Europe Economics

Indexation and Efficiency Incentives for Electricity and Natural Gas Distribution in the Regulatory Period from 2025

Final report

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Contents

Executive Summary

VREG has commissioned Europe Economics to help in setting the tariff methodology for the Flemish electricity and natural gas distribution system operators (DSOs), for the regulatory period beginning in January 2025. The tariff methodology is used to calculate the cap on the revenues that DSOs can earn from distribution network tariffs.

The aims of this study are to provide advice to VREG on indexation parameters and efficiency incentives. This requires the following:

- A detailed analysis of the firm's endogenous costs in the historical reference period 2019-2023 (for different types of cost breakdown).
- Analysis and advice on whether indexation parameters should be adjusted to account for changes in input prices in the sector.
- Analysis and advice on the frontier shift parameters to be used to account for productivity improvements.

Data

The work involved collecting data from different sources. VREG provided data on endogenous costs, output data, merger savings (imposed on DSOs following the merger of Infrax and Eandis in 2018) and electricity transmission fees for 2019, 2020 and 2021. Fluvius provided cost data for the whole of Fluvius and for each DSO for 2019-2023, and provided a cost breakdown by different functions (defined internally by Fluvius and coded using a 5-digit code) as well as into different inputs (indirect costs, labour, materials, plant and equipment, energy, contractor costs and other). Fluvius also provided data on the total merger savings that it achieved following the merger in 2018, as well as additional costs incurred as a result of the Covid-19 pandemic.

Phase 1: Evolution of costs

In a first phase we have analysed the evolution of costs and unit costs in different costs categories across time. To be able to observe the underlying trend in costs (due to efficiency improvements only) our analysis excludes any savings that have taken place as a result of the merger, and expenditure incurred due to the Covid-19 pandemic (as they are understood to be atypical).

Overall costs
The total endogenous costs comprise the sum of operational costs, depreciation and a return on capital. Throughout the period 2019-2023, endogenous costs of electricity and gas have shown a steady increase, in nominal terms. However, when expressed in constant 2024 prices the results show a real decrease in endogenous costs in the period 2019-2023 for both sectors: a drop of around 1 per cent in electricity and 4 per cent in gas.

To see the evolution across time VREG uses linear trends, which are then extrapolated to estimate expected costs for the regulatory period 2025-2028. The estimated trends show an annual increase (calculated as the Compound Average Growth Rate) of 0.8 per cent for electricity and an annual drop of 0.2 per cent for gas.[1] We note however, that the results are only preliminary because the 2023 costs used are the budgeted costs provided by Fluvius.

[1] The trends include corrections for the merger savings imposed by VREG in the period 2019-2024.

We have also compared the evolution of costs against three of the outputs produced by Fluvius: network users, network length and volume delivered (for both electricity and gas). We have seen that unit costs are falling in both sectors, though the fall is more substantial in gas.

Costs by activity
To investigate further the evolution of costs we have analysed the evolution of different cost activities (activities represent cost headings of actions and tasks needed for the distribution of electricity and gas). When analysed across the period, we did not find any clear upward or downward trend in the cost of most activities. Some changes are significant across the period, but these represent categories which account for very small share of the costs. We note that some results are based on 2023 budgeted data, so we recommend a recalculation of the metrics once actual data are available.

Costs by type
Costs for different functions have been allocated by Fluvius into the following categories: indirect; labour; materials; plant and equipment; energy; contractor costs; and other. The analysis by different cost types shows that the largest shares are accounted for by plant and equipment and labour costs, for both gas and electricity, over the last four years. It is worth noting a downward trend in indirect costs (i.e. costs not directly attributable to any activity) for both electricity and gas which runs persistently over each of the four years of the period; and a big drop in labour costs taking place after 2020. A significant increase can also be observed, for both gas and electricity, in energy costs and also an increase in energy income. The shift is driven by significant expected changes in the energy costs for 2023 which we understand to be the result of DSOs having to fulfil their social supplier and supplier of last resort obligations at a time when high energy prices are feeding through into the price that Fluvius has to pay when its existing energy purchase contracts expire. Finally, an upward trend can be observed in "other" costs within the gas segment. There is no clear evidence of any other consistent trends for the remaining categories.

Overhead costs breakdown
To provide a more detailed analysis of the overhead costs, we have taken the total opex and capex overhead costs for electricity and gas and disaggregated them using the breakdown of Fluvius' total overheads between activities and input cost types.

- The evolution of overhead costs by activity shows the following: For both electricity and gas segments, "Finance, Legal and ICT" is the largest cost activity in each year except 2022, when "Grid operation" is slightly larger.
- The evolution of overhead costs by type shows the following: For both electricity and gas segments, labour costs are consistently the largest component of overhead, followed by the "other" category. Materials and contractors have very small (and diminishing) shares. For electricity, the labour component of overhead follows an inverted U-shape, rising from 2020 to 2021 before falling again in 2022 and 2023. In gas, the labour costs within overhead fall consistently year-on-year. In both segments, there is a significant rise in "other" costs associated with overheads from 2020 to 2023.

Phase 2: Approach to indexation

Phase 2 of the project assesses the indexation parameter(s) used in the tariff methodology for the upcoming regulatory period.

Our review into the approach to indexation in other jurisdictions indicates that most regulators in the electricity and gas sectors apply indexation to all elements of allowed revenues (including operating costs, depreciation and return) using the Consumer Prices Index (the CPI) or a closely related index to index allowed revenues. Of the regulators considered only Ofgem (in Great Britain) applied any special indexation arrangements to take account of real price effects (RPEs).[2]

Using our two-stage framework, we assess the case for RPEs in a robust and transparent manner. The first stage assesses the case for RPEs for individual cost items. To qualify for an RPE, a cost area must pass the following two criteria:

1. Are there sufficient and convincing reasons to think that CPI does not adequately capture the input price?
2. Is there a significant likelihood that the value of the wedge between the input price and CPI will differ substantially from zero over the regulatory period? A cost area passes this second criterion if either of the following sub-criteria is passed:
    A. Is the expected value of the wedge between the input price and CPI materially different from zero? OR
    B. Does the wedge between the input price and CPI exhibit high volatility over time?

Informed by the breakdown of Fluvius' operating costs (opex), we assess each cost category that accounts for at least 5 per cent of opex separately against these criteria. The cost categories assessed are: labour (general and executive), energy, contractors and administration.

Our analysis indicates the presence of potential RPEs for two cost categories: labour (general and executive) and energy. In particular, labour qualifies for an RPE mechanism if weight is placed on Federal Planning Bureau (FPB) forecasts of real wage growth. In the case of energy, the volatility of the wedge between input prices and CPI indicate that further consideration should be given to an RPE mechanism in the second stage of the analysis.

The second stage of our framework then investigates what, if anything, should be done about these RPEs. The two potential approaches to address this include setting an ex ante RPE allowance (reflected in a net frontier shift estimate), or using ex post indexation. The choice between these two approaches depend on a number of factors, which suggest an ex ante RPE allowance for the following reasons:

- Practical issues around input price indices (a time lag present for wage data and the lack of a suitable index for energy costs) suggest that ex post indexation may not be feasible for labour and energy RPEs.
- While both approaches could give rise to small perverse incentives relating to the mix of inputs, ex post indexation creates a small additional perverse incentive over the long-term.
- Ex post indexation would not be consistent with the wider regulatory methodology due to double counting long-term RPE wedges, as these would be captured in both the efficiency trend and in indexation.

For labour costs, our analysis would suggest an ex ante labour RPE allowance of 0.7 per cent per annum over the next regulatory period for both the electricity and gas sectors based on FPB forecasts of future wage growth. However, our analysis has found that past FBP forecasts have tended to overstate wage growth compared with subsequent outturn data. This is a factor that VREG may wish to bear in mind when deciding how much weight to place on these forecasts. We calculate the labour wedge as a share of endogenous costs to arrive at a net frontier shift estimate (covered in Phase 3 of the project).

At the same time, the ongoing shift within Fluvius from statutory personnel to contractual workers, who do not enjoy the same beneficial labour conditions, is expected to lead to a reduction in wage rates over time, thus potentially offsetting some of the expected real wage growth for the 2025-2028 period. Therefore, VREG will need to make a policy decision on whether to include an ex ante RPE allowance for labour in the net frontier shift estimate, and if so what the magnitude of that allowance should be.

[2] The term "real price effects" refer to the input prices faced by a regulated firm changing in real terms (i.e. rising faster or slower than the general inflation index used to index the prices of the regulated firm).

Given the absence of publicly available forecasts regarding the future energy price pressure faced by Fluvius, we recommend an energy RPE of 0 per cent over the next regulatory period for both the electricity and gas sectors.

Phase 3: Estimating the scope for frontier shift

In Phase 3, we estimate Fluvius' scope for frontier shift in the next regulatory period by conducting a Total Factor Productivity (TFP) analysis based on the growth accounting database EU KLEMS. Our core analysis uses data for the Netherlands and Belgium, with greater weight given to data for the Netherlands due to the Belgian data being incomplete. We also include data for France and Germany for sensitivity analyses. Our analysis primarily focuses on estimates of gross output TFP growth, though we give some lesser weight to value added TFP growth estimates.

