assumptions.

We consider the return at an industry-wide level rather than at the level of individual network companies for the following reasons:

- we are looking at a proxy for an average return to consumers across the whole package of innovation projects, as the return to each project will be variable;
- innovation spending will not always lead to benefits as some innovations might fail to reach proof of concept at scale and will be abandoned; and
- the emphasis in the RIIO framework on dissemination of learnings from innovation.

We have made the following simplifying assumptions, which seem appropriate for the level of accuracy that could be delivered through this exercise:

- Innovation funding (e.g. under the NIC and the NIA) is assumed to have been equivalent to 1% of base revenue each year throughout RIIO-1.
- We have focused on the impact on totex directly rather than attempting to unpick the impact on allowed revenues specifically.
- We have considered consumers as a single group – i.e. not taking into account inter-generational equity issues which would recognise that the group of consumers that fund the innovation allowances will not be entirely the same as the group that receives the later benefits.
- The innovation spend is entirely additional compared to what the companies would have done in the absence of the innovation mechanisms.
- The benefits of the RIIO-1 innovation funding are fully realised during the RIIO-2 period only (in terms of higher annual improvements in ongoing efficiency), with the resulting reduction in costs persisting beyond RIIO-2.

We recognise that in practice, the speed at which innovation leads to ongoing efficiency improvements will vary across projects. The process for large, multi-year innovation projects in the energy sector takes time and can span across multiple price controls. A network company would need to first make a business case for the innovation project in question, secure funding, invest in R&D and subsequently organise trials to test the new technology. Once tested at a smaller scale, larger trials would need to take place to demonstrate proof of concept at large scale. Only when the network company starts embedding (rolling out) the project into its BAU operations, will it realise cost reductions or productivity improvements. Any successful large (and ‘disruptive’) innovation projects trialled and tested in RIIO-1 would only be embedded towards the end of RIIO-1 or in RIIO-2 where some ongoing efficiency improvements might be observed. As such, the innovation cycle cuts across multiple price control cycles and the effects ultimately take a long time to feed through to customers.

On the other hand, embedding smaller innovation projects into BAU would take less time than for larger, more transformative, innovation projects. The efficiency improvements generated by such smaller projects could even be realised within a single price control cycles with additional benefits extending into the following price control cycle. For example, innovation linked to opex could be quicker to implement within a price control than innovation requiring some new equipment to be installed as part of repex, but innovation in repex is likely to result in lower maintenance requirements in the longer-run so any benefits would be realised in the following price control cycles.

We have also considered the duration of the benefits of innovation. This has two aspects – one is to do with how quickly the innovation becomes obsolete; and the second is the extent to which the innovation funding brings innovation forward earlier than it would otherwise would have happened (as opposed to it never having happened without innovation funding).

Table 2.6 lists the main assumptions used to estimate proxy for efficiency improvements to give consumers a reasonable return on innovation funding. This set of assumptions, including an assumption of 0.2% annual improvement in ongoing efficiency during RIIO-2, would provide consumers with a return of 4.2% on the innovation funding provided in RIIO-1.

Table 2.6: Main assumptions used to estimate proxy for efficiency improvements to give consumers a reasonable return on innovation funding

Element	Assumption
Ongoing annual efficiency improvement in the absence of innovation funding	1%
Size and speed of benefits in terms of average annual cost savings	1% reduction in annual costs from the end of RIIO-2 (which is equivalent to the annual innovation funding over 8 years of RIIO-1) Based on an assumption of straight-line improvement in efficiency during RIIO-1, this is consistent with a 0.2% additional improvement in annual ongoing efficiency during RIIO-2 as a result of RIIO-1 innovation funding.
Duration of benefits from innovation	20 years

Source: CEPA analysis

Table 2.7 summarises the results of the sensitivity analysis on the assumptions shown in Table 2.6,[48] which covers the level of underlying ongoing efficiency assumed (i.e. without innovation), size and speed of cost savings, and duration of benefits of innovation.

Table 2.7: Sensitivity analysis on implied rate of return to consumers

Change in assumption	Assumption in sensitivity	Implied return to consumers
Ongoing efficiency improvement in the absence of innovation funding	0%	5.1%
Size and speed of benefits in terms of average annual cost savings	0.1% annual improvement in ongoing efficiency during RIIO-2 as a result of RIIO-1 innovation funding (i.e. 0.5% lower costs by the end of RIIO-2)	-0.6%
Size and speed of benefits in terms of average annual cost savings	0.3% annual improvement in ongoing efficiency during RIIO-2 as a result of RIIO-1 innovation funding (i.e. 1.5% lower costs by the end of RIIO-2)	7.2%
Duration of benefits from innovation	45 years	6.4%

Source: CEPA analysis

Based on this sensitivity analysis, it appears that an annual efficiency improvement of up to 0.2% during RIIO-2 is a reasonable estimate for the level of cost savings required to provide consumers with a reasonable return on innovation funding in RIIO-1.

[48] In the sensitivity analysis, all assumptions are as shown in Table 2.6 unless otherwise stated.

The figure of 0.2% contains some further inherent assumptions that Ofgem will have to consider in deciding to take the impact of innovation funding into account when setting an ongoing efficiency challenge:

- the only benefits that accrue to customers are cost savings – i.e. no account is taken of other benefits such as environmental benefits and quality of service; and
- no additional ongoing efficiency driven by innovation funding in RIIO-1is already embedded in the baseline spending plans submitted by the companies.

2.5. COMPANIES' PROPOSALS ON ONGOING EFFICIENCIES

This sub-section summarises the companies' proposals on ongoing efficiencies as presented in the Business Plans that they have published.

2.5.1. GDN submissions for RIIO-2

The four GDN companies made use of similar sources of evidence to support the ongoing efficiency estimates incorporated within their respective business plans. These included:

- analysis of the EU KLEMS database;
- historical trends and forecasts in UK economy-wide productivity growth; and
- analysis of the historical efficiency performance of network companies.

Cadent, SGN and Northern Gas Networks (NGN) all explicitly refer to a First Economics report for the Energy Networks Association (ENA) on ongoing efficiency.[49] In addition, Cadent's submission explicitly discussed whether there was scope for innovation to shift the efficiency frontier, as well as the ongoing efficiency analysis presented in Ofwat's Price Review 2019 (PR19) Draft Determination.[50] SGN also discussed PR19, including reasons why Ofwat's proposals on the ongoing efficiency challenge could not be directly transferred to the GD sector. [51]

Wales & West Utilities (WWU)[52] and NGN[53] both estimate that they can achieve ongoing efficiencies of around 0.5% per annum over RIIO-2. The Oxera paper provided as part of the WWU submission[54] describes an estimated range for TFP of 0.4% to 0.8%, and labour productivity of 0.9% to 1.2%, with an overall benchmark for ongoing annual efficiency improvement of 0.4% to 0.8%.

Cadent cites an ongoing efficiency target for an efficient company of 0.53%. However, its business plan submission sets an ongoing efficiency target for its own networks of 0.94% whilst stating it will be a frontier company by the start of RIIO-2.

The rationale provided by the companies for setting ongoing efficiency targets for RIIO-2 below the level that Ofgem set for RIIO-GD1 include:

- the UK's recent productivity performance being lower than the longer-term historical trend, and

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[49] First Economics (2019) *Frontier Productivity Growth*. A report prepared for the Energy Networks Association

[50] Cadent (2019) *Transforming experiences. Customers. Communities. Colleagues. Our plan for 2021 – 2026.*

[51] SGN (2019) *RIIO-GD2 Business Plan.* Appendix 5 Cost Efficiency.

[52] Wales & West Utilities (2019) *Our business plan for 2021 – 2026. A sustainable business in a changing and dynamic sector*

[53] Northern Gas Networks (2019) *RIIO-GD2. Business Plan 2021 – 2026.*

[54] Oxera (2019) *Establishing an appropriate efficiency challenge.* Prepared for Wales & West Utilities Limited.

- the Bank of England's 'low' productivity growth forecast for the next three years. WWU specifically refers to setting their ongoing efficiency challenge 0.2% above the BoE's TFP forecast of 0.3% that prevailed at the time of business plan submission.

SGN sets more challenging targets,[55] stating that its plan includes average productivity improvements across its two networks of 1.4% per annum on opex and 0.7% on capex and repex. This equates to around 1% per annum improvement on totex.

2.5.2. Transmission companies' submissions

National Grid Gas Transmission (NGGT)[56] and National Grid Electricity Transmission (NGET)[57] both present an ongoing annual efficiency target for opex of 1.1%. NGGT implies an 0.8% ongoing efficiency target for capex, based on a 4% capex reduction target over the course of RIIO-2. An equivalent figure for capex is not explicitly set out in the business plan published by NGET.

Scottish Hydro Electric Transmission (SHET) sets a lower ongoing efficiency of 0.5% per annum for opex and 0.3% for capex[58].

SPT[59] suggests a net frontier shift of 0 as RPEs and ongoing efficiency improvements are expected to cancel each other out. This is consistent with an annual ongoing efficiency improvement of 1%.

2.6. ONGOING EFFICIENCY CHALLENGE IN OTHER PRICE CONTROL PROCESSES

In this section, we consider how the ongoing efficiency challenge was set in RIIO-1, and the issues covered in Ofwat's final determination on PR19.

2.6.1. Ongoing efficiency challenge for RIIO-GD1 and RIIO-T1

For RIIO GD1 and T1 (NGET and NGGT), Ofgem set the values for ongoing efficiency shown in Table 2.8. Ofgem did not set its own ongoing efficiency challenge either for the fast-tracked transmission companies in RIIO-T1 (SPT and SHET) or for all companies in RIIO-ED1, because it accepted the ongoing efficiency challenges proposed by the companies.

Table 2.8: Summary of the ongoing efficiency values used in RIIO-1

	RIIO-GD1	RIIO-T1 (NGGT TO and NGET TO)
Opex	1.0%	1.0%
Capex	0.7%	0.7%
Repex	0.7%	-
Totex	**0.8%**	**0.7%**

Source: Ofgem[60]

[55] SGN (2019) *RIIO-GD2 Business Plan.* Appendix 5 Cost Efficiency.

[56] National Grid Gas Transmission (2019) *Delivering the future gas transmission system. National Grid Gas Transmission's Business Plan 2021-2026.*

[57] National Grid Electricity Transmission (2019) *Delivering the future electricity transmission system. National Grid Electricity Transmission's Business Plan 2021-2026.*

[58] Scottish Hydro Electric Transmission (2019) *RIIO-2 Business Plan Data Tables.* Table A1.6

[59] SP Energy Networks (2019) *RIIO-T2 Business Plan 2021-2026*

[60] Ofgem (December 2012) *RIIO-T1/GD1: Real price effects and ongoing efficiency appendix*. Final decision – appendix.

The figures in Table 2.8 were informed by the historical improvement in efficiency between 1990 and 2007 for different samples of comparator sectors in the 2009 EU KLEMS dataset.[61]

The 1.0% ongoing efficiency target for opex was based on the partial factor productivity measures derived from EU KLEMS for the samples of selected industry averages and all industry average numbers.

The 0.7% capex and repex efficiency targets were informed by the total factor productivity (TFP) numbers for construction, which was referred to as the principal comparator. It also took account of the average TFP for other industries.

2.6.2. Smart Grids Benefits in RIIO-ED1

For RIIO-1, Ofgem wanted network companies to demonstrate the extent to which the Low Carbon Networks Fund (LCNF) and other innovation incentives had resulted in smart solutions that are expected to generate savings in RIIO-1 and onwards. At the time of the RIIO-1 draft determinations for slow-track companies, Ofgem defined savings related to smart grids as:

- smart metering data;
- network capacity (through avoiding or delaying work to increase the capacity of the network); and
- other smart grid savings (other benefits related to smart solutions).

Ofgem's analysis of the business plans submitted by slow-track companies showed that not all DNOs had sufficiently considered and demonstrated the potential benefits of smart grid solutions and the associated cost savings to consumers by adoption smart grids solutions. As a result, Ofgem decided to reduce the slow-track DNOs allowances to take account of additional savings which companies did not include in their business plans. Ofgem estimated that a reduction of 2.2% of totex should be applied to all slow-track DNOs to reflect smart grid savings – this was on top of the smart grids savings the DNOs have already included in their plans.

Northern Powergrid (NPg) appealed Ofgem's price control decision to the CMA, stating that the smart grid benefit adjustments made to NPg's totex allowances were disproportionate and unjustified. In its final determination, the CMA determined that the adjustment Ofgem applied to NPg was not justified because the CMA was:

"not satisfied that [Ofgem] had established that there was risk of a material underestimation of [Smart Grid Benefits] that had not been adequately addressed through [Ofgem]'s general cost benchmarking exercise."[62]

The CMA granted NPg an additional £31.5m in allowed totex, of which £11m is reflected in higher allowed revenue (after applying the IQI) during the eight years of RIIO-ED1, with the rest recovered in future price controls.

When considering the relevance for the RIIO-2, it is important to note that the CMA noted the importance for GEMA of challenging the DNOs to ensure that innovation benefits were sufficiently incorporated into the business plans.

"GEMA had been consistent throughout the RIIO process that DNOs needed to demonstrate how they had considered using smart grid solutions… Public money has been used to fund pilot schemes and GEMA noted heightened consumer interest in ensuring that SGBs were adequately reflected in the price control. It is, in our view, consistent therefore with GEMA's objectives for it to prioritise smart grid solutions in the price control and provide constructive challenge to the DNOs to incorporate them sufficiently in their business plans." [63]

Therefore, the lessons for Ofgem from the SGB appeal outcome are:

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[61] The detailed descriptions and results of the EU KLEMS analysis for the comparator sectors in RIIO-1 are listed in Appendix A.1.

[62] Competition and Markets Authority (2015) *Northern Powergrid (Northeast) Limited and Northern Powergrid (Yorkshire) plc v the Gas and Electricity Markets Authority. Final Determination.* Para 4.143

[63] Competition and Markets Authority (2015) *Northern Powergrid (Northeast) Limited and Northern Powergrid (Yorkshire) plc v the Gas and Electricity Markets Authority. Final Determination.* Para 4.131

- The importance of establishing the extent to which innovation benefits have already been embedded in the business plans submitted by the companies.[64]
- The importance of a transparent and robust methodology for estimating innovation benefits.
- Being able to show that it has made a 'fair' assessment of the outcomes and risks in setting the ongoing efficiency challenge.
- Providing the network companies with sufficient time and information to assess and, if necessary, challenge Ofgem's data, modelling and conclusions.

2.6.3. Ofwat's Final Determination for PR19

We also considered the ongoing efficiency challenge of 1.1% per annum set by Ofwat in its PR19 final determination.[65]

Ofwat considers scope for frontier efficiency improvements from two sources:

- ongoing efficiency improvements in the economy that the water sector should be able to emulate; and
- one-off efficiency improvements from water companies making greater use of the totex and outcomes framework at PR19.

Using data from EU KLEMS, Ofwat's consultant (Europe Economics) estimated that the water companies should be able to achieve ongoing efficiencies of between 0.6% and 1.2% per year on wholesale totex. This is before allowing for the impact of the introduction of the totex and outcomes framework which Ofwat estimated could drive additional efficiencies.[66]

Europe Economics recommended that a number on the upper end of this range should be chosen for two reasons:

- Although Europe Economics argued that TFP measured in GO terms was a more accurate measure of frontier shift, it stated that some weight should be placed on VA measures of productivity growth. As VATFP estimates are always going to be higher than a GO TFP equivalent, placing emphasis on VA measures implied selecting a challenge on the upper end of their range.
- TFP estimates in EU KLEMS data do not take into account the potential cost savings from quality improvements that are 'embodied' in the inputs used by the sector – labour, capital and intermediate inputs.[67] Failure to take into account 'embodied' change could omit key sources of cost savings. Europe Economics suggested that TFP growth estimates might need to be uplifted by as much as 60% to account for embodied technological change.

In addition, Ofwat considered that the PR19 regulatory framework could drive one-off efficiency gains within the water sector. In particular, the totex and outcomes framework that was introduced at PR14 allowed water companies to achieve additional efficiency gains through innovation and lower cost solutions. As such, Ofwat considered that there should be a period of time in which the water sector makes 'industry catch-up' efficiency gains as its input mix and approach to delivering outcomes are re-optimised. This process will move the sector closer to the productivity levels of comparator sectors in which the existing capex-opex balance has not been

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[64] See 4.137 of the CMA's Final Determination; *"Further, we conclude that GEMA's assessment of DNO business plans did not provide material support for the view that there was an SGB shortfall that justified an adjustment."*

[65] Ofwat (2019) *PR19 Final Determinations – Securing Cost Efficiency Technical Appendix*.

[66] Europe Economics (2019) *Real Price Effects and Frontier Shift – Final Assessment and Response to Company Representations*.

[67] EU KLEMS takes into account disembodied technical change that allows inputs to be converted into outputs such as better management. Embodied technical change refers to efficiency improvements which is embodied in the factors of production such as more advanced machinery.

distorted by a historic capital bias. Ofwat's consultant (KPMG) estimated that the impact of the totex and outcomes framework on the water sector might generate additional productivity improvements of between 0.2% and 1.2% per year.[68]

On the basis of the analysis described above, Ofwat set an ongoing efficiency challenge of 1.5% at the draft determination stage.

However, Ofwat's thinking on the impact of the totex and outcomes framework changed between draft and final determination. This is due to a weakening of evidence on the outperformance of the totex and outcomes framework. Ofwat compared outturn expenditure against the PR14 allowance to show that outperformance over PR14 has declined, in particular for middle or average performing companies. Based on this evidence, Ofwat did not consider that the totex and outcomes framework is as likely to generate continued one-off efficiency gains going into PR19. Based on this judgement, Ofwat lowered its overall ongoing efficiency challenge from 1.5% at the time of the draft determination to 1.1% for the final determination.

[68] KPMG and Aqua Consultants (2018) *Innovation and efficiency gains from the totex and outcomes framework*.

3. SETTING THE ONGOING EFFICIENCY CHALLENGE

Setting the final ongoing efficiency challenge requires a view to be taken on the weighting given to the different pieces of evidence for the ongoing efficiency challenge that were presented in Section 2. Factors for consideration in making this judgement are:

- The uncertainty around estimating future productivity improvements, particularly at a time of change within the energy sector, and potential disruption in the wider economy.
- The balance between backward-looking evidence and forward-looking evidence, which will be influenced by the view on how good a guide history will be to the future.
- How to interpret productivity evidence from different sources in a way that tries to ensure that figures are compared on a like for like basis.
- The need for coherence with the approach taken to other elements of the price control; such as the extent to which forecast expenditures have been cut through the cost assessment process – e.g. whether the ongoing efficiency challenge has to address areas in which a robust efficiency challenge could not be identified in the cost assessment process, or to mitigate the risk of double-counting of expected efficiency gains across different elements of the price control.[69]
- The current uncertainty around the magnitude and duration of any impact on productivity of the COVID-19 crisis, both for the wider economy and for energy network companies. Such effects are not captured in the forward-looking productivity estimates reviewed in this report (because of the time at which those estimates were produced). At the time of writing, it is not immediately clear that the COVID-19 crisis will affect ongoing efficiency for network companies specifically, beyond the effect of restrictions on working practices in the near term. It may affect other sectors more materially, which would change the relationship between wider economic productivity and the level of ongoing efficiency improvements that can be achieved in the energy network sector.

This section begins describing a reference point for a stretching ongoing efficiency challenge informed by growth accounting analysis. We then discuss the evidence for making adjustments up and down from this reference point in order to reach the final position on the ongoing efficiency challenge. It is helpful to consider these pieces of evidence as different perspectives on the outlook for frontier efficiency improvements (e.g. on which historical time period best reflects outlook for future productivity; on whether ongoing efficiency improvements in energy networks are more strongly driven by economy-wide productivity or by sector-specific factors). Ofgem can then use these different perspectives to make a judgement on which perspectives it sees as fitting best within the overall framework of the RIIO-2 price control.

3.1. USING GROWTH ACCOUNTING ANALYSIS TO SET A REFERENCE RANGE

Section 2.1 described the well-established methodology for using growth accounting analysis to inform the ongoing efficiency setting challenge. That section also described the range of estimates that can be gathered from the 2019 EU KLEMS dataset based on different assumptions for:

- the time period;
- the productivity metrics; and
- the comparator industries.

[69] For example, the cost benchmarking process may be the way in which companies are exposed to some of the additional efficiency gains that stakeholders like the Challenge Group and some Consumer Engagement Groups stated that there is scope for.

This section describes the choices made in these areas to set a reference range for the ongoing efficiency challenge for RIIO-2. It then discusses how the values produced by alternative choices can then be used to inform any adjustment to the reference range in determining the final ongoing efficiency challenge.

The reference range for the ongoing efficiency challenge in this report is based on the following choices.

The time period for the reference values is 1997-2016.

The reference point uses as much of the data as is possible from the 2019 EU KLEMS dataset. This captures two complete business cycles, based on our analysis of the OBR data on output gaps. We consider that a longer time period over several business cycles is likely to reduce sensitivity to measurement error and outlier years, and hence result in an average productivity growth rate that may be more representative of long-run underlying factors. As a relatively simple approach, this also avoids the need for potentially arbitrary judgements on what shorter samples should be selected. Including data for the most recent years available also addresses the point made by many of the network companies that at least some weighting should be given to the slow growth in productivity seen since the global financial crisis of 2008-2009.

The industry samples used for the reference values are the unweighted average of selected industries (excluding manufacturing), and the weighted average of all industries (excluding real estate, public admin, education, health and social services).

Using these groups to set the reference value has two main advantages. First, it allows the reference value to capture trends in:

- the four industries seen as closest to energy networks in RIIO-1, with energy networks having been described as the construction and maintenance of an asset combined with some customer-/business-facing services (construction, wholesale and retail trade: repair of motor vehicles and motorcycles; transportation and storage; and financial and insurance activities);[70] and
- economy-wide trends (weighted average of all industries), which are also more comparable with economy-wide productivity forecasts produced by the OBR and the BoE.

Secondly, the productivity values from EU KLEMS for these groups over the reference time period (1997-2016) are around the middle of the range across all the sample groups presented in Table 2.2 in Section 2.1.2.

The productivity metrics used for the reference values are Total Factor Productivity (TFP) Value Added (VA) for capex and repex; and Labour Productivity (LP) VA for opex ongoing efficiency estimates.