We have identified a set of eight comparator sectors from the NACE II classification of sectors in the latest EU KLEMS dataset, with our selection guided by consideration of the sectors' competitiveness and the similarity of the sectors' activities to the energy distribution sector. We estimate average TFP growth for these comparators over four different time periods, with most weight given to the estimates calculated over the full NACE II period excluding 2020 (which we consider an atypical year due to the Covid-19 lockdowns in this year). We also analyse TFP data from an earlier version of the EU KLEMS dataset that uses NACE I sector classifications and covers an earlier time period.

Our analysis of gross output TFP has led to a recommended range for frontier shift of 0.3 to 1.1 per cent. The upper bound of this range is based on the TFP growth performance of the stronger performing comparator sectors. The lower bound is based on the average TFP growth over the the full NACE II period across all comparators.

Three additional considerations lead us to recommend selecting a point estimate at the upper end of our recommended range. Firstly, there are strong reasons to believe that TFP growth rates could revert to pre-global financial crisis levels in the next regulatory period. Secondly, TFP estimates do not seek to measure embodied technical change (i.e. technical change embodied in capital, labour and intermediate goods), which means TFP estimates are likely to understate the scope for frontier shift. Finally, we place some weight on value added measures of TFP growth, which are higher than gross output measures. With these considerations in mind, we recommend a selected point estimate for frontier shift of **1.1** per cent for gas and electricity.

If VREG decides to apply a labour RPE based on the FBP forecast, then we would recommend the following net frontier shift figures:

- 0.94 per cent for electricity.
- 0.96 per cent for gas.

If VREG decides **not** to apply a labour RPE, our net frontier shift assumption for both electricity and gas is 1.1 per cent.

It is possible that by extrapolating the cost trend forward, the methodology is already accounting for frontier shift (or at least an element of frontier shift). If this were the case, applying a frontier shift assumption could double-count the frontier shift requirement. To investigate this possibility, we have used two different approaches: unit cost analysis and Data Envelopment Analysis (DEA). In both cases, the underlying approach involves identifying the most efficient DSOs and investigating whether these have increased their efficiency over time.

We have found that the efficient firm in the electricity sector tends to underperform in 2023, compared with our expectations for productivity improvements. Our results suggest that a full frontier shift challenge should be applied in the electricity sector (either 0.94 or 1.1 per cent per annum, depending on whether or not

VREG decides to apply a labour RPE). However, we have noticed that the results are very much dependent on the values observed in 2023 data. We also note that 2023 is budgeted data and we would therefore recommend that the VREG repeats the analysis with outturn data, when these are available.

For the gas sector we found that one of the firms identified as efficient in 2019 and 2020 always outperforms the improvement implied by our net frontier shift assumption. This is an indication that frontier shift is already captured in the linear trend in the gas sector, implying that no additional frontier shift challenge should be imposed. The other firm identified as efficient tends to underperform but we have shown that this is a very small firm with very low recorded costs at the beginning of the period. We have concluded that this firm is probably an outlier and that its results do not affect the conclusions we have obtained for the rest of the sample. Hence, our overall conclusion is that no frontier shift challenge should be applied in the gas sector. However, in the same way as for the electricity sector, we recommend that the analysis is updated when outturn 2023 data become available, to make sure that the results are not affected.

1 Introduction

VREG has commissioned Europe Economics to help in setting the tariff methodology for the Flemish electricity and natural gas distribution system operators (DSOs), for the regulatory period beginning in January 2025. The tariff methodology is used to calculate the cap on the revenues that DSOs can earn from distribution network tariffs. The specific requirements of the study are to analyse the evolution of recent endogenous costs (in the reference period 2019-2023), and provide advice on the indexation parameters and efficiency incentives elements of the allowed income for DSOs' endogenous costs.

The methodology that VREG expects to use for the next regulatory period is based on the methodology used for the regulatory period 2021-2024,[3] which involved the use of a historical linear cost trend with adjustments for inflation and expected productivity gains.

1.1 Overview of the tariff methodology (2021-2024 regulatory period)

In establishing the revenue caps, VREG's methodology for 2021-2024 distinguished between endogenous and exogenous costs.

- Exogenous costs are those that cannot be influenced by DSOs. It is understood that they are beyond their control and cannot be reduced through efficiency improvements. The DSOs are allowed revenues to cover these costs.
- Endogenous costs are the costs of network and data management activities, and include the cost of investment, operating expenditure and financing costs. Endogenous costs can be influenced by the decisions of DSOs. The tariff methodology is especially directed at estimating the allowance for such costs, such that they are reasonable and necessary for network operation.

There are also some "other" costs (for example, fines) that are borne by the distribution network operator and may not be passed on through distribution network tariffs.

The revenues for endogenous costs are subject to a regulatory revenue allowance which is based on the evolution of the costs of the industry. The formula which is used to calculate the regulatory revenue allowance takes account of:

- Year-on-year inflation (as measured by the Consumer Prices Index, CPI).
- A linear cost trend, estimated by calculating trend improvements in the costs of the whole sector over a historical reference period.
- A reduction equivalent to the expected costs savings from the recent merger of DSOs (based on VREG's research into the efficiency gains that Fluvius could achieve from the merger).
- Frontier shift, estimated from productivity improvements in comparable competitive sectors.

There is also an adjustment to incentivise quality of service, which is outside the scope of this study.

1.2 Objectives of the study

The aims of this study are to provide advice to VREG on indexation parameters and efficiency incentives. This requires the following:

[3] The most recent methodology also built on the approach used in the previous regulatory periods (2015-2016 and 2017-2020).

- A detailed analysis of the firm's endogenous costs in the historical reference period 2019-2023 (for different types of cost breakdown).
- Analysis and advice on whether indexation parameters should be adjusted to account for changes in input prices in the sector.
- Analysis and advice on the frontier shift parameters to be used to account for productivity improvements.

1.3 Structure of the report

The structure of the report is the following:

Chapter 2 provides a description of the data and the different transformations we have done during the course of our analysis.

Chapter 3 provides our analysis of endogenous costs using different types of cost breakdown.

Chapters 4 to 6 provide our work on real price effects.

Chapters 7 to 8 contain the analysis on frontier shift.

Chapter 9 concludes.

There is additional information in the form of appendices.

Phase 1: Evolution of costs

Europe Economics

2 Data collection

In this chapter we set out the data collection process for the different pieces of data used in the study.

2.1 Data obtained from different sources

2.1.1 Data from VREG

Cost data
VREG's preliminary calculations for the 2025-28 price review have been provided in a file which contains the endogenous costs, for electricity and gas (for 2019-2023), as well as VREG's calculated trend. VREG provided separate cost data for each DSO as well the total costs for the entire Fluvius entity.

Output data
VREG provided data for three outputs:

- Number of network users on Low Voltage (LV) and Medium Voltage (MV) network.
- Length of cables (underground and overhead lines).
- Volumes (offtake volumes, billed to suppliers).

Data are provided at the DSO level. We constructed a total aggregate figure for Fluvius as a whole.

Data on volumes contain some anomalies for December 2020 for some DSOs (Fluvius Antwerpen, Fluvius West, Fluvius Limburg and PBE). We have been told that the anomalies are due to the way Fluvius constructed the data for such operators.[4] The implications of this are that volume data for 2020 are not comparable to the other years.

All data have been corrected by VREG to account for changes in the operating areas of the DSOs. This means that data are comparable across time and across DSOs. (These changes affect Fluvius Antwerpen and Iveka in 2019-2020 and Gaselwest and Imewo in 2019-2021.)

Data on merger savings
VREG envisaged a schedule of cost savings to be imposed on DSOs following the mergers of Infrax and Eandis in 2018. For the period 2019-2024, a total of €73 million in savings was imposed in the electricity sector, and €36 million in the gas sector in real 2018 prices.[5]

Fluvius also provided data on the expected and achieved merger savings for the period 2019-2023. Fluvius' expected savings data relate to opex savings only and are, in some cases, slightly lower than the data from VREG (see further below).

Merger savings' corrections
VREG's methodology corrects the cost data for the savings that were imposed on the DSOs following the merger. The methodology subtracts the total merger savings from the costs, except for those cost savings that are expected to have already been achieved at each point in time. The same approach has been used for data at the DSO level. In this case, DSO-specific merger cost savings have been constructed using DSO's cost shares.

4 This is the result of the uniformisation of the data following the merger of companies.
5 See Annex 12 of the Tariff Methodology 2017-2020.

Transmission fees data
VREG provided corrected electricity transmission fees for 2019, 2020 and 2021 (the corrections are made to exclude some charges[6]). The fees data are used to assess what the impacts on the trend would be if such costs were included within endogenous costs. The set of transmission fees used in our trend analysis are reported in Table 2.1.

Table 2.1: Transmission fees data

Year	Transmission fee (€, current prices)
2019	370,781,327*
2020	366,972,989*
2021	387,220,727*
2022	414,717,852
2023	386,679,004**

Source: Fluvius. * Corrected fee provided by VREG. ** Budgeted data.