As discussed in Section 2.1.1, there is no consistent expert view on whether VA or GO are better productivity measures. Based on the reference time period and industry samples, the VA measures are close to the highest ongoing efficiency values proposed by any of the network companies in their RIIO-2 submissions. Some network companies also explicitly supported the use of VA measures.

The GO measures for TFP and for LP sit close to and even below even the lowest ongoing efficiency values proposed by any of the network companies in their RIIO-2 submissions. In addition, the 2019 EU KLEMS database does not include all of the data traditionally required to reproduce GO TFP estimates. Therefore, we have had to use an approximation to construct the GO measures shown in this report. This approximation may work less well for LP than for TFP measures.

Therefore, we have used VA measures to set the reference values, with GO measures considered as part of possible downside adjustments to these reference values.

Table 3.1 sets out the reference values from the EU KLEMS dataset based on the choices set out above.

[70] These four industries represent about 40% of the all-industry sample, based on share of value added or gross output.

Table 3.1: EU KLEMS data for efficiency benchmarks for RIIO-2 (to 1 d.p.)

Sector	TFP VA 1997-2016	LP VA at constant capital 1997-2016
Unweighted average selected industries (exc. manufacturing)	0.6%	1.0%
Weighted average all industries	1.0%	1.2%
Midpoint reference value	**0.8%**	**1.1%**

Source: CEPA analysis of EU KLEMS data

3.2. POSSIBLE ADJUSTMENTS TO THE REFERENCE VALUES BASED ON GROWTH ACCOUNTING

We can use the full set of EU KLEMS results presented in Section 2.2 to explore the possible impact on the ongoing efficiency challenge of using different choices to those underpinning the reference values. These alternative choices are described below.

The EU KLEMS values could be calculated on the basis of a shorter time period. Using 2006-2016 would use only the most recent business cycle, as opposed to using it as one of two business cycles in the period from 1997-2016. Using a shorter time period for growth accounting analysis tests the impact of taking the view that the slow productivity growth since the global financial crisis represents a structural break in the economy-wide potential for productivity improvements.

This argument was cited by network companies in support of ongoing efficiency targets of around 0.5% submitted in the RIIO-2 business plans. For example, Oxera used a similar time period (2007-2016) in the analysis that it provided to support WWU's business plan stating that it represents a full economic cycle.[71] This was supported by evidence that since the global financial crisis in 2008-2009 productivity growth in the UK has been below its long-term trends. Putting more weight on this time period would therefore represent a downwards adjustment from the reference value.

Our June 2019 Frontier Shift report[72] discussed the challenges of showing that a structural break has occurred in data series, which is particularly difficult when considering a cyclical variable like productivity. There was a period of highly unusual economic conditions around the financial crisis of 2008-2009, which account for about 20% of this shorter time period. In addition, the BoE has reported that the fall in UK productivity since the financial crisis is attributable to the performance of four sectors which together accounted for one-third of total output: manufacturing, finance, ICT and professional services. Manufacturing and finance together accounted for three-quarters of the decline in productivity growth.

For comparator industries, there are three alternative choices captured in the EU KLEMS analysis set out in Section 2.2:

- Using the construction sector (F) only as a comparator – i.e. putting 100% weight on the construction sector. The construction sector is included in the sample groups used to construct the reference values in our EU KLEMS analysis in Section 2.1. Construction accounts for 25% of the selected industries excluding manufacturing[73], and around 10% of the weighted average of all industries. Giving more weight to construction would produce a downwards adjustment from the reference values presented in Table 3.1.
- Including the four manufacturing sub-industries in the sample of selected industries (chemicals and chemical products (C20); computer, electronic and optical products (C26); electrical equipment (C27); and

[71] Oxera (2019) *Establishing an appropriate efficiency challenge.* Prepared for Wales & West Utilities Limited.

[72] CEPA (2019) *RIIO-GD2 cost assessment – frontier shift.*

[73] This is an implicit weight because it is an unweighted average of four sectors.

transport equipment (C29_C30)). As productivity improvements have been relatively higher in these sub-industries, this would represent an upwards adjustment from the reference value.

- Using the unweighted average for all industries excluding real estate, public admin, education, health and social services. We would not suggest considering this option further because of the risk that this average is distorted by the impact of the financial crisis on particular sectors that are neither close comparators for the energy networks, competitive industries, and/or represent a small part of the economy (and hence have more influence over an unweighted average than the average one).

At this stage, our analysis has focused on analysing the sample groups used to inform the ongoing efficiency challenge set by Ofgem in RIIO-GD1 and RIIO-T1. Ahead of the Final Determination, Ofgem may wish to review whether these groupings should be amended or new ones created to act as closer comparators to the gas distribution and electricity transmission sectors.

In considering alternative comparator groups, Ofgem should consider how the regulated nature of energy networks means that companies may be less exposed to negative shocks that can arise in competitive markets. Relying exclusively on outlooks and historical analysis that do not capture reduced exposure to market risk and negative shocks would then underestimate the scope for cost efficiencies in energy networks. To practically compensate for this underestimation risk, Ofgem could pick the upper values of economy-wide productivity figures like those contained in EU KLEMS[74].

In the SSMD, Ofgem confirmed that it would focus comparative analysis on:

"those sectors that have similarities with network companies, e.g. those that have significant asset management roles; and to exclude sectors (e.g. the energy sector) where historical performance is heavily influenced by increases in productivity realised after privatisation".

Some network companies suggested alternative groupings, such as in Oxera's report for WWU which proposed the following samples:

- Capex: Construction (F); Other manufacturing; repair and installation of machinery and equipment (C31-C33)
- Repex: Construction (F); Wholesale and retail trade; repair of motor vehicles and motorcycles (G); Other manufacturing; repair and installation of machinery and equipment (C31-C33); Transport and storage (H49– H53)
- Opex: Transport and storage (H49– H53); Professional, scientific, technical, administrative and support service activities (M-N); Telecoms (J61); IT and other information services (J62J63); Wholesale and retail trade; repair of motor vehicles and motorcycles (G)

With respect to productivity metrics, putting weight on GO measures would represent a downwards adjustment to the reference value.

3.3. USING FORWARD-LOOKING PRODUCTIVITY ESTIMATES TO ADJUST THE ONGOING EFFICIENCY CHALLENGE

Some of the company submissions support the use of productivity forecasts in setting the ongoing efficiency challenge. Section 2.2 discusses the latest available forecasts for:

- Hourly labour productivity, applicable to opex, from the OBR and the BoE, and

[74] In doing so, Ofgem would have to pay regard to any lessons from the PR19 appeal process; where one of the grounds for appeal cited by the companies making the appeal is that Ofwat arbitrarily set a target towards the top end of the range implied by EU KLEMS, through a 'selective choice' (of comparator sectors and time period).

- Total factor productivity, applicable to capex/repex, from the BoE.

These are economy-wide forecasts and hence are most comparable to the weighted average of all industry sample in the EU KLEMS analysis.

These forecasts do not cover the whole RIIO-2 period (2021-2026). The BoE labour productivity forecast runs to 2022, the BoE total factor productivity forecast is a single value from 2020-Q1 2023, and the OBR labour productivity forecast runs to 2024. This raises the challenge of what assumptions to use for the latter years of the RIIO-2 period especially when there is a rising trend in the forecast over the period, which is the case for the labour productivity forecasts from both OBR and BoE.

If we take a simple average of the forecasts for years covered by RIIO-2, the labour productivity forecasts from the BoE and OBR are 1.0% and 1.15% respectively, which is comparable to the reference value of 1.1% for opex from the EU KLEMS analysis.

The TFP forecast of 0.1% from the BoE represents a major downside on the reference value of 0.8% from the EU KLEMS analysis. It is also below the values proposed by the companies in their own submissions.

3.4. USING HISTORICAL PERFORMANCE OF THE NETWORK COMPANIES TO ADJUST THE ONGOING EFFICIENCY CHALLENGE

Section 2.3 discusses the potential to use the historical performance of the companies to directly inform the efficiency target for RIIO-2. At this stage, we would not support taking this further forward because:

- The difficulty in producing a robust estimate of historical productivity gains in the energy network sector.
- Ofgem has developed a separate mechanism – the wedge between allowed return and expected return – to address the issues identified in relation to the tendency of network companies to outperform allowances.
- Ofgem's cost assessment process may capture the scope for out-performance where it is related to catch-up efficiency.

3.5. USING FORWARD-LOOKING EVIDENCE ON ENERGY SECTOR PRODUCTIVITY TO ADJUST THE ONGOING EFFICIENCY CHALLENGE

Section 2.4 discusses factors specific to the energy sector that may change the expectations of the scope of future improvements in frontier efficiency during RIIO-GD2 and RIIO-T2. At this stage, we only consider innovation funding in RIIO-1 as a source of possible adjustment to the reference value for the ongoing efficiency challenge.

This is because the issues around step changes in funding and the efficiency embedded in reputational incentives are factors for Ofgem to consider once it has taken a position on the cost allowances it proposes to set for RIIO-2 in comparison to RIIO-1.

Section 2.4.1 describes how both theory and the available evidence suggests that that some degree of causality (in terms of direction) can be expected between innovation spending and ongoing efficiency improvements in the energy network sector. However, we have not yet identified robust evidence for establishing a firm quantitative relationship between innovation funding and the scope for frontier efficiency improvements in the energy network sector.

Therefore, we have estimated that an annual ongoing efficiency improvement challenge of up to 0.2% could represent a reasonable return to consumers on the upfront funding they provided in the form of innovation allowances in RIIO-1.

Deciding how this 0.2% figure should be reflected in the ongoing efficiency challenge will be based on judgement on how important the following factors might be:

- The importance of benefits to consumers other than cost savings – such as environmental benefits and quality of service.

- If benefits from innovation funded in RIIO-1 will fully feed through more quickly to cost savings for consumers than by the end of RIIO-2 (and hence result in a lower ongoing efficiency improvement required to provide a reasonable return).
- If benefits from innovation create longer-lasting cost savings for consumers than 20 years (and hence result in (and hence result in a lower ongoing efficiency improvement required to provide a reasonable return).
- The degree of additional ongoing efficiency driven by innovation funding in RIIO-1 that is already embedded in the baseline spending included in the companies' business plans; which is an issue highlighted in Northern Powergrid's successful appeal against Ofgem's Smart Grid Benefits adjustment in RIIO-ED1 (which is discussed further in Section 2.6.2).

This must be weighed against the fact that the 0.2% does not capture any of the potential upside that might accrue if innovation funding can deliver greater improvements than assumed as being required to provide a reasonable return to consumers. This raises a question of where the burden of proof should lie in establishing the relationship between innovation funding and ongoing efficiency – i.e. to what extent do the networks need to be able to demonstrate efficiency gains from innovation projects in their business plan submissions.

Another factor to consider is that the provision of the price control funding for innovation means that innovation in the energy network sector may be less sensitive to economy-wider shocks than in competitive industries. In this regard, we note that at the time of CEPA's review of RIIO-1,[75] most network companies argued for the retention of the RIIO-1 innovation mechanisms. This was on the basis the incentives inherent in the RIIO model alone were unlikely to deliver the big scale innovation required to meet decarbonisation targets.

3.6. SETTING THE FINAL ONGOING EFFICIENCY CHALLENGE

This section has described the creation of reference values for the ongoing efficiency challenges for opex and for capex/repex based on EU KLEMS analysis. It has then discussed how different pieces of evidence may be used to make upward or downwards adjustments from the reference values.