2.1.2 Data from Statbel

Inflation data (consumer price indices) are from Statbel, the Belgian statistical office.

Table 2.2: Inflation data (July of corresponding year)

Year	CPI
2018	107.43
2019	108.96
2020	109.76
2021	112.25
2022	123.05
2023	128.14
2024	133.36*

Note: CPI as recorded in July of the year.
Outturn CPI data (for 2018-2023) is available at [https://statbel.fgov.be/en/open-data/consumer-price-index-and-health-index].
* The CPI value for July 2024 based on the latest monthly forecasts provided by Belgium's Federal Planning Bureau at Federal Planning Bureau - Consumer price index & Inflation forecasts (December 2023 forecast).

2.1.3 Data from Fluvius

Fluvius provided cost data for the whole of Fluvius and for each DSO for 2019-2023. Fluvius is currently using a new cost allocation model introduced in 2020 which has some differences from the model used in previous years. Cost data are also subject to an ongoing standardisation process of Eandis and Infrax's accounting systems following the merger of these companies into Fluvius System Operator, in 2018. These recent changes have implications on the comparability of data between years, especially from 2019 onwards. It should also be noted that data for 2023 is budgeted data and that data for 2019 was provided in a different and less granular format.

Function and costs components
Cost data were provided broken down by different functions, defined internally by Fluvius and coded using a 5-digit code. There is a total of 222 functions defined for electricity and 164 for gas and these comprise very detailed cost lines (for example: General depreciation; Depreciation of buildings; Data room; Business

[6] Since 2022, these charges are not included in the transmission fee but are integrated in a new federal excise duty.

coordination; Corporate finance; Controlling & Pricing; Manage financing; …). For the purpose of analysis these have been grouped into fewer categories (see Chapter 3).

We also asked Fluvius to provide a breakdown of function costs into the following components:[7]

- Overheads.[8]
- Labour, which is broken down further into: executives, white-collar workers, logistics employees, and meter readers.
- Materials.
- Plant and equipment.
- Energy.
- Contractor costs.
- Other.

Merger savings and Covid-19 costs
Fluvius also provided data on the total merger savings that it achieved following the merger of Infrax and Eandis in 2018. Savings are only available for Fluvius as a whole, and were provided for 2020, 2021, 2022 and 2023 (budgeted data was provided for this last year). There were no merger savings identified for 2019.

The additional costs incurred as a result of the Covid-19 pandemic in the years 2020, 2021 and 2022 were also provided. Merger savings and Covid-19 costs are provided for each cost function line. (Covid-19 costs represent, overall, a negligible share of total costs.)

Overhead costs
Finally, Fluvius provided additional data containing total opex and capex overheads for electricity and gas over the historical period 2019-2023 (this is Fluvius' total overhead costs allocated to different business segments). It also provided a separate file with data on the breakdown of total overhead costs into different type of inputs: labour, materials, plant and equipment, energy, contractor costs, and other. These data are for Fluvius as a whole (including its non-energy activities) but provide a useful indication of how the overhead costs allocated to electricity and gas distribution are spread amongst the different inputs. (Overhead costs for gas and electricity account for over 90 per cent of total overhead costs for Fluvius.)

2.2 Adjustments to data

2.2.1 Excluded costs

Adjustments are made to the cost data reported by Fluvius, in order to align with VREG's tariff methodology. Some analyses exclude certain costs reported by Fluvius in the disaggregated cost breakdown. For instance, all financial costs and returns are excluded in the activity cost breakdown (Section 3.2) as they are not part of operating costs or depreciation.

2.2.2 Breakdown of Fluvius' reconciliation cost line

Fluvius' reported costs include a cost line titled "General Service". This is a cost line that is included to reconcile the total overhead costs with the costs that have been mechanically allocated as overhead into different functions' expenditure. The reconciliation line ensures that the *allocated* overhead costs tally with the *actual* overhead reported costs.

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7 Costs were provided in a matrix so that the cost of each function was also divided into the different components.

8 Fluvius' methodology notes that a surcharge of 30% is applied to electricity and gas opex and capex costs to account for overhead costs.

On the advice of VREG, we have decomposed the "General Service" cost line into different cost components. The decomposition is based on additional data reported by Fluvius, and enables us to reallocate costs initially defined as "overhead" into different input cost categories (indirect, labour, materials, plant and equipment, energy, contractor costs, other).

We have also reallocated the merger savings reported for "General Service" into different input cost categories. The reallocation of these merger savings is based on the share of each input cost category in the total overhead costs for Fluvius as whole (see Section 2.1.3).

3 Evolution of costs

This chapter analyses the evolution of costs across time. It uses a number of different datasets, as explained below.

The analysis of overall costs (i.e. the totals for Fluvius) uses data which have been provided by VREG and which contain endogenous costs calculated in line with VREG's tariff methodology.

The analysis of costs by activity and type uses data on depreciation and operating costs, provided by Fluvius. This includes outturn data from 2019 to 2022 and Fluvius' budgeted data for 2023. For this type of analysis data excludes certain costs, in line with VREG's methodology for ex-post reporting model (see previous chapter). The analysis also excludes from the costs any expenditure incurred due to the Covid-19 pandemic (as such expenditure is understood to be atypical). To be able to observe the underlying trend in costs (due to efficiency improvements only) our analysis also excludes any savings that have taken place as a result of the merger. (This has been done by adding Fluvius' reported cost savings from the merger back into the costs data.) This is different to the method used by VREG in the tariff methodology for 2021-2024 but the approach is useful to be able to see the evolution of costs excluding Covid-19 costs and those cost reductions arising from the merger. Fluvius provided data for 2019-2022 (and budgeted data for 2023). However, because of differences in the way data were recorded in 2019, the analysis of costs by activity and type can only be undertaken for 2020-2023.

The analysis of overheads uses Fluvius data on total opex and capex overheads which have been broken down using Fluvius' disaggregation of its total overhead costs into types of input. Data are sourced from separate data files and do not contain Covid-19 expenditures or merger savings. Hence the analysis of opex and capex overheads is without such corrections (and the results should be interpreted with this in mind).

In the last sections of this chapter we compare Fluvius' reported data with the allowed revenues from the previous regulatory period to assess whether productivity gains have been achieved.

For the calculation of figures in real prices, all results use 2024 inflation forecasts available in December 2023, except for the analyses of data provided by Fluvius (on different costs breakdowns by activity, type and overheads) that used inflation forecasts obtained in September 2023 (the difference is in the order of decimals so this does not affect the main findings and conclusions of the analysis).

3.1 Overall costs

In this section we analyse Fluvius' endogenous costs, for electricity and gas as a whole. Our analysis covers:

- The evolution of total endogenous costs from 2019 to 2023.
- Analysis of the trend (2019-2023).
- The evolution of unit costs from 2019 to 2023.

3.1.1 Evolution of total endogenous costs from 2019 to 2023

The total endogenous costs comprise the sum of operational costs, depreciation and a return on capital.[9]

The endogenous costs of electricity and gas have shown a steady increase, in nominal terms, during the period 2019-2023 in Flanders: electricity costs were in the order of €868 million in 2019 and increased to €1 billion

[9] Data provided by VREG (December 2023)

in 2023; gas costs evolved from €438 million to €494 million, over the same period. This represents an increase of around 16 and 13 per cent in both sectors, respectively. However, the increase in costs happened at a time when general consumer prices (as measured by inflation) were also increasing. As the increase in prices for the period 2019-2023 was around 18 per cent, the increase in observed costs is, in comparison, noticeably lower. To abstract from any inflation effects, we have expressed the endogenous costs in constant 2024 prices. The results, in real terms,[10] show a real decrease in endogenous costs in the period 2019-2023 for both sectors: a drop of around 1 per cent in electricity and 4 per cent in gas (Table 3.1).

Table 3.1: Endogenous costs (€ million): electricity and gas 2019-2023

	Electricity (current prices)	Gas (current prices)	Electricity (constant 2024)	Gas (constant 2024)
2019	868	438	1,062	536
2020	870	438	1,057	532
2021	826	428	981	508
2022	921	450	999	488
2023*	1,010	494	1,052	514
Change: 2019-2023	16.4%	12.8%	-1.0%	-4.1%

Note: * 2023 uses budgeted cost data.
Source: Data provided by VREG.

3.1.2 Analysis of the trend (2019-2023)

In this section we analyse the trends in endogenous costs for gas and electricity. We use linear trends, which are then extrapolated to estimate expected costs for the regulatory period 2025-2028. The historical reference period used is the five-year period 2019-2023 (using budgeted data for 2023), with all costs inflated to 2024 prices (based on forecast CPI for July 2024).[11] The results use data provided by VREG and follow VREG's methodology.[12]

The results of our analysis are reported in Table 3.2, below, for electricity and gas. For each trend we report the expected endogenous costs ("e") for 2025 and 2028 that are implied by the historical trend. We also report the annual change in costs that the trend represents (this is the compound annual growth rate, CAGR). We have calculated two trends for electricity and one trend for gas.