We suggest that Ofgem should focus on considering the case for the following adjustments:

- **Giving some weight to the GO measures from EU KLEMS.** As discussed in Section 3.1, there is no consistent expert view on whether VA or GO are better productivity measures. As described in Section 2.1, we used a formula to produce proxies for the GO values from the data included in the 2019 EU KLEMS dataset. GO measures sit close to or below even the lowest ongoing efficiency values proposed by any of the network companies in their RIIO-2 submissions. Therefore, we would not suggest putting 100% weighting on the GO measures (i.e. completely replacing the VA values).
- **Productivity forecasts from the OBR and BoE.** Placing some weight on these forecasts would help to capture additional insight into the scope for productivity potential beyond simply extrapolating historical trends. We would suggest the EU KLEMS analysis remains the main source of the ongoing efficiency challenge with these forecasts being used as supporting evidence rather than main evidence. Doing this would suggest a slight increase in the ongoing efficiency challenge for opex, based on labour productivity. There would be a reduction in the ongoing efficiency challenge for capex, based on the BoE forecast of annual TFP growth of 0.1%. The extent of this decline would depend on the weight placed on the BoE productivity forecast.
- **Ensuring a reasonable return for consumers from the innovation funding provided in RIIO-1.** We discussed the case for an upwards adjustment of up to 0.2% to ensure that consumers receive a reasonable return on investment. The extent of this adjustment will depend on how Ofgem weights the other factors discussed in Section 3.5.

[75] CEPA (2018) *Review of the RIIO Framework and RIIO-1 Performance.*

We suggest that at this stage, Ofgem should not adjust the reference value for the following factors:

- **Using a shorter time period (2006-2016**). This time period already accounts for just over 50% of the time period used to define the reference value. Putting more weight on the shorter time period would represent an assumption that the global financial crisis has created a strong structural break in the long-term productivity of the economy at large, and also the energy network sector; which means that earlier time periods are less useful as a guide to future productivity growth. It is not clear to us that the evidence exists for such a strong assumption at this stage when it is challenging to confidently identify a structural break in long-term productivity growth. Most of the evidence presented by the companies in this regard has been on the basis that productivity has grown more slowly since 2008-2009 (which is captured in the longer time period) rather than making a case for why this will continue to be the case during RIIO-2. In addition, using forward-looking productivity forecasts may be a better approach of capturing any underlying change in productivity potential at an economy-wide level.
- **Putting more weight on the construction sector as a comparator,** particularly for capex. The construction sector is included in both sample groups used to construct the reference value; with a weighting of 25% in one of the samples. The historic productivity estimates for the construction sector are at the bottom of the range of ongoing efficiency challenges proposed by the companies. Historic productivity estimates for an individual sector can be sensitive to the time period chosen. For example, extending the time period back 2 years (i.e. 1995-2016 rather than 1997-2016) would increase the estimated average productivity improvement for the construction sector from 0.3% to 0.6% (TFP VA). Therefore, it is not clear at this point that there is a compelling case to place more weight on the construction sector to adjust down the ongoing efficiency challenge from the reference value.
- **Including the four manufacturing sub-industries in the comparator samples.** This would push up the ongoing efficiency challenge. At this stage, there is not a compelling case to go towards the top of the possible EU KLEMS range by placing weight on these particular sub-industries. This is something that Ofgem could review as part of the development of the Final Determinations.

Table 3.2 shows the potential adjustments listed above as a delta from the midpoint of the reference range; with the adjustments shown in bold being the ones that we identified as candidates for particular focus by Ofgem. Consideration of these adjustments shown in bold only produces a suggested range of:

- 0.5% to 1.2%[76] for the ongoing efficiency challenge for capex and repex; and
- 0.5% to 1.4%[77] for the opex efficiency challenge.

The lower bound of 0.5% for these ranges is determined by the GO measure (1997-2016) for the weighted average of all industries (as shown in Table 2.3),

In Table 3.2, unless otherwise stated, the change shown represents the adjustment if a 100% weighting was effectively given to the alternative approach (i.e. use only the sample including the manufacturing sub-industries in the selected industries sample, and put no weight on any other samples).

The adjustments shown in Table 3.2 cannot always simply be added together, particularly for the different options for EU KLEMS analysis. Appendix 0 includes a table showing the impact of different permutations of alternative approaches on EU KLEMS.

[76] This is the top of the EU KLEMS reference range combined with a value of 2% for the innovation efficiency challenge.

[77] This is the top of the EU KLEMS reference range combined with a value of 2% for the innovation efficiency challenge.

Table 3.2: Summary of movements in ongoing efficiency value away from reference value

Direction of effect	Driver	Change in value for capex/repex from reference value	Change in value for opex from reference value
Upside (+ve)	Including the four manufacturing sub-industries in selected industry sample in EU KLEMS	+0.8%	+1.1%
	Delivery of reasonable return for consumers from RIIO-1 innovation funding	**Up to +0.2%**	**Up to +0.2%**
	OBR and BOE labour productivity forecasts		**Up to +0.05%**[78]
Reference value	**EU KLEMS VA 1997-2016**	**0.8%** (range: 0.6%-1.0%)	**1.1%** (range: 1.0-1.2%)
Downside (-ve)	Use 2006-2016 data only from EU KLEMS[79]	-0.3%	-0.6%
	Construction sector as main comparator in EU KLEMS[80]	-0.3%	-0.6%
	BoE TFP forecast[81]	**-0.3%**	
Lower bound	**Using GO rather than VA**	**-0.3%**	**-0.6%**

Source: CEPA analysis of data from EU KLEMs, OBR and BoE

In addition to the factors shown in Table 3.2, there are other factors that Ofgem may wish to consider in setting the ongoing efficiency challenge in its Final Determinations for RIIO-2.

Respondents to PR19 expressed concern that greater reliance on CPI-based indexation (and other output-price indices) for a greater share of input costs could give rise to risks of double-counting if ongoing efficiency is also applied to those input costs.

The interaction between RPE indexation and ongoing efficiency was discussed in the SSMD, in which Ofgem stated:

"*We will consider applying an ongoing efficiency assumption wherever we apply an RPE that reflects a network's input price, but will consider the extent that output prices already reflect ongoing efficiency improvement.*"

On this issue, it is important to distinguish between:

- RPEs, which are trying to capture changes in input prices to extent that they differ materially from general inflation in order to minimise the risk of windfall gains and losses by companies; and
- Ongoing efficiency, which relates to how the network companies use the various inputs.

[78] This adjustment is based on the higher of the BoE forecast and the OBR forecast when averaged over RIIO-2. Labour productivity is forecast to increase over time by OBR and BoE. This means that upwards adjustment would be even larger if assume forecast out to 2026 stayed at level of last forecast year (1.3% in 2024 for OBR), rather than taking simple average of RIIO-2 years covered by the forecast.

[79] The lower bound is reached by putting a weighting of 35% for capex and 40% for opex on the 2006-2016 period as a stand-alone time period. This would be in addition to the inherent weighting that it has of just over 50% of the full time period (1997-2016) – i.e. would equate to overall weighting for 2006-2016 time period overall of 68% capex, and 70% for opex.

[80] The lower bound is met by placing 60% weighting on construction as comparator sector for capex, and 86% for opex.

[81] The lower bound is reached by putting a 43% weighting on the BoE TFP forecast.

For RPEs, the question is about what is the most appropriate proxy for changes in input prices; rather than which efficiency assumptions are embedded in the proxy measure.

For ongoing efficiency purposes, it is not clear how much, if any, of an ongoing efficiency challenge is imposed if input prices (with zero RPEs) and the output price (i.e. totex allowance) are indexed to the same measure.

Furthermore, it is uncertain how much CPI(H) (which is the general indexation measure used for RIIO-2) is affected by changes in UK-wide productivity as opposed to housing cost changes, or foreign improvements in productivity or even changes in exchange rates, given the role of imports in the basket of goods and services used to set the index. This makes it very hard to identify any firm recommendation for how this factor should be taken into

At the time of writing, there is much uncertainty about the outlook for two atypical events that may affect economy-wide productivity over the RIIO-2 period. These events are the COVID-19 crisis, which may persist for an uncertain amount of time, and the conclusion of the transition period for the UK's exit from the EU at the end of 2020. At this stage, we have not included any adjustment in the ongoing efficiency challenge to reflect these events as it is unclear what the impact may be on economy-wide productivity over the next few years, and how this may translate into the productivity of energy network companies which operate in a regulated sector. More information on the possible impacts of these events may be available for Ofgem to consider as part of setting the Final Determinations.

4. REAL PRICE EFFECTS

In its RIIO-2 Sector-Specific Methodology Decision paper (SSMD), Ofgem confirmed its intention to make use of indexation to account for Real Price Effects (RPEs). [82] This will replace the fixed ex-ante allowances over the price control period set for RPEs in RIIO-1.

4.1. TASKS IN IMPLEMENTATION OF INDEXATION APPROACH

The SSMD and Ofgem's accompanying consultation on the RIIO-2 tools for cost assessment[83] described how Ofgem intended to approach the five main tasks required to set up the indexation approach for use in RIIO-2:

1. **Determination of input cost structures.** Setting the indexation mechanism requires Ofgem to assess the share of totex by category (e.g. labour costs, materials, transport).
2. **Materiality.** Ofgem will apply indexation to cost areas where there is strong evidence suggesting that the company's input prices (e.g. labour, materials) will **materially** track above or below general economy inflation (based on the Consumer Price Index (CPI) or Consumer Prices Index including owner occupiers' housing costs (CPIH)) over RIIO-2. Ofgem will use materiality thresholds, but the burden is predominantly on the companies to demonstrate where RPEs are expected to be material – companies are required to provide robust evidence that the general economy measure of inflation is not a suitable proxy for the input price inflation.
3. **Selection of the indices for each cost category.** For input costs where RPEs are expected to be material, Ofgem will use a series of tests to identify the index/indices to be used as a proxy for the input price inflation faced by the companies over RIIO-2.
4. **Developing forecasts for the indices.** Ofgem will develop forecasts for the input cost areas that will be subject to indexation for the RIIO-2 time period. There will then be an annual true-up 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.
5. **Treatment of cost areas not subject to RPE indexation.** Ofgem will need to decide its approach for the input costs that are not expected to differ materially from general economy inflation.

The remainder of this chapter describes in turn the analysis undertaken to inform Ofgem's decision on each of these tasks.

4.2. DETERMINATION OF INPUT COST STRUCTURES

4.2.1. Approach to determining input cost structure

In the June 2019 consultation document on cost assessment tools for RIIO-2, Ofgem lists the following categories of input costs that were used in RIIO-GD1:

- Direct Labour.
- Contract Labour.
- Materials.
- Plant & equipment.
- Transport.

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[82] Ofgem (2019) *RIIO-2 Sector-Specific Methodology – Core document.* Decision Paper.

[83] Ofgem (2019) *RIIO-2 tools for cost assessment.*

- Other.

Responses from the network companies that referred to these categories almost universally accepted the categorisation set out in Ofgem's consultation document. One response stated that splitting the labour costs into direct and contract labour might have an impact on the incentives faced by a company when it makes decisions about how to employ its workforce. Reviewing this categorisation is outside the scope of this report. In practice, under the indexation approach described in this report, the same indices with the same weightings are used for all labour categories.

The analysis in this report considers the input cost categories as defined in the final version of the RPE tab in the Business Plan Data Tables (BPDTs). This means that we use the cost information directly provided by the network companies in their business plan submissions.

The only difference from the categorisation used in RIIO-1 is the change in the definition of the two labour cost categories, from Direct Labour and Contract Labour to General Labour and Specialised Labour. Therefore, in the remainder of this section, we consider RPEs based on the following input cost categories:

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

To create a composite totex index, we weighted the selected indices for each input category according to the share of totex represented by each input cost category. To do this, we used the submitted cost structure information provided to us by Ofgem. We conducted the analysis based on total forecast expenditure across the RIIO-2 period to reduce any impact of the investment cycle on spending in any particular category. We did not review the robustness of the categorisation of costs by each company as that was not in scope of our work.

Consistent with the approach taken at RIIO-1, we:

- assume that all eight GDNs have the same notional cost structure; and
- use a company-specific structure for each of the transmission companies, NGET, SHET, SPT, NGGT (TO) and NGGT (SO).

Using a notional structure for GDNs is in line with the view set out by Ofgem in the SSMD that setting RPE allowances based on company-specific structures could reward inefficient structures. The notional structure was constructed using an unweighted average of the eight GDNs' stated cost structures in their business plan submissions.

However, as there are insufficient comparators to generate a notional structure for the transmission companies, we applied the proportions of input costs as stated in the business plan submitted by each company.

4.2.2. Findings on input cost structure

Table 4.1 summarises the notional structure of each network used in our RPE analysis, based on the business plan information provided to us by Ofgem. It illustrates that the majority of costs are related to:

- labour, ranging from 41% (SPT) up to 70% for the GDNs; and
- to materials, ranging between 14% (GDNs) to 29% (SPT and NGGT TO).

In line with the approach taken in RIIO-1, the 'Other' category is assumed to track the general inflation level in the economy, as so were not considered for further analysis Apart from the Other category, the only other category with a share above 10% is Plant & equipment for SHET.

Table 4.1: Notional cost structure of each network company

[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

Source: CEPA analysis of BPDTs

4.3. Assessing the materiality of RPEs

The Ofgem SSMD states that RPEs will only be applied where there is strong evidence that there is expected to be a material difference between the general economy measure of inflation and input price inflation over RIIO-2. The June 2019 consultation on tools for cost assessment sets out Ofgem's intention to use the following approach to determining materiality:

- Ofgem expect companies to show that each RPE is material relative to both totex and general consumer price inflation.
- Ofgem expect companies to provide clear evidence of a sustained deviation between input costs and general consumer price inflation.

In their business plan submissions, the following network companies made specific points on the approach to assessing materiality:

- **[REDACTED]**
- **[REDACTED]**
- **[REDACTED]**
- **[REDACTED]**
- **[REDACTED]**
- **[REDACTED]**

4.3.1. Approach used in this report for assessing materiality

We report the findings of the risk-based approach to assessing materiality described in CEPA's 2019 Frontier Shift paper[84] published alongside Ofgem's consultation on cost assessment tools. This approach focuses on two tests:

- identifying cost categories that represent a relatively large share of totex; and
- identifying cost categories that would likely face relatively large movements over time.

A cost category has to pass at least one of the two tests to be assessed as being material, and hence suitable for indexation.

[84] CEPA (2019) *RIIO-GD2 cost assessment – frontier shift.*

4.3.2. Test 1- Applying the materiality threshold to share of totex

We used two thresholds to carry out the assessment against the cost structures presented in Table 4.1.

- 10% of totex, as proposed in the June 2019 Frontier Shift paper.
- 5% of totex. This was used to test the sensitivity of the assessment to the level of the totex threshold, in light of a suggestion of a lower threshold level from one of the network companies.

Table 4.2 presents the results of this assessment.

Table 4.2: Results of assessment against totex materiality threshold

Cost area	GDNs	NGGT (TO)	NGGT (SO)	NGET	SHET	SPT
General Labour	[Green]	[Green]	[Green]	[Green]	[Green]	[Green]
Specialist Labour	[Green]	[Green]	[Green]	[Green]	[Red]	[Green]
Materials	[Green]	[Green]	[Green]	[Green]	[Green]	[Green]
Plant & Equipment	[Red]	[Amber]	[Red]	[Amber]	[Green]	[Amber]
Transport	[Red]	[Red]	[Red]	[Red]	[Red]	[Red]
Legend	***Share of totex above 10% [Green]***		***Share of totex between 5% and 10% [Amber]***		***Share of totex below 5% [Red]***	

Source: CEPA analysis of BPDTs

As shown in Table 4.2, the following cost categories exceeded the 10% threshold. As they were judged to have passed the materiality, they are included in the RPE indexation model that we provided to Ofgem.

- Labour (for all companies)
- Materials (for all companies)
- Plant & Equipment (for SHET only)

The following cost category fell between the 10% and 5% thresholds. This meant that although it failed the first materiality test, its share of totex merited further assessment against the second materiality test (for volatility):

- Plant & Equipment (for NGGT TO, NGET, SPT).

All other cost categories were assessed as not being material, and hence were not considered further for indexation.

4.3.3. Test 2- Expected impact on totex of volatility in cost category

The second materiality test was carried out on Plant & Equipment for NGGT (TO), NGET and SPT. This test considers the expected impact on totex of price movements in a cost category. As described in the June 2019 Frontier Shift paper, the threshold for passing the test is for the expected impact to be above 0.5% of totex over RIIO – 2. This is also consistent with the approach suggested by Cadent in its RIIO-2 business plan submission.[85]

[85] Cadent (2019) *Transforming experiences. Customers. Communities. Colleagues. Our plan for 2021 – 2026.* Appendix 09.22 Real Price Effects

Cadent proposes that indices are applied where the potential price variation for any costs compared to business plan forecasts are likely to be at least 0.5% of controllable totex, which equates to 0.2% of RoRE[86] for Cadent.

This test uses the three indices included for Plant & Equipment in the RIIO-1 RPE analysis to assess the level of volatility in the indices relative to the CPIH.[87] We compared the simple average out-turn values of the three indices over the last ten years against the evolution of the CPIH index. This gives 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.

Over the last ten years, the estimated impact of RPEs in the Plant & Equipment cost would have been 0.16% of totex (2 d.p.). This is significantly below the threshold of 0.5%.

We carried out sensitivity analysis to estimate the extent to which the volatility in the indices would have had to rise to breach the materiality threshold of 0.5% impact on totex. This sensitivity analysis suggests that the difference between the indices and CPIH would have to have been over 100% higher each year over the last ten years for the Plant & Equipment RPE to have had a material impact on totex. This suggests that the level of price volatility around the Plant & Equipment cost area is not likely to be material and thus it should not be included within the RPE indexation mechanism for NGGT (TO), NGET and SPT.

4.3.4. Findings of materiality tests

Based on the first materiality test (above 10% of totex), the Labour (combining general and specialist labour) and Materials cost areas for all companies are taken forward for RPE indexation. The Plant & Equipment cost area is also taken forward for RPE indexation for SHET only.

Plant & Equipment costs for the other TOs fail both materiality tests. The difference in indexation of cost categories across TOs reflects the decision to use company-specific cost structures for these companies, rather than a common or notional cost structure. This is consistent with the Ofgem decision that the burden of proof should be predominantly be on the companies to demonstrate where RPEs are expected to be material.

The result of the materiality tests means that only SHET will have its cost allowances adjusted as the result of differences between Plant & Equipment price movements and CPI(H). This is consistent with the assumption that based on the company-specific cost structures provided to use by Ofgem, SHET is more exposed to these costs than other TOs. Hence it has demonstrated that RPEs in this cost category are material for it according to the criteria proposed by Ofgem.

If the totex materiality threshold was set at 5%, then this Plant & Equipment costs for the other TOs would just pass the materiality test. However, we note that this cost category also fell significantly short of passing the second test.

4.4. PROCESS FOR SELECTING INDICES FOR THE INDEXATION MECHANISM

4.4.1. Approach to index selection process

CEPA's 2019 Frontier Shift paper[88] set out an approach to determining the suitability of indices for use within the RPE indexation mechanism. The paper defined pass-fail criteria that any index that is included within the mechanism should reach. It also set out some desirable features that could be used to choose between different indices that pass the threshold criteria.

Table 4.3 lists the pass-fail criteria presented in the 2019 Frontier Shift report.

Table 4.3: Pass-fail assessment criteria for selection of input price indices

Criterion	Rationale for criterion	Substantiation	Grading
A. Simplicity			

[86] RORE: Return on Regulatory Equity

[87] ONS Machinery and equipment output PPI. ONS Machinery and equipment input PPI. PAFI plant and road vehicles.

[88] CEPA (2019) *RIIO-GD2 cost assessment – frontier shift.*

The index represents a material cost or identifiable portion thereof	Proportion of costs covered by the given index	Share of sector totex and mapping to cost categories	Pass / fail
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	Pass / fail
B. Accuracy			
Reflects movements in the respective input cost category (or a distinct portion thereof) for a notional efficient 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	Pass / fail
C. Independence			
The index has a low or no chance of being manipulated by actions of companies in the sector[89]	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.	Pass / fail

Source: CEPA

In the interests of continuity and simplicity, our assessment of which indices to include in the RIIO-2 indexation mechanism started with the indices used during the RIIO-1 RPE determination. Table 4.4 lists these indices by each of the cost categories that passed the materiality test: Labour and Materials for all companies, and Plant & Equipment for SHET only.

[89] This would also need to be monitored on an ongoing basis.

Table 4.4: Indices used in the RIIO-1 RPE process

RIIO-1 indices
Labour costs (general and specialist)
Office for National Statistics (ONS) Average Weekly Earnings (AWE) private sector
ONS AWE construction
ONS AWE transport & storage
Price Adjustment Formulae Indices (PAFI) civil engineering
British Electrical Allied Manufacturers Association (BEAMA) electrical engineering (only for Electricity Transmission)
Materials costs
FOCOS Resource Cost Index (RCI)
PAFI steelwork
PAFI plastic pipes
PAFI copper piping
Plant & equipment costs
PAFI plant and road vehicles
ONS machinery and equipment output Producer Price Inflation (PPI)
ONS machinery and equipment input PPI

Source: Ofgem[90]

To see if the indices used in RIIO-1 remained suitable for use in RIIO-2, we assessed them against the pass-fail criteria listed in Table 3.3. The indices passed all the criteria:

- **Simplicity.** All indices represent a material portion of the companies' cost base; either defined as a portion of totex, or based on the potential impact of volatility in the index on totex as assessed in the materiality threshold tests.
- **Accuracy.** In selecting the indices, we are trying to find indices that reflect the type of cost pressures that the companies will face rather than perfect matches for each company's cost drivers. This will provide some protection to companies and to consumers against the risks associated with RPEs, whilst continuing to provide the companies with an incentive to manage RPE risk where possible. The mix of indices chosen to reflect each cost area provides a good overall reflection of the movements in the costs that the companies will face.
- **Independence.** As the indices are based on data from a wide range of economic sectors; whilst the performance of the network companies could influence the performance of the indices, they are unlikely to have a material impact on any of them. For instance, the Office for National Statistics (ONS) Average weekly earnings (AWE) index is based on a sample of around 9,000 employers in Britain.