The trend in the first column ("1 Replicating VREG approach") uses the total endogenous costs as reported by Fluvius under the current regulatory accounting methodology used by VREG. The total endogenous costs comprise the sum of operational costs, depreciation and a return on capital. The historical trend for the total endogenous costs for electricity corresponds to an annual increase of 0.8 per cent, while for gas the historical trend corresponds to an annual reduction of 0.2 per cent. Extrapolating the trend forwards, the expected costs for electricity for 2025 are approximately €1,010 million (in 2024 prices) and the expected costs for 2028 are approximately €1,033 million. For gas, the expected 2025 costs are slightly under €486 million and the expected 2028 costs are slightly under €483 million. These figures are reported in the first column of Table 3.2.

For electricity, we have calculated an additional trend to investigate the impact that recategorizing transmission fees as endogenous (rather than exogenous) would have on the trend. The results are reported in column two of Table 3.2 ("2 Adding transmission fees"). The calculations are based on the same data from 2019-2023. As shown in the table, the trend becomes less steep when transmission fees are included,

[10] A real value is one that has been adjusted for inflation. It therefore allows the comparison of values across time as if the prices of goods or services had remained unchanged.
[11] See Chapter 2.
[12] The trends include corrections for the merger savings imposed by VREG in the period 2019-2024.

dropping from an annual increase of 0.8 per cent to an annual increase of 0.2 per cent. The expected costs for 2025 and 2028 are much higher than in column one because the transmission fees are very large.

Table 3.2: Trend analysis for electricity and gas (€ millions, 2024 prices)

	(1) Replicating VREG approach	(2) Adding transmission fees
Electricity		
2025e	1,010	1,422
2028e	1,033	1,429
CAGR	0.8%	0.2%
Gas		
2025e	486	N/A
2028e	483	N/A
CAGR	-0.2%	N/A

Note: "e" denotes expected costs. "CAGR" denotes the annual change in endogenous costs implied by each trend, calculated as the compound annual growth rate.
Source: Data provided by VREG and Europe Economics analysis. The trends include corrections for the merger savings imposed by VREG in the period 2019-2024.

3.1.3 Evolution of unit costs from 2019 to 2023

We have compared the evolution of costs against three of the outputs produced by Fluvius: network users, network length and volume delivered (electricity and gas). Unit costs are falling in both sectors, though the fall is more substantial in gas.

- For the electricity DSOs, the unit cost for all three outputs has decreased significantly over the period 2019 to 2022. As shown in Table 3.3, the cost per user is down by 9 per cent, the cost per km of network is down by 8 per cent, and the cost per MWh of electricity delivered is down almost 3 per cent. The figures reflect that the users and length outputs increased over that period and this translates into larger unit-cost reductions than the values found for overall costs (see Table 3.1). The finding is not the same for volume unit costs, as these reduced between 2019 and 2022.
- For the gas DSOs, the reductions over the period are more pronounced. As shown in Table 3.4, the cost per user is down by nearly 14 per cent and the cost per km of network is down by 10 per cent. The cost per MWh of gas delivered is down by nearly 6 per cent. These trends reflect, again, the increase in gas users and length of network, and a reduction in the delivered volumes, in the period 2019-2022.

Table 3.3: Endogenous costs per user, network length and volume: electricity (€, 2024 prices)

	Electricity cost / Users	Electricity cost / Length (km)	Electricity cost / Volume (MWh)
2019	307.1	8,128.9	33.7
2020	302.3	8,010.3	N/A
2021	277.5	7,386.9	31.2
2022	279.8	7,457.3	32.7
2023	292.5	7,773.4	N/A
Change: 2019-2022	-8.9%	-8.3%	-2.8%
Change: 2019-2023	-4.7%	-4.4%	N/A

Note: * 2020 volume data not available (due to a change in reporting methodology within Fluvius).
Source: Data provided by VREG.

Table 3.4: Endogenous costs per user, network length and volume: gas (€, 2024 prices)

	Gas cost / Users	Gas cost / Length (km)	Gas cost / Volume (MWh)
2019	241.8	9,398.5	8.4
2020	235.8	9,283.6	N/A
2021	221.0	8,824.5	7.3
2022	208.6	8,443.2	7.9
2023	218.3	8,877.9	N/A
Change: 2019-2022	-13.8%	-10.2%	-5.8%
Change: 2019-2023	-9.7%	-5.5%	N/A

Note: * 2020 volume data not available (due to a change in reporting methodology within Fluvius).
Source: Data provided by VREG.

3.2 Cost by activity

This section presents the evolution of depreciation and operating costs by activity. The analysis uses data provided by Fluvius which have been adjusted to align them with VREG's tariff methodology (see Chapter 2). The different activities have been defined in conjunction with Fluvius and VREG and represent different actions and tasks needed for the distribution of electricity and gas. The activities have been constructed by grouping different functions for which Fluvius collects cost data and which are needed to undertake the different operating activities.[13] There is a total of 222 functions defined for electricity and 164 for gas. These were grouped into respectively 40 and 36 activities (Table 3.5).

[13] The functions are defined internally by Fluvius and are reported using a 5-digit code.

Table 3.5: Constructed activities for analysis

Electricity	Gas
Branches	Active Protection
Buildings	Buildings
Cabin	Measuring Device
Measuring Device	Communication
Communication	Customer Cabin
Public Service Obligations	Public Service Obligations
Customer Service	Customer Service
Dispatching	Dispatching
Energy Delivery	Distribution Cabin
Facility Management	Energy Delivery
General Depreciation	Facility Management
Head Office Finance Functions	General Depreciation
Finance	Head Office Finance Functions
General	Finance
Studies	General
HR	Network Management
ICT	Studies
Logistics	HR
Low-Voltage Network	ICT
Market Operations	Logistics
Medium-Voltage Network	Low Pressure Network
Other (negligible)	Market Operations
Network Management	Medium Pressure Network
Net losses	Net losses
Overhead	Overhead
Prevention	Pressure Reducing Station
Projects	Projects
Public Lighting Grid	Purchase
Purchase	Receiving Station
Switching Station	Service Management
Teletransmission Network	Vehicles
Transformer Station	
Vehicles	

Source: constructed (Fluvius and VREG).

3.2.1 Evolution of activity

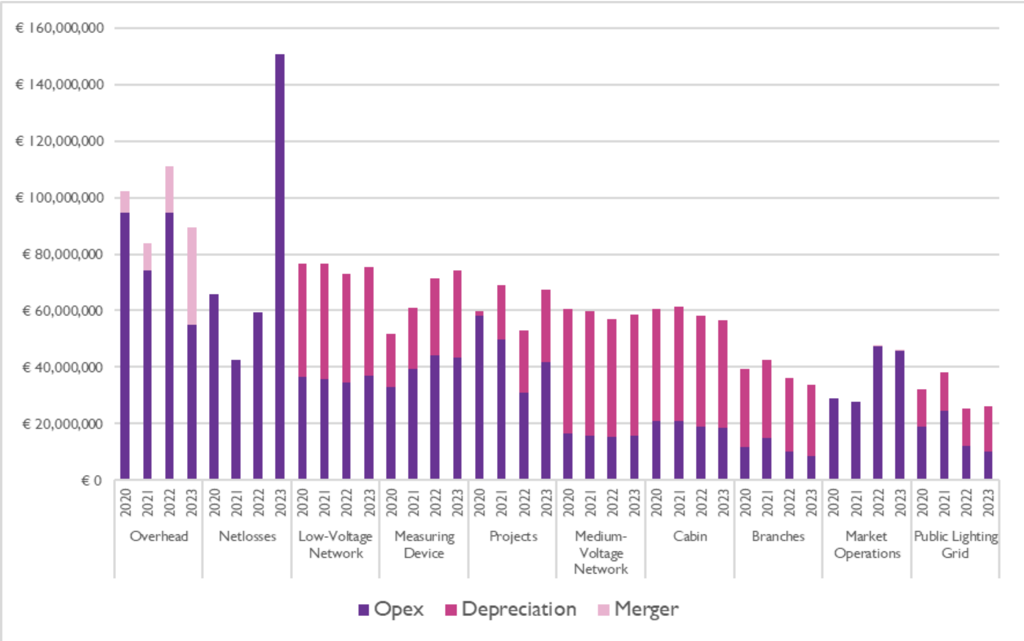
There is disparity in the shares of costs that the different activities represent, some of them accounting for less than 1 per cent of costs (the shares of all activities can be seen in Table 3.6 and Table 3.7, further below). To provide a meaningful visual representation across time, we have shown the top 10 activities in electricity and gas (Figure 3.1). The graphs break down opex and depreciation and also show the amount of costs reported as merger savings by Fluvius. (Covid-19 cost are small and have been excluded from the graphs for easier representation of the figures. 2019 data are excluded due to differences in the way data were recorded.) The results show the following:

- Regarding electricity costs, the analysis reveals that the largest cost component over the period as a whole is “Overhead”, followed by “Net Losses”. Except for “Overhead”, “Net Losses” and “Market Operations”, all costs types contain significant depreciation costs. Merger-related savings, instead, are all accounted for in “Overhead” costs (accounting for approximately 18 per cent of those costs). Overall, there is no clear upward or downward trend in the cost of activities during this period.
- Regarding gas costs, the analysis reveals that “Low Pressure Network”, “Service Management” and “Measuring Device” costs make up the largest shares of costs. Although most of the cost of activities is largely made up of opex, it is worth noting that some activities with large cost shares (such as “Low

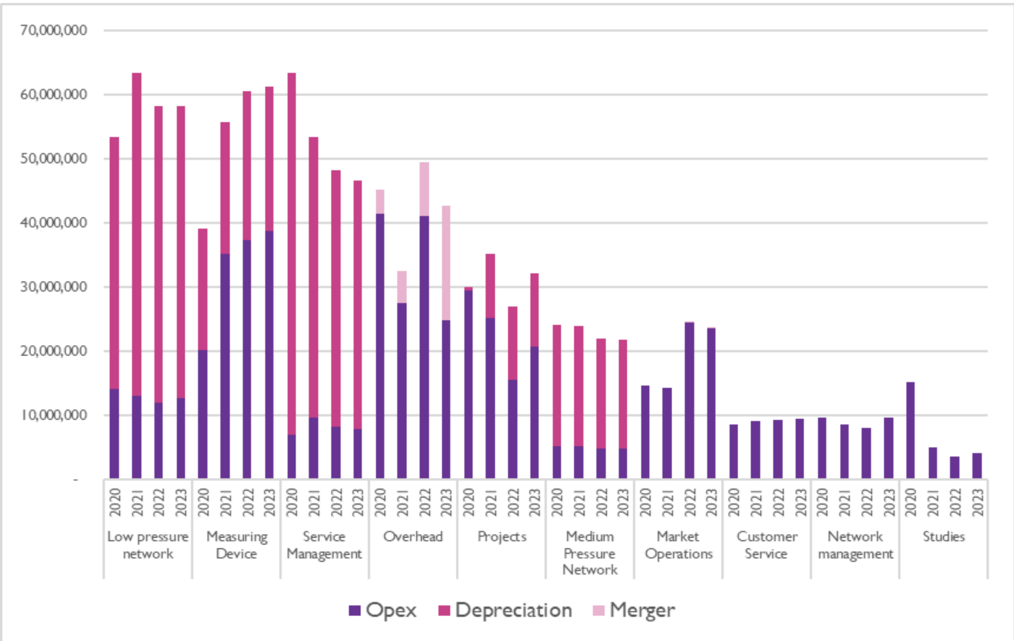
Pressure Network", "Service Management" and "Medium Pressure Network") are mostly made up of depreciation costs. As in the electricity sector, the bulk of the merger-related savings are accounted for in "Overhead" costs (accounting for approximately 21 per cent of these costs). Again, there is no clear upward or downward trend in the cost of most activities during this period.

Figure 3.1: Evolution of costs by activity (€, 2024 prices). Top 10 activities.

Electricity



Gas



Source: Fluvius data, Europe Economics analysis.

3.2.2 Trends by activity

We have represented the evolution of the costs by activity using two metrics: the compound annual growth rate (CAGR) and the slope of the trend calculated using the costs in different years. We note that both measures are calculated using very few data points (four data points between 2020 and 2023) and are likely to be influenced by extreme observations. This is especially true for 2023 values, which are based on Fluvius' budgeted (and not outturn) data. For this reason, the results are presented both with and without 2023 data.

Taking the CAGR excluding 2023 we can see that values range from -211.68 to 74.71 per cent, in the electricity sector (Table 3.6). Some of the largest decreases take place in categories which account for a very small share of total costs. When examining categories representing more than 1 per cent of costs in electricity, it can be seen that "Studies" experiences the largest cost decrease (CAGR of -163.60 per cent). Conversely, the "Buildings" cost activity sees the most significant cost increase (CAGR of 74.71 per cent). Of the activities with larger cost shares, "Overhead" and "Measuring Device" show a positive cost trend over the 3 years (CAGR of 4.6 and 16.2 per cent respectively). All other major cost activities with a share of more than 5 per cent experience a decreasing cost trend: such as "Net losses" (-5.81%), "Low-Voltage Network" (-2.61%), "Projects" (-5.61%), "Medium-Voltage network" (-3.01%) and "Cabin" (-1.78%). Some of the observed changes reflect the sensitivity of the CAGR to small variations in the data (especially for those categories that represent small cost shares). It is also possible that some changes are subject to the variations in the cost reporting used, as costs might be categorized under different function areas in different years (especially as a result of the standardisation of different accounting practices following the merger in 2018, and the change to a new cost allocation model, introduced in 2020, see Chapter 2). For this reason, it is difficult to draw a firm conclusion on the different observed trends.

Table 3.6: Electricity cost trends by activity, 2020-2023 (data corrected for merger savings)

	Share of cost (%)	Trend excluding 2023		Trend including 2023	
		CAGR (%)	Slope gradient	CAGR (%)	Slope gradient
Overhead	12.68	4.61	4.56	-1.03	-1.00
Net losses	10.43	-5.81	-3.24	45.81	27.16
Low-Voltage Network	9.90	-2.61	-1.97	-0.98	-0.74
Measuring Device	8.48	16.21	9.81	12.83	7.72
Projects	8.17	-5.61	-3.39	1.04	0.65
Medium-Voltage Network	7.74	-3.01	-1.78	-1.41	-0.84
Cabin	7.76	-1.78	-1.07	-2.52	-1.51
Branches	4.98	-3.75	-1.48	-5.97	-2.33
Market Operations	4.93	28.40	9.43	21.54	7.13
Public Lighting Grid	4.01	-10.74	-3.40	-9.54	-3.04
General Depreciation	2.35	-49.08	-8.22	-31.03	-6.04
Customer Service	2.34	2.80	0.49	1.99	0.35
Public Service Obligations	2.06	10.52	1.64	4.56	0.70
Network Management	1.99	-9.57	-1.43	-3.06	-0.47
Studies	1.98	-163.60	-12.23	-44.30	-7.10
Vehicles	1.89	8.72	1.28	0.71	0.10
Head Office Finance Functions	1.12	2.24	0.20	-5.15	-0.45
Switching Station	1.62	-4.30	-0.53	-2.06	-0.26
Other (negligible)	1.25	-19.00	-1.69	-1.78	-0.17
General	1.19	8.81	0.78	5.53	0.49
Logistics	1.12	-18.90	-1.62	-11.14	-1.00
Buildings	1.01	74.71	4.12	42.79	2.50
Teletransmission Network	1.00	1.62	0.12	6.93	0.51
Energy Delivery	0.75	-211.68	-9.51	3.41	0.19
Transformer Station	0.70	-159.85	-3.64	-24.62	-1.43
Dispatching	0.72	-26.30	-1.42	-13.54	-0.79
ICT	0.59	-192.83	-8.94	-165.86	-5.37
Prevention	0.27	-3.54	-0.07	0.58	0.01
Communication	0.12	0.63	0.01	-1.02	-0.01
Facility Management	0.10	-17.02	-0.12	-0.63	0.00
Purchase	0.09	47.25	0.28	20.44	0.12
HR	0.07	-13.38	-0.07	-7.48	-0.04
Customer Cabin	0.00	-300.00	0.00	58.74	0.00
Finance	-3.40	-20.55	4.42	11.16	-2.72

Source: Fluvius data, Europe Economics analysis.

Similarly, for gas, considering the CAGR excluding 2023, we observe values ranging from -264.20 to 47.69 percent (Table 3.7). When examining categories representing more than 1 percent of costs in gas we can observe that "Energy delivery" shows the most substantial cost decrease, with a CAGR of -237.76 percent. Conversely, "Market Operations" sees the most significant cost increase (CAGR of 28.97 percent). As with the electricity sector, it is worth noting that "Overhead" and "Measuring Device" experience an increase in costs over the 3 years (CAGR of 5.12 and 21.12 percent, respectively). The activity with the largest cost share, "Low Pressure Network," also experiences an increase in costs (CAGR of 4.10 percent).