4.4.2. Findings of index selection process

The index selection process identified that the RIIO-1 indices remained suitable for use for the cost categories identified as material in RIIO-2 for the GDNs and the transmission companies. Therefore, we have not investigated whether new indices would also be suitable for use in RIIO-2.

[90] Ofgem (2012) *RIIO-T1/GD1: Real price effects and ongoing efficiency appendix.* Final decision – appendix.

4.5. FORECASTS FOR THE INPUT PRICES SUBJECT TO RPES

In the RIIO-2 SSMD, Ofgem set out that that it will include a forecast of RPEs in the upfront allowance. There will then be an annual true-up after the publication of the relevant index/indices, and a final true-up will occur at the end of RIIO-2 as part of the close-out process.

We note the particular challenges for making such forecasts at the moment, given the level of uncertainty in the general economy in relation to COVID-19 as well as the UK's exit from the EU. Therefore, this section includes forecasts for the selected indices on the assumption that Ofgem will decide to use a similar forecasting approach as applied in RIIO-1, i.e. making use of published forecasts where available, and otherwise using the long-term average of the relevant indices, rather than applying a new or independent forecasting approach

For the forecasting process, it is desirable that the indices chosen for the indexation process have published forecasts available for them and/or have been produced for a long time period of time to inform forecasts based on historical patterns.

4.5.1. Approach to forecasting RPEs over the RIIO-2 period

We now describe how we arrived at the estimated RPE forecasts for each of the expenditure categories that we have recommended for indexation:

- Labour (for all companies).
- Materials (for all companies).
- Plant & Equipment (for SHET only).

We forecast each index in nominal terms, following as far the approach used for forecasting indices in RIIO-1. In general, we use independent forecasts of annual growth rates for a given index, where they exist. For the periods not covered by an independent forecast, we apply the long-term average annual growth rate from 2000 onwards.[91]

The real effects shown in Table 4.5, Table 4.6, and Table 4.8 are calculated relative to forecast CPIH. Indices are then weighted to form a composite RPE index for the given cost category. The forecasts and weightings described in this section are included in the RPE modelling file that we provided Ofgem alongside this report.

We start by describing the forecasts produced for economy-wide inflation.

Economy-wide inflation

HM Treasury collates independent forecasts for a range of economic indicators in 2021 and 2022, including inflation.[92] HMT only reports CPI forecasts. Our working assumption is that Ofgem will apply CPIH, which includes a component for owner occupiers' housing costs, which accounts for around 16% of the index and is the main driver between the CPI and CPIH inflation rates.

We adjust the average of the independent CPI forecasts collected by HMT by reducing the annual growth rate by 0.1%. This has been the difference between CPI and CPIH in the most recent three years of available data.

For the period beyond the time horizon of the forecasts collated by HMT, we calculate the long-term average annual growth rate for CPIH based on data from 2000 onwards. This implies that the economy will generally return to an equilibrium in which monetary variables revert to their average growth rates. We excluded data from 2009/10 and 2010/11 from the average in light of concerns that the financial crisis around this period could cause growth rates not to be reflective of long-term trends.

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[91] We explored an approach using linear regression based on CPI(H). However, as we do not have long-term CPI(H) forecasts so this would add variation to the long-term forecast; and hence it did not meet the burden of proof to switch from the RIIO-1 approach.

[92] HMT (March 2020). *Forecasts for the UK economy*. For the purposes of this analysis, we assume the 2021 forecasts are a reasonable proxy for the equivalent growth rate in the 2021/22 financial year and so on.

Table 4.4 sets out the resulting forecasts for CPI and CPIH to the end of the RIIO-2 period.

Table 4.4: Forecast economy-wide inflation

Index	2019/20	2020/21	2021/22	2022/23 – 2025/26
Approach	Outturn data	HMT forecast (less 0.1% for CPIH)		Long-term avg.
CPI (ONS code D7BT)	1.66%	1.60%	1.90%	
CPIH (ONS code L522)	1.63%	1.50%	1.80%	2.01%

Source: ONS, and CEPA analysis of ONS data

Labour

Short-term forecasts for 2020 and 2021 are drawn from the HMT consensus forecasts for average earnings for the whole economy.

For 2022/2023 onwards, we use forecasts for the following indices, which were all used in RIIO-1:

- the average weekly earnings (AWE) for the private sector,
- the AWE for the construction industry;
- the AWE for the transport & storage industry;[93];
- the Price Adjustment Formula Index (PAFI) for civil engineering labour;[94] and
- the BEAMA labour index for electrical engineering[95] (which is included for ET only).

The forecast for each index is based on the long-term trend, i.e. back to 2000.

The overall Labour RPE is constructed as an unweighted average of the indices. For the GDNs and NGGT, each index has a weighting of 25%. For ET, five indices are used which means that each has a weighting of 20%.

[93] All three AWE indices available from the ONS.

[94] Published by BCIS.

[95] Labour index published British Electrotechnical and Allied Manufacturers Association (BEAMA).

Table 4.5: Forecast RPE for labour indices

Index	2019/20	2020/21	2021/22	2022/23 – 25/26
HMT consensus forecast for average earnings		1.48%	1.28%	
AWE private sector (ONS code K54V)	1.55%			0.99%
AWE construction (ONS code K553)	2.88%			1.21%
AWE transport & storage (ONS code K5B7)	-0.51%			0.93%
PAFI civil engineering (BCIS code 1701)	1.96%			2.23%
BEAMA electrical engineering (ET only)	*0.98%*			*0.61%[a]*

Source: CEPA analysis of data from HMT, ONS, BCIS, and BEAMA
Note: Data for the BEAMA index is not currently available for the full year of 2019, so this is set at the long-term average from 2000-18 excluding 2009-10.

Materials

We have used the same indices for Materials as RIIO-1. Forecasts for each of the indices used to construct the Materials RPE are based on the long-term average of the particular index (back to 2000). This is because we could not identify forecasts from independent sources that satisfied our robustness criteria.

Table 4.6: Forecast RPE for material indices

Index	2019/20	2020/21	2021/22	2022/23 – 25/26
Plastic pipes and fittings (BCIS code 1532)	1.40%	1.90%	1.60%	1.39%
Copper pipes and accessories (BCIS code 4358)	-0.70%	3.03%	2.72%	2.51%
Structural Steelwork - Materials: Civil Engineering Work (BCIS code 4463)	-3.78%	2.58%	2.28%	2.07%
FOCOS Resource Cost Index of Infrastructure: Materials (BCIS code 7467)	-1.19%	2.73%	2.43%	2.21%

Source: CEPA analysis of data from BCIS

As these reflect the materials purchased by network companies for opex and capex (including repex for GDNs), the weighting of the indices will differ according to sector. The FOCOS resource cost index of infrastructure (materials) offers a reasonable proxy for opex materials across all the sectors.[96] To proxy changes in the costs of capex/repex materials purchased different sectors, the following indices are used:

- **GDNs:** An unweighted average of PAFI indices for steelworks, copper piping and accessories, and plastic pipes[97] (i.e weighting of 33% for each index).
- **GT:** 100% weighting on the PAFI index for steelworks.
- **ET**: 100% weighting on the PAFI index for copper piping and accessories.

These weightings are then compounded by the weighting of opex to capex (and repex spend) to create the overall weightings shown in Table 4.7. The cost structure for materials for most of the network companies leads to a weighting for materials of 25% for opex-and 75% for capex (and repex). SPT's business plan implies a slightly greater use of materials in opex activities. As such, for SPT, the copper piping index is giving a weight of 65% rather than 75% in the composite RPE.

[96] Published by BCIS.

[97] Published by BCIS.

Table 4.7: Material index weighting

Index	GDNs	NGGT (TO)	NGGT (SO)	NGET	SHET	SPT
Plastic pipes and fittings (BCIS code 1532)	25%	0%	0%	0%	0%	0%
Copper pipes and accessories (BCIS code 4358)	25%	0%	0%	75%	75%	65%
Structural Steelwork - Materials: Civil Engineering Work (BCIS code 4463)	25%	75%	75%	0%	0%	0%
FOCOS Resource Cost Index of Infrastructure: Materials (BCIS code 7467)	25%	25%	25%	25%	25%	35%

Source: CEPA analysis of data from BCIS

Plant & equipment

As a result of the materiality tests, our finding was that Plant & Equipment will be subject to RPE indexation for SHET only. As with the materials category, we have not identified any suitable independent forecasts. Our forecasts are therefore based on the long-term averages of the indices used in the RIIO-1 analysis, as these passed our selection criteria. We use an unweighted average of three indices (i.e. weighting of 33% on each index):

- PAFI for plant and road vehicles;[98]
- the input Producer Price Indices (PPI) for machinery & equipment;[99] and
- output Producer Price Indices (PPI) for machinery & equipment

Table 4.8: Forecast RPE for Plant & Equipment indices (SHET only)

Index	2019/20	2020/21	2021/22	2022/23 – 25/26
PAFI plant and road vehicles (BCIS code 1702)	0.26%	1.13%	0.83%	0.62%
Machinery & equipment output PPI (ONS code K389)	-0.26%	0.38%	0.08%	-0.13%
Machinery & equipment input PPI (ONS code MB4U)	-0.36%	0.08%	-0.22%	-0.43%

Source: CEPA analysis of data from ONS and BCIS

4.5.2. Findings of forecasting RPEs over the RIIO-2 period

The tables below summarise the forecast composite RPEs for each category produced using the indices and forecasting approach for RIIO-1.

[98] Published by BCIS.

[99] The input and output price indices are both available from the ONS.

Table 4.9: Forecasts for Labour RPE

Index	2019/20	2020/21	2021/22	2022/23 – 25/26
GDNs and GT	1.47%	1.48%	1.28%	1.34%
ET	1.37%	1.48%	1.28%	1.19%

Source: CEPA analysis

Table 4.10: Forecasts for Materials RPE

Network	2019/20	2020/21	2021/22	2022/23 – 25/26
GDNs	-1.07%	2.56%	2.26%	2.04%
GT	-3.14%	2.62%	2.32%	2.10%
NGET and SHET	-0.82%	2.95%	2.65%	2.43%
SPT	-0.87%	2.92%	2.62%	2.40%

Source: CEPA analysis

Table 4.11: Forecasts for Plant & Equipment RPE (SHET only)

Index	2019/20	2020/21	2021/22	2022/23 – 25/26
SHET	-0.12%	0.53%	0.23%	0.02%

Source: CEPA analysis

Finally, Table 4.12 combines the above category-level RPEs weighted by the notional cost structure of each network to produce a totex-level RPE estimate.

Table 4.12: Forecasts for Totex RPE (2 d.p.)

Network	2019/20	2020/21	2021/22	2022/23 – 25/26
GDNs	0.89%	1.38%	1.20%	1.22%
NGGT (TO)	-0.19%	1.50%	1.31%	1.28%
NGGT (SO)	0.32%	1.28%	1.11%	1.11%
NGET	0.64%	1.64%	1.44%	1.34%
SHET	0.46%	1.52%	1.29%	1.16%
SPT	0.32%	1.45%	1.28%	1.18%

Source: CEPA analysis

4.6. APPROACH TO COST AREAS NOT SUBJECT TO RPE INDEXATION

Ofgem will also have to determine an approach to dealing with input cost areas that are not subject to RPE indexation. We summarise below the issues raised in our 2019 Frontier Shift paper[100] below and set out our updated view.