Table 3.7: Gas cost trends by activity, 2020-2023 (data corrected for merger savings)

	Share of cost (%)	Trend excluding 2023		Trend including 2023	
		CAGR (%)	Slope gradient	CAGR (%)	Slope gradient
Low Pressure Network	16.73	4.10	2.38	1.57	0.91
Service Management	15.19	-13.95	-7.56	-10.06	-5.56
Measuring Device	15.55	21.12	10.65	14.16	7.07
Overhead	12.19	5.15	2.18	2.29	0.96
Projects	8.91	-5.08	-1.55	-0.61	-0.19
Medium Pressure Network	6.59	-4.46	-1.04	-3.81	-0.89
Market Operations	5.54	28.97	4.92	22.15	3.74
Customer Service	2.61	3.65	0.33	2.88	0.26
Network Management	2.59	-9.26	-0.81	-0.47	-0.04
Distribution Cabin	1.99	2.95	0.21	-4.22	-0.30
Head Office Finance Functions	1.36	-10.93	-0.50	-0.82	-0.04
Studies	2.00	-164.69	-5.79	-47.01	-3.43
General Depreciation	1.78	-22.41	-1.41	-14.16	-0.93
Energy Delivery	1.55	-237.76	-12.93	-379.88	3.94
General	1.22	5.57	0.21	15.11	0.59
Logistics	1.25	-18.39	-0.81	-10.68	-0.49
Pressure Reducing Station	0.88	-14.24	-0.47	-15.35	-0.50
Receiving Station	0.83	2.09	0.06	3.42	0.10
Customer Cabin	0.76	-4.17	-0.11	3.35	0.09
Public Service Obligations	0.82	-131.53	-1.64	-30.81	-0.96
Dispatching	0.72	-26.41	-0.64	-13.07	-0.34
ICT	0.42	-192.83	-2.91	-165.86	-1.75
Active Protection	0.41	-7.51	-0.10	-0.33	0.00
Facility Management	0.32	-24.19	-0.30	-27.43	-0.33
Vehicles	0.21	-37.59	-0.30	-36.17	-0.29
Buildings	0.20	16.29	0.11	11.51	0.07
Communication	0.13	1.14	0.01	-0.54	0.00
Purchase	0.10	47.69	0.14	20.88	0.06
HR	0.07	26.65	0.06	16.77	0.04
Other (negligible)	0.00	N/A	N/A	-251.83	0.00
Finance	-0.42	-264.20	-1.60	-264.71	-1.54
Net losses	-2.50	-161.76	6.00	-23.66	2.23

Source: Fluvius data, Europe Economics analysis.

It is important to note that some of the CAGRs change significantly when calculated adding 2023 data. This reflects two things: the fact that some of 2023 data is provisional (based on budgeted data), and that the results are based on very few data points (and influenceable by small variations in the data). The results should therefore be treated with caution. Conclusions on the trend would benefit from a recalculation once actual data for 2023 is reported.

We have also calculated the trends with the original data (without correcting for merger savings). As expected, the trends are steeper (costs show greater reductions as these are due to the savings achieved from the merger). The results are presented in the Annex.

3.3 Cost by type

The analysis by different cost types is presented in this subsection. Depreciation and operating costs have been provided by Fluvius and have been adjusted to align them with VREG's tariff methodology (see Chapter 2). The different costs functions have been allocated by Fluvius into the following categories: indirect; labour;

materials; plant and equipment; energy; contractor costs; and other.[14] Indirect costs are equivalent to overhead costs (i.e. costs that cannot be directly attributed to a specific activity). We further broke down energy into costs and revenues to be able to explore and provide greater detail on the negative costs (i.e. revenues) for some years in the gas sector (see below). All costs subtract any Covid-19 expenditure and also exclude any savings that have taken place as a result of the merger (to be able to observe underlying trend in costs due to efficiency improvements only).As seen in Figure 3.2, the largest shares of the cost are accounted for by plant and equipment and labour costs, for both gas and electricity, over the last four years (the smallest share is attributed to materials, followed by contractor costs). It is worth noting a downward trend in indirect costs for both electricity and gas which runs persistently over each of the four years of the period; and a big drop in labour costs taking place after 2020. A significant increase can also be observed, for both gas and electricity, in energy costs and also an increase in energy income (which appears in the figures as negative costs). The shift is driven by significant changes in the costs for 2023 which are expected to be the result of DSOs having to fulfil their social supplier and supplier of last resort obligations (which involve purchasing and selling energy) at a time when energy prices are expected to be high. Finally, an upward trend can be observed in "other" costs within the gas segment. There is no clear evidence of any other consistent trends for the remaining categories. Although some trends can be observed, conclusions need to be drawn with caution given the limitations found in the data and the fact that just a few data points are being analysed.

Figure 3.2: Evolution of cost types (€, 2024 prices)

Source: Fluvius data (include allocation by Fluvius), Europe Economics analysis.

3.4 Overhead costs breakdown

We have conducted additional analysis of Fluvius' overhead costs using two supplementary data files, both provided by Fluvius. The first file contains data on total opex and capex overhead for electricity and gas over the historical period 2019-2023. In a second file, Fluvius has provided data on how its total overhead costs (across all of its business segments, including non-energy activities) are distributed into different activities and input cost types. These data do not contain Covid-19 expenditures or merger savings, hence the analysis is without such corrections (and the results should be interpreted with this in mind). It should be noted that the analysis in this section uses opex and capex overheads, whereas the preceding analyses only considered overhead allocated to opex and depreciation (see Chapter 2 for a description of total opex and capex overhead costs allocated to gas and electricity, as provided by Fluvius).

To provide a more detailed analysis of the overhead costs, we have taken the total opex and capex overhead costs for electricity and gas and disaggregated them using the breakdown of Fluvius' total overheads between

[14] For the purpose of RPE analysis (Chapter 5) indirect costs are reallocated into different input cost categories (labour, materials, plant and equipment, energy, contractor costs, administration).

activities and input cost types. Electricity and gas account for over 90 per cent of all of Fluvius' overhead costs, so the shares for Fluvius as a whole provide a good estimate of the shares for electricity and gas.

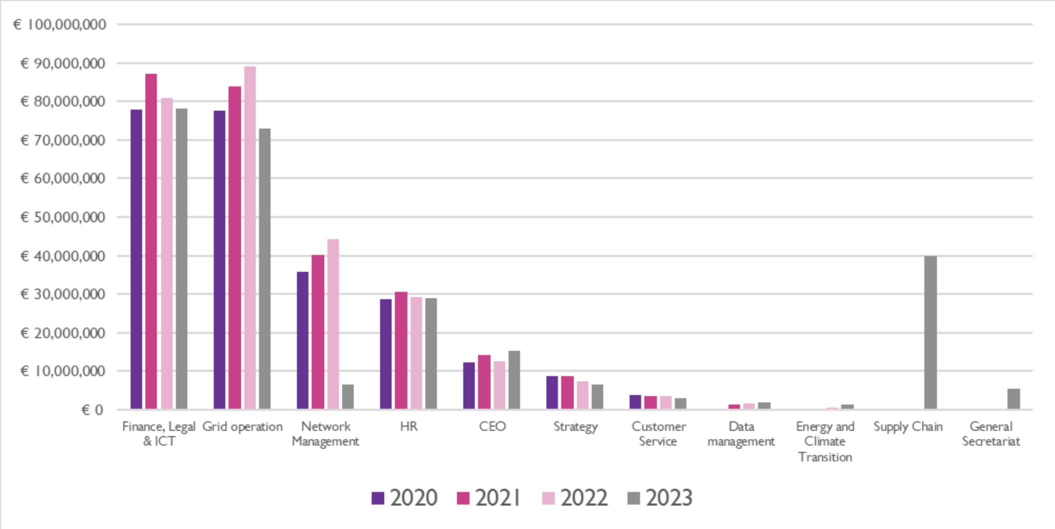
- The data provided by Fluvius for total overhead costs by activity contain eleven categories (these are slightly different to the functions and categories that Fluvius records for some other of its costs): CEO ; Customer Service; Data management; Energy and Climate Transition; Finance, Legal & ICT; General Secretariat; Grid operation; HR; Network Management; Strategy; and Supply Chain.
- The input overhead cost categories align with those used to disaggregate the total endogenous costs: Labour; Materials; Contractor costs; Other.

3.4.1 Overhead costs by activity: evolution across time

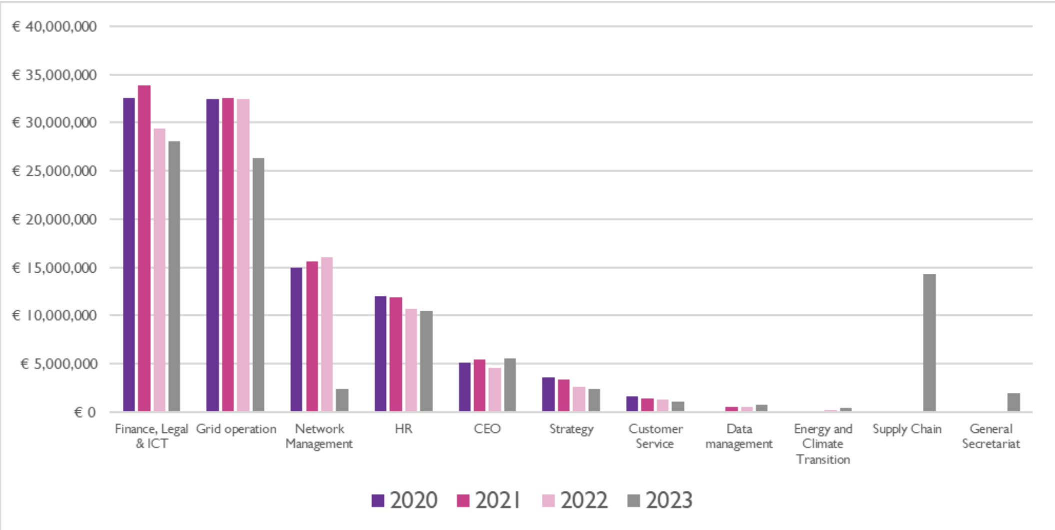
The results of applying the breakdown by activity to the annual overhead costs (opex and capex) for electricity and gas are presented in the figures below. For both electricity and gas segments, "Finance, Legal and ICT" is the largest cost activity in each year except 2022, when "Grid operation" is slightly larger. There is a noticeable drop in the "Network Management" and "Grid Operations" categories in 2023 that coincide with the introduction of the "Supply Chain" and "General Secretariat" categories in that same year. We note that "Energy and Climate Transition" only have costs reported in 2022 and 2023 (Figure 3.3).