4.6.1. Issues raised in 2019 Frontier Shift paper[101]

Our 2019 paper highlighted two main considerations for the treatment of costs not subject to RPE indexation: (i) the need to ensure the approach to RPEs is consistent with the treatment of ongoing efficiency; and (ii) Ofgem's

[100] CEPA (2019) *RIIO-GD2 cost assessment – frontier shift.*

[101] CEPA (2019) *RIIO-GD2 cost assessment – frontier shift.*

intention to move from RPI to a CPI-based measure (CPIH or CPI) as the general measure of inflation in the price control.

Consistency with the treatment of ongoing efficiency

CPIH, like RPI, is an economy-wide output price inflation measure, capturing movements in input prices and ongoing efficiency improvements across the economy as a whole. The index will also capture international productivity improvements to the extent that it is affected by imported goods.

Respondents to the PR19 process have expressed concerns that indexing costs with CPIH may risk some double counting if ongoing efficiency is also applied to those costs as part of incorporating frontier shift into companies' cost allowances.

Decomposing CPIH into its constituent parts to control for this potential effect is difficult,[102] and so is unlikely to be a practical option for the RIIO-2 price controls. There are two main ways to approach these costs:

- applying zero RPEs and non-zero ongoing efficiency (the status quo); or
- applying zero RPEs and zero ongoing efficiency.

Change in the general measure of inflation used in RIIO

Applying zero RPEs and non-zero ongoing efficiency was the approach that Ofgem had previously applied in price controls and so sets the default approach. We highlighted in June 2019 that it was relevant to consider this point in more detail than might otherwise be the case given the transition from RPI to a CPI-based measure of inflation, which has historically tended to give a lower annual growth rate. For example, Ofgem assumed the RPI-CPIH wedge to be 1.049% in the RIIO-2 SSMD.

Changing the basis of general indexation in the price control affects the financial impact of linking certain cost categories to it, raising the question of if any simplifications in this area remain appropriate.

4.6.2. Updated view

We consider that on balance, Ofgem should continue to apply non-zero ongoing efficiency assumptions to non-indexed costs. It can consider any issues with this approach as one factor to inform its judgements of selecting its final ongoing efficiency assumptions from the range of evidence available.

Basis for keeping the status quo treatment of non-indexed cost areas

There are several reasons why we consider it reasonable for Ofgem to keep from the RIIO-1 price controls its treatment on application of ongoing efficiencies to costs with zero RPEs

- It is a proportionate approach for cost areas with limited evidence on RPEs, and for those areas representing a relatively small share of costs.
- It is consistent with the approach used to test for RPE materiality.
- The impact of the move from RPI to CPIH may not be as material as previously expected.

We elaborate on these points below.

Cost areas with limited evidence on RPEs

External price indices will rarely be a perfect match for the costs faced by an energy network. This may particularly be the case for smaller and/or more specialist cost categories.

When considered individually, each cost category will be materially different from CPIH at different points in time. However, that will also be the case for cost categories within CPIH itself. As such, evidence on individual cost components, particularly small ones, does not necessarily provide grounds to reject CPIH as the basis for updating

[102] See for example the discussion of the use of CPIH in Section 3 of Earwaker (March 2019) *A review of Ofwat's PR19 approach to estimating frontier shift.*

a portfolio of input prices for energy networks, particularly when there may be concerns about the alternative indices available.

As CPIH itself will already be a measure of inflation used in the price control, it provides a reasonable default approach for the treatment of such costs, in the absence of evidence that an alternative index would provide a material improvement in the accuracy of the companies' allowances.

Ofwat has already made the transition from RPI to CPIH as part of its PR19 determination. As part of its Final Determination, it only allowed RPEs for labour costs with all other costs having a zero RPEs. Ofwat has applied ongoing efficiency assumptions to all costs without making an adjustment for if RPEs were allowed or not. That approach is consistent with the continued application of the approach used by Ofgem in the RIIO-1 price controls.

A simplified approach for small cost shares

Ofgem adopted this approach for "*other*" and "*transport*" costs in the RIIO-1 price controls. For GDNs and NGET, this approach applied to around a quarter of all costs but up to around 40 percent of all costs for NGGT.

The materiality analysis completed for this report suggests that non-indexed costs may represent no more than 30% of all costs in any one case. As such, if the simplified approach adopted for RIIO-1 was seen to be reasonable, it may be difficult to justify that it is not reasonable for RIIO-2, when applied to a smaller share of costs.

Table 4.13: Estimate of RIIO-2 cost areas not subject to RPE indexation

	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]		[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

Source: CEPA analysis of BPDTs

Consistency with RPE materiality testing

The materiality assessment conducted in Section 0 is conducted based on the materiality of RPEs rather than the materiality of frontier shift. RPEs relate to different types of input costs. Ongoing efficiency relates to how those inputs are combined as part of a particular activity. As such, it is difficult to consider the materiality of frontier shift for a given input cost type in isolation (or types) or even to try to remove the impact of ongoing efficiency on a certain cost category.

Impact of the change in general indexation measure

As noted above, there is a material wedge between RPI and CPIH. It is relevant to note, however, that even at the ED1 final determination, Ofgem had already started to adjust for some of the difference between RPI and CPIH. In assessing RPEs, including for costs with zero RPEs, it removed 0.4 percentage points to account for the step-change in RPI that occurred in 2010.[103]

In March 2020, HM Treasury and the ONS consulted on reforms to the RPI methodology and provide further information on the drivers of the differences between RPI and CPIH. The analysis presented in that report highlights that 0.7 percentage points of the difference between the two measures of inflation are the result of a contentious "*formula effect*" that leads to RPI tending to register higher levels of inflation than CPIH.

> *"Since 2010, the measured rate of RPI annual inflation has been on average one percentage point per annum above the CPIH. The effect of the different formulae that the RPI uses accounts for around 0.7*

[103] Ofgem (2014) *RIIO-ED1: Final determinations for the slowtrack electricity distribution companies*. Business plan expenditure assessment

percentage points of this difference. This can predominantly be attributed to clothing prices, which account for 0.4 percentage points of the formula effect since 2010." [104]

None of the differences between RPI and CPIH indicate that RPI would be a better predictor of input prices for non-indexed costs. Furthermore, we expect that if Ofgem were to retain the use of RPI for this purpose it would likely consider making an adjustment to it to account for factors that mean it may over-estimate the economy wide level of inflation. That adjustment might be as high as 0.7 percentage points, meaning the materiality of the change from RPI to CPIH might not be as great as suggested from the indicative in the CEPA 2019 paper.

Informing the ongoing efficiency range

As set out above, we consider that retaining the RIIO-1 approach for costs with zero RPEs remains a proportionate approach for RIIO-2.

We understand that conceptually some parties will have concern that this treatment of these costs could entail some double counting of ongoing efficiency. However, we are not aware of any evidence to either confirm the expected direction of that impact or its direction for Ofgem's upcoming determinations.

We consider therefore that this may be one factor that Ofgem may wish to consider quantitatively as part of assessing the range of evidence available on ongoing efficiency, recognising that care would need to be taken when trying to adjust for the efficiency improvements related to specific (and generally small) classes of inputs used by the energy network companies.

[104] HM Treasury and UK Statistics Authority (2020) *A Consultation on the Reform to Retail Prices Index Methodology*.

Appendix A **SUPPORTING INORMATION ON USE OF EU KLEMS**

This appendix supports the discussion of growth accounting analysis in Section 2.1 of the main report. It shows the EU KLEMS estimates considered by Ofgem in RIIO-1, and the sector weightings that we have used in our analysis of EU KLEMS data for RIIO-2.

A.1. EU KLEMS DATA CONSIDERED IN RIIO-1

Table A.1 lists the different samples of comparator sectors in the 2009 EU KLEMS database that Ofgem considered in setting the ongoing efficiency challenge for RIIO-GD1 and RIIO-T1 (NGET and NGGT). Ofgem did not set its own ongoing efficiency challenge either for the fast-tracked companies in RIIO-T1 (SPET and SHET) or for all companies in RIIO-ED1, because it accepted the ongoing efficiency challenges proposed by the companies.

Table A.1: Elements of the 2009 EU KLEMS database considered in RIIO-1

Element	Considered in RIIO-1:
Time Period	• 1970-2007, which was the full data set available at the time
Productivity metrics	• Total Factor Productivity (TFP), and Partial Factor Productivity (PFP: Labour, and labour and intermediate outputs) • Value added (VA) and Gross Output (GO) for both TFP and PFP measures.
Comparators	• Construction. • Unweighted average of selected industries (Manufacture of Chemicals & Chemical Products, Manufacture of Electrical & Optical Equipment, Manufacture of Transport Equipment, Construction; Sale, Maintenance & Repair of Motor Vehicles/Motorcycles; Retail Sale of Fuel; Transport & Storage; Financial Intermediation). • Unweighted average selected industries (excluding manufacturing). • Unweighted average all industries (excluding real estate, public admin, education, health and social services). • Weighted average of all industries (excluding real estate, public admin, education, health and social services).[105]

Source: CEPA analysis of Ofgem RIIO-1 documents

[105] Ofgem calculated the weights on the basis of the proportion of VA at current basic prices or the proportion of GO at current basic prices, dependent on the measure that it was averaging.

Table A.2 contains the resulting set of EU KLEMS estimates considered by Ofgem in setting the ongoing efficiency challenge for RIIO-GD1 and for RIIO-T1 (NGET and NGGT).

Table A.2: Average annual growth rates for productivity measures from EU KLEMS (1970 to 2007) used in RIIO-1

Sector	Total Factor Productivity (TFP) Value Added (VA)	Labour & Productivity (VA) at constant capital	TFP (GO)	Labour & Intermediate Input Productivity (GO) at constant capital	Labour & Intermediate Input Productivity (GO)
Construction	0.7%	0.7%	0.3%	0.3%	0.4%
Unweighted average selected industries	2.3%	2.8%	0.9%	0.9%	1.1%
Unweighted average selected industries (exc. manufacturing)	1.1%	1.2%	0.5%	0.6%	0.8%
Unweighted average all industries	1.3%	1.5%	0.5%	0.5%	0.8%
Weighted average all industries	1.1%	1.1%	0.5%	0.5%	0.8%

Source: Ofgem[106]

A.2. SECTOR SAMPLES USED IN ANALYSIS OF 2019 EU KLEMS

Table A.3, A.4 and A.5 list the industries that comprise the three different samples of comparator sectors in the analysis of the EU KLEMS database presented in Section 2.1.2. The table also shows weightings for each industry. In line with Ofgem's approach in RIIO-1; these weightings are basis of the proportion of VA at current basic prices or the proportion of GO at current basic prices, dependent on the productivity metric being used.

In practice, these weightings are only used to produce a weighted average for the all-industry sample, as reported in Section 2.1.2. For an unweighted average, the implicit weighting for each (sub)industry is simply 100% divided by the number of (sub)industries included in the sample – i.e. 12.5% for each of the 8 (sub)industries in the selected industries sample; 25% for each of the 4 industries included in the selected industries excluding manufacturing:

Some of the industry sectors are broken down into sub-sectors in the 2019 EU KLEMS database, e.g. Manufacturing (C). Therefore, a decision has to be taken on whether the unweighted average for each sample is based on the industry figure or on each of the sub-industry figures. In presenting the results shown in Section 2.1.2, we have used the following approach:

- Selected industries sample – we have counted each sub-industry separately on the basis that it has been specifically selected for inclusion in this sample. This is because some Manufacturing sub-industries have not been considered.
- All industries sample – we have only counted the industry-level data, and have not considered any individual sub-industry. This is because selection for this sample has happened at the industry level rather than sub-industry level.