Figure 3.3: Overhead breakdown by activity (€, 2024 prices)

Electricity



Gas



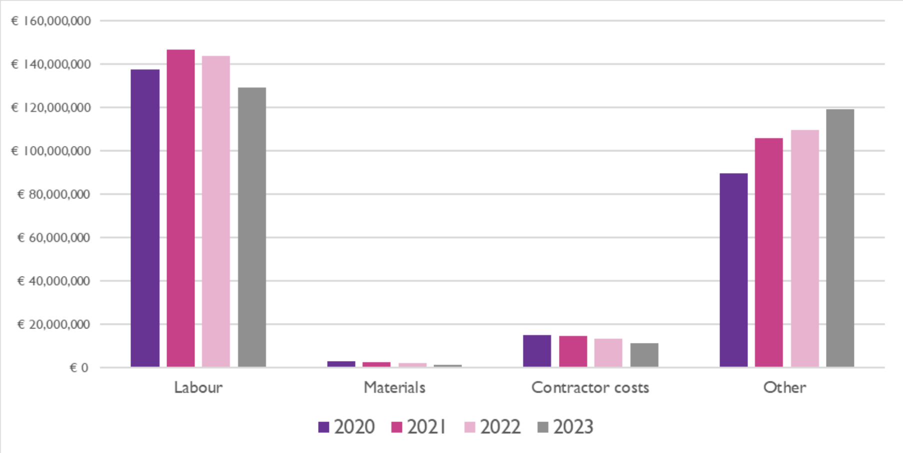
Source: Fluvius data, Europe Economics analysis.

3.4.2 Overhead costs by type: evolution across time

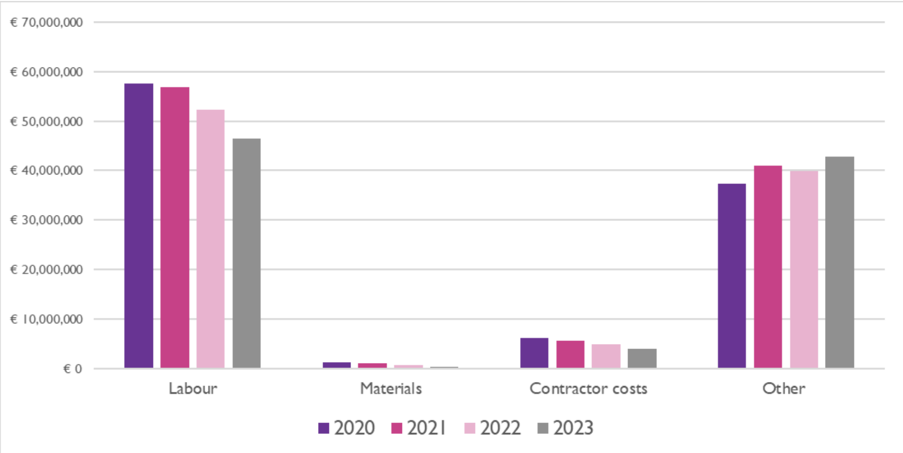
The results of applying the breakdown by input cost type to the annual overhead costs (opex and capex) for electricity and gas are presented in the figures below. For both segments, labour costs are consistently the largest component of overhead, followed by the "other" category (this category is analysed further in Section 5.8, as part of our framework for assessing RPEs). Materials and contractors have very small (and diminishing) shares. For electricity, the labour component of overhead follows an inverted U-shape, rising from 2020 to 2021 before falling again in 2022 and 2023. In gas, the labour costs within overhead fall consistently year-on-year. In both segments, there is a significant rise in "other" costs associated with overhead from 2020 to 2023. We note that the overhead breakdown indicates that there are no overhead costs in the input cost categories energy and plant and equipment (Figure 3.4).

Figure 3.4: Overhead breakdown by input type (€, 2024 prices)

Electricity



Gas



Source: Fluvius data, Europe Economics analysis.

3.5 Achievement of productivity gains: 2020-2023

We have also looked at the merger efficiencies achieved in comparison to the original savings envisaged by VREG. Data have been provided by Fluvius and show that Fluvius has not achieved the cost efficiencies expected from the merger over the period 2020-2023 (Table 3.8). By the end of 2022, Fluvius achieved less than a quarter of the imposed merger savings. Fluvius' budgeted data for 2023 indicates that progress is anticipated in this regard, with the gap between allocated savings and achieved savings expected to shrink. Nonetheless, by the end of the period there will still be more than half of the allocated savings remaining to be achieved. We note, however, that this analysis is based on non-audited data. Further, the tariff methodology only imposes a linear savings trend to be achieved in 2024, with Fluvius having flexibility as to how it achieves these savings. Hence, final conclusions should be drawn after 2024.

Table 3.8: Merger savings: allocated by VREG and achieved by Fluvius

	Allocated (€m 2018 prices)	Allocated (€m 2024 prices)	Achieved (€m 2024 prices)	Remaining (€m 2024 prices)
Electricity 2022	73	91	19	71
Gas 2022	36	45	9	35
Electricity 2023*	73	91	39	52
Gas 2023*	36	45	20	25

Note: *Achieved savings for 2023 based on budgeted data.
Source: VREG and Fluvius.

3.6 Advice on future reporting models

The annual reporting models which are collected as part of VREG's tariff methodology contain several tables with data on Fluvius' revenues and costs (containing, for example, the income statement, endogenous costs, depreciation and operating costs) broken down by the two-digit categories of the Belgian GAAP accounting standards. The reporting models constitute an important piece of analysis for determining the endogenous costs of Fluvius and also for estimating the linear cost trend that the VREG uses in the tariff methodology.

However, despite annual reporting models being available, for the purpose of the current study Europe Economics needed to ask Fluvius for additional data to be provided, and also to provide data at different levels of breakdown. Europe Economics also had to undertake a significant number of calculations and transformations to the data provided to make it suitable for the analysis. The problems encountered refer to data under this breakdown (and not the costs reported in VREG's current ex-post reporting models using Belgian GAAP, which are rigorously audited). The list of issues encountered can be summarised as follows:

- **Problems in the delimitation of costs categories:** Fluvius records its costs according to different functions it has defined using a 5-digit code. However, the precise definition of such functions and how these delimit costs is based on internal practice and not a standardised method. Furthermore, the mapping of the functions to different higher-level activities (used to provide electricity and gas services) is not clear. Fluvius assisted us by providing a detailed mapping (which used the best of their analysts' knowledge) but the data collection process would benefit from a more rigorous and documented approach, so that the analysis can be replicated in the future with greater certainty about what each function relates to.
- **No clear delimitation of costs types:** A similar problem was encountered when using data broken down by type of inputs ("indirect"; "labour"; "materials"; "plant and equipment"; "energy"; "contractor"; "other"), also categorised on the basis of information from Fluvius. Again, a rigorous and documented approach would benefit such an exercise.
- **Large proportion of costs in "other" category.** The data provided by Fluvius allocated a large proportion of costs to the "other" category. It would be advantageous for future analysis of RPEs if Fluvius is able to do further work to allocate more of the costs currently in the "other" category to the other input cost types (i.e. labour, materials, plant and equipment, energy, contractor costs, administration).
- **Lack of consistency across time (company and area delimitation):** Some of the data were not consistent across time. This was because of changes in the DSO's operating areas, and also as a result of the merging of companies (this happened for costs but also for data on December 2020 electricity and gas volumes for Fluvius Antwerpen, Fluvius West, Fluvius Limburg and PBE). To allow for a consistent analysis of costs, data should be corrected so that they are comparable across DSOs and time.
- **Flexibility in the reporting of overheads in different cost lines:** We had a number of meetings with Fluvius to be able to understand the reporting of overhead costs. Fluvius' method involves allocating overhead costs to different cost lines using different steps, but the components of such lines are not always consistent across the years. As a result, it is difficult to understand the evolution of such costs

across time (we are grateful to Fluvius for providing additional information on the allocation of overheads in different categories so that the costs analysed in the report were comparable). The reporting of Fluvius should provide greater detail of overhead costs and a breakdown of such costs into different cost lines.

- **No data on merger savings:** DSOs can benefit from costs savings from the efficiencies that can be derived from the 2018 merger (Eandis and Infrax merged into Fluvius System Operator in 2018). However, the DSO costs are also used to estimate the linear trend of the endogenous costs during the historical reference period to provide a measure of time efficiency improvement. In order to be able to estimate a linear trend that is representative of just efficiency improvement and not merger effects, a separation between merger savings from the rest of costs is needed. Fluvius has been providing these data upon request but a standardised process for the reporting of such costs should be established.
- **Some errors in the records:** We have found some errors in the data in a small number of cases. The errors were easy to correct but this calls for more standardised recording methods to be used and also for a proper data auditing process to be implemented.