[106] Table 2.1 in Ofgem (2012) *RIIO-T1/GD1: Real price effects and ongoing efficiency appendix.* Final decision – appendix.

Table A.3: Industries included in selected industries sample used in analysis of 2019 EU KLEMS

Industries	Industry Code	Value Added Weighting	Gross Output weighting
Manufacturing (selected sub-industries)			
…Chemicals and chemical products	C20	2.2%	3.3%
…Computer, electronic and optical products	C26	1.5%	1.6%
…Electrical equipment	C27	1.1%	1.1%
…Transport equipment	C29_C30	4.8%	7.6%
Construction	F	19.3%	22.6%
Wholesale and retail trade; repair of motor vehicles and motorcycles	G	33.6%	27.6%
Transportation and storage	H	13.9%	13.9%
Financial and insurance activities	K	23.7%	22.2%

Source: CEPA analysis of EU KLEMS data

Table A.4: Industries included in selected industries excluding manufacturing sample used in analysis of 2019 EU KLEMS

Industries	Industry Code	Value Added Weighting	Gross Output weighting
Construction	F	21.3%	26.2%
Wholesale and retail trade; repair of motor vehicles and motorcycles	G	37.1%	32.0%
Transportation and storage	H	15.4%	16.1%
Financial and insurance activities	K	26.2%	25.7%

Source: CEPA analysis of EU KLEMS data

Table A.5: Industries included in all industries excluding real estate, public admin, education, health and social services sample used in analysis of 2019 EU KLEMS[107]

Industries	Industry Code	Value Added Weighting	Gross Output weighting
Agriculture, forestry and fishing	A	1.0%	1.1%
Mining and quarrying	B	1.5%	1.3%
Total manufacturing	C	14.8%	19.8%
Electricity, gas, steam and air conditioning supply	D	2.6%	4.5%
Water supply; sewerage; waste management and remediation activities	E	1.5%	1.5%
Construction	F	8.8%	11.0%
Wholesale and retail trade; repair of motor vehicles and motorcycles	G	15.4%	13.4%
Transportation and storage	H	6.4%	6.8%
Accommodation and food service activities	I	4.4%	4.0%
Information and communication	J	9.3%	7.4%
Financial and insurance activities	K	10.8%	10.8%
Professional, scientific, technical, administrative and support service activities	M_N	18.2%	14.4%
Arts, entertainment and recreation	R	2.2%	1.9%
Other service activities	S	3.1%	2.2%

Source: CEPA analysis of EU KLEMS data

A.3. IMPACT OF DIFFERENT APPROACHES TO EU KLEMS

Table A.6 illustrates the impact of different permutations of alternative approaches on EU KLEMS. Unless otherwise stated, the EU KLEMS value is based on the choices made for the reference range in terms of time period (1997-2016), VA measure, and industry comparators (unweighted average of selected industries excluding manufacturing; weighted average of all industries).

For simplicity, Table A.6 assumes 100% weighting for the alternative approach (i.e. there is no lower bound to the adjustment, unlike in Table 3.2) – i.e. the 100% weighting for the 2006-2016 time period would mean that a 0% weighting is placed on 1997-2016 as a separate time period (so the results for that time period are not considered in setting the ongoing efficiency challenge).

[107] The industry codes for the excluded industries are L (real estate), O (public admin), P (education), and Q (health and social services).

Table A.6: Adjustments from reference value for different EU KLEMS permutations

Direction of effect	Driver	Capex/repex	Opex
Upside on reference value if redefined as (+ve)	Including the four manufacturing sub-industries in selected industry sample in EU KLEMS	+0.8%	+1.1%
	Including the four manufacturing sub-industries in selected industry sample; **and** use 2006-2016 data only from EU KLEMS	+0.1%	+0.1%
Reference value	**EU KLEMS VA 1997-2016**	**0.8%** (range: 0.6%-1.0%)	**1.1%** (range: 1.0-1.2%)
	Including the four manufacturing sub-industries in selected industry sample; **and** use GO measures	-0.3%	-0.5%
Lower bound in Table 3.2	*(0.5% for capex/repex and for opex)*	*-0.3%*	*-0.6%*
Downside on reference value if redefined as (-ve)	Using GO rather than VA	-0.4%	-0.65%
	Construction sector as main comparator	-0.5%	-0.7%
	Construction sector as main comparator **and** use 2006-2016 data only from EU KLEMS	-0.4%	-0.8%
	Including the four manufacturing sub-industries in selected industry sample **and** use 2006-2016 data only from EU KLEMS **and** use GO measures	-0.5%	-0.8%
	Construction sector as main comparator **and** use GO measures	-0.7%	-0.9%
	Construction sector as main comparator **and** use 2006-2016 data only from EU KLEMS **and** use GO measures	-0.7%	-1.0%
	Use 2006-2016 data only from EU KLEMS **and** use GO measures	-0.8%	-1.15%
	Use 2006-2016 data only from EU KLEMS	-0.85%	-1.5%

Source: CEPA analysis of EU KLEMS data

Appendix B **INNOVATION MECHANISMS IN OTHER SECTORS**

Regulators in other countries and in other sectors in the UK that are subject to price control regulation have followed varying approaches to encourage innovation and productivity growth over time. This section provides a short overview of relevant examples of innovation and ongoing efficiency.

B.1. DEMAND MANAGEMENT INNOVATION ALLOWANCE MECHANISM (AUSTRALIA)

The Australian Energy Market Commission (AEMC) oversees the innovation allowance (DMIA) mechanism for Australian electricity distribution companies. The objective of the DMIA is to provide electricity distribution network companies with funding for R&D in demand management projects that have the potential to reduce long-term network costs. The allowance is expected to fund innovative projects that have the potential to deliver ongoing reductions in demand or peak demand.[108]

The allowance is calculated as $200,000 plus 0.075% of the relevant distributor's maximum allowed revenue. The first component acknowledges smaller distributors could have been prevented from undertaking some projects if only a revenue percentage was used to calculate funding. The second component reflects that larger distributors may have more opportunities to trial technology, given the size of their networks. The Australian Energy Regulator (AER) provides an ex ante allowance in five lots (one for each year of the regulatory control period). Any unspent allowance is recovered from distributors through a carryover amount deducted from the distribution business allowed revenue during the next regulatory control period.

In December 2019, the AEMC introduced a DMIA for electricity transmission.[109] This is expected to encourage the transmission business to expand and share their knowledge and understanding of innovative demand management projects that have the potential to reduce long term network costs and, consequently, could lower prices for consumers.

Current AER proposals will revise the existing DMIA in the following ways:

- increase funding available (by roughly 30% compared to 2015);
- tighten the criteria for project eligibility to encourage more innovative projects, whilst maintaining an option for indicative project pre-approval to maintain certainty; and
- clarify project reporting requirements to place a greater emphasis on sharing project learnings across the industry and with consumers.

B.2. WATER (GB)

The water sector in England & Wales has historically not had the same explicit regulatory focus on driving forward innovation which would enable us to compare with the approach taken by Ofgem in RIIO-1. However, Ofwat has inserted the drive for greater innovation as one of the leading themes of the 2019 price review (PR19) final determination for water and wastewater companies in England and Wales.[110]

Central to this approach is Ofwat's decision to provide up to £200m in additional funding for transformative innovation over the period from 2020 to 2025. Similar to the approach taken by Ofgem in RIIO-1 (e.g. the NIC), Ofwat has set out that the funding will be run through an annual innovation competition and the aim is to drive cultural change in the sector and to "*jump start*" innovative activities which can become BAU in the future. For example, Ofwat expects the competition to lead to the water and wastewater companies working closely with each

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[108] AEMC (2015) *Demand Management Incentive Scheme, Rule Determination.*

[109] AEMC (2019) *National Electricity Amendment DMIS for TNSPS.*

[110] Ofwat (2019) *PR19 Final Determinations*.

other, their supply chain, and wider stakeholders to deliver innovation. In order to ensure that competition is open to stakeholders across the sector, new entrants and third parties[111] will have access along with the existing 17 water and wastewater companies that are regulated through the PR19 price control. To ensure company stakeholder buy-in, Ofwat expects to see the sector develop a joint innovation strategy in 2020. The strategy will have areas of focus for the innovation competition and to examine the sector's strengths and weaknesses in innovation. It will also ensure that the competition funding is appropriately targeted and delivers value for customers.[112]

As far as we are aware, there is no data available on the estimated quantitative impact of the PR19 innovation competition on ongoing efficiency in the water sector. However, we note that Ofwat has set out within the competition's guiding principles that innovation fostered through the competition must provide public value for all customers in England and Wales.

In addition to the £200 million innovation competition, Ofwat has also developed an enhanced outcome delivery incentive (ODI) to promote innovation across the water and wastewater sector.[113] Seven companies have enhanced rates on certain performance commitments which means that they receive larger payments if they:

- innovate and perform better than the current best performance in the sector; and
- share how they achieved this with other water companies, so the whole sector can improve, making things better for all customers.

Changes to frontier performance through innovation will not only provide direct benefits to the customers of the company in question but will also enable more stretching benchmarks for other companies which will benefit customers more widely. Ofwat has not estimated how much it expects the level of performance to improve as a result of the enhanced ODI. We would expect that the innovation data to be gathered through PR19 reporting would provide a basis for such an analysis to be performed at PR24.

B.3. RAIL (GB)

ORR's periodic review of Network Rail's outputs and revenue is designed to promote efficiency and innovation.[114] However, there is no specific funding for innovation. Therefore, the pressure on Network Rail to innovate comes from two sources.

The first is the general network price control framework. Network Rail is provided with specific efficiency targets for each year of its five-year control period. Train operators (both passenger and freight) pay some variable access charges to Network Rail to meet the marginal costs of running their services (but not more than Network Rail's revenue requirement). This encourages operators to invest in R&D and innovation in efficient techniques to potentially reduce these access charges.

The second driver of innovation is a mechanism included in ORR's price control framework for Network Rail for 2014-2019 -– the route-level efficiency benefit sharing (REBS) mechanism, replacing the earlier (less disaggregated) efficiency benefit sharing mechanism. Train operators could opt into receiving a capped share of Network Rail's outperformance or underperformance payments.[115]. This was intended to encourage train operators to work with Network Rail to drive down industry costs. In practice though, operators were concerned about the downside risk involved and DfT was not supportive of operators increasing their returns beyond that anticipated in

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[111] Third parties will initially be provided access to the innovation competition through collaborative bids with the water and wastewater companies.

[112] Ofwat (2019) *Time to Act Now: Driving Transformational Change in the Sector.*

[113] Ofwat (2019) *PR19 Final Determinations.*

[114] This section is informed by UKRN (2015) *Innovation in regulated infrastructure sectors*.

[115] ORR (2013) *Periodic Review 2013: Final determination of Network Rail's outputs and funding for 2014- 19*

Franchise Agreements. This incentive was removed as of the start of CP6 in 2019, in part due to a shift towards more reputational incentives given the reclassification of Network Rail as a public-sector body.[116]

[116] ORR (2018) *PR18 draft determination overview*

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