Looking forward, VREG should ensure greater robustness of the disaggregated data used in the analysis. This would imply providing guidance on the reporting of costs (at different levels of breakdown) and providing additional measures for auditing the data. This should be particularly directed at the reporting of costs and merger savings.

The tariff methodology envisages a linear trend for the total endogenous costs so, in principle, there is no need for additional cost breakdown or for breakdown at the DSO level. However, VREG might wish to consider having costs breakdowns to assess the suitability of different indexation parameters (costs of inputs), or to separately analyse different cost components. The typology for cost breakdown should be defined for such purposes. VREG might also want to evaluate the costs by comparing the performance of different DSOs. This would allow VREG to estimate alternative efficiency measures. In such a case, the methods for separating general costs (overheads and merger savings) by DSO should be clearly established to avoid variations in the cost breakdown reporting.

PHASE 2: REAL PRICE EFFECTS

Europe Economics

4 Approaches to Indexation in Other Jurisdictions

This chapter summarises the approach to indexation used by electricity and gas regulators in other European jurisdictions, namely:

- Wallonia (CWaPE)
- The Netherlands (ACM)
- Germany (Bundesnetzagentur)
- France (CRE)
- Ireland (CRU)
- Great Britain (Ofgem)

For each jurisdiction we summarise the approach taken by the regulator to indexing allowed revenues (including any indexation for real price effects[15]) for both the electricity and gas sectors.

Finally, we assess these approaches used in other jurisdictions and consider their overall relevance to VREG in the Flanders context.

4.1 Review of approaches to indexation in other jurisdictions

4.1.1 Wallonia

The Commission Wallonne pour L'Energie (CWaPE) regulates the tariffs that gas and electricity DSOs can charge customers in the Walloon Region. CWaPE published the final tariff methodology for both the electricity and gas sectors covering the period between 2025-2029 in June 2023.[16] This section summarises CWaPE's approach to indexation of allowed revenues.

In the 2025-29 tariff methodology for both electricity and gas, indexation was applied to operating expenditure, depreciation and return, using the health index.[17] The authorised income for the DSOs comprised of net operating costs, the fair profit margin, a quality term, expenses relating to the deployment of smart electricity meters and, where applicable, a share of the amount to be cleared of regulatory balances from previous years.[18] An additional allowance was also made for "transition costs" for the years 2026 to 2029 to allow DSOs to undertake network extensions and upgrades necessary for the energy transition – these additional costs were indexed in the same way as other controllable costs.

CWaPE sets the budgets for controllable net operating expenses based on the actual controllable net operating expenses recorded by the DSO during the reference years[19] (i.e. between 2019 and 2022). CWaPE then applies both an efficiency and an indexation factor.

[15] The term "real price effects" is used in regulation to refer to the input prices faced by a regulated firm changing in real terms (i.e. rising faster or slower than the general inflation index used to index the prices of the regulated firm).
[16] This follows an agreement between CWaPE and the DSOs to postpone what was going to be the 2024-2028 regulatory period by a year.
[17] CWaPE (2023): "Méthodologie tarifaire pour la période régulatoire 2025-2029"
[18] CWaPE (2023): "Méthodologie tarifaire pour la période régulatoire 2025-2029" p.18.
[19] The previous (2015-19) methodology determined controllable costs based on DSOs' budget estimates.

During the consultation period preceding the publication of the final methodology, DSOs raised the following points regarding the indexation of allowed revenues:

- Use of health index[20] vs consumer price index (CPI): DSOs requested CWaPE to use the CPI (consumer price index) instead of the health index, arguing that the former takes into account the price of fuel. CWaPE decided to continue using the health index for the purposes of indexing allowing revenues stating that this contributed to regulatory stability. CWaPE also noted that during the consultation on the draft 2019-2023 tariff methodology, it was the DSOs who argued in favour of using the health index over the CPI as – in their view at the time – the majority of the controllable costs consisted of salary costs which are indexed on the basis of the health index rather than the CPI.
- Use of an ex post revision mechanism for controllable costs based on the actual (outturn) health index: At the DSOs' request, CWaPE decided to reinstate an ex post revision mechanism for controllable costs for 2025 to 2029 based on the actual health index for these years. While the mechanism formed part of the tariff methodologies prior to the 2019-2023 tariff methodology, as requested by DSOs it was removed for the current tariff period to give DSOs greater predictability and stability regarding their controllable cost budget. While CWaPE noted that it understood the DSOs' motivation to protect themselves against unpredictable increases in the health index in the current inflationary context, it highlighted that it would be inconsistent for DSOs to once again argue in favour of removing the revision mechanism when developing the 2030-2034 tariff methodology. This is because the ex post revision mechanism works both ways meaning that when the actual health index turns out to be lower than the budgeted health index this leads to lower controllable costs calculated ex post (compared with the budgeted controllable costs calculated ex ante) and vice versa.
- Increasing the health index to reflect the evolution of costs: Some DSOs argued that the health index should be increased to be more representative of the evolution of costs (faced by DSOs). CWaPE disagreed with this proposal noting that the level of costs for each DSO is different and depends on many parameters e.g. the DSO's salary policy, use of contractors, etc. This means that the price increases/ variations are also different between DSOs which means that applying a fixed increase to all DSOs would be inadequate and unjustified.[21]

CWaPE also noted that Article 54 of the 2025-2029 tariff methodology provides for the possibility of revising the controllable costs in the event of exceptional circumstances beyond the control of the DSO which has a long-lasting and significant upward impact on its controllable costs.

CWaPE did not apply any indexation for RPEs (and did not include any ex ante allowance for RPEs either).

4.1.2 The Netherlands

The Netherlands Authority for Consumers and Markets (ACM) regulates the tariffs that the gas and electricity network companies of the Netherlands can charge customers. The current regulatory periods for both electricity and gas distribution in Netherlands run from 2022 to 2026. The ACM's final methodology decisions for both sectors were published in September 2021.[22]

ACM used CPI as its inflation index to index allowed revenues, for both gas and electricity distribution. For electricity, indexation was applied to operating costs, depreciation and the regulatory asset base.[23] In the case

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[20] The health index is determined by removing a number of products from the consumer price index product basket, in particular alcoholic beverages (bought in a shop or consumed in a bar), tobacco products and motor fuels except for LPG. The health index is used for the indexation of housing rents. Source: Statbel [online].

[21] For further details on the arguments by CWaPE, see p.103 of CWaPE (2023): "Annexe 1: Motivation de la méthodologie tarifaire pour la période régulatoire 2025-2029" [online].

[22] ACM's 2022-2026 decisions for electricity grid operators and gas grid operators are available here (electricity) and here (gas). The information on ACM's methodology in this case study is taken from these documents.

[23] ACM (2021) "Methodebesluit regionale netbeheerders elektriciteit 2022-2026" p.67

of the regulatory asset base, indexation for 2022-2026 was applied using half of the estimated CPI (0.9 per cent rather than 1.8 per cent), and the "real-plus" weighted average cost of capital (WACC) used by ACM only had half of the inflation effect stripped out. The rationale for this approach is that DSOs are expected to incur large expenditures to meet the needs of the energy transition, which could lead to financial pressure on DSOs under a standard real WACC approach where the return on capital is spread over a longer time horizon than a nominal WACC approach. ACM considered the "real-plus" WACC approach struck a balance between mitigating the concerns of network operators, while at the same time taking short-term affordability for consumers into account.

In the gas sector, ACM used a nominal WACC, rather than indexation of the asset base, to compensate investors for inflation.[24] This was a change from previous ACM approaches, as ACM decided that a real WACC would lead to a distribution of capital costs over time that does not align with the expected decrease in grid use. One of the aims of the previous real WACC approach was to ensure that current network users pay the same in real terms for the same service as future network users, but if future usage is declining this argument no longer holds, and instead a real WACC approach would lead to a decreasing number of network users bearing the costs of the inflation compensation.

ACM did not apply any indexation for RPEs (and did not include any ex ante allowance for RPEs either).

4.1.3 Germany

The Bundesnetzagentur (BNetzA)[25], the regulator for energy markets, sets price controls for the gas and electricity network companies operating in Germany. The current regulatory period for electricity distribution runs from 2023 to 2027 and for gas distribution it runs from 2019 to 2023.

BNetzA determines a revenue cap for each calendar year of the entire regulatory period. The revenue cap is set on the basis of operators' base level of costs (comprising both permanently non-controllable costs[26] and generally controllable costs) and their efficiency level.[27] It also includes the costs of financing necessary investments through depreciation of capital assets and the imputed rate of return on equity.[28]

The revenue cap is adjusted on January 1 of each calendar year in the event of a change in:

- the overall consumer price index;
- non-controllable cost shares; and
- volatile cost shares.

For the first of these adjustments, the overall consumer price index published by the Federal Statistical Office[29] for the penultimate calendar year before the year for which the revenue cap applies is used to determine the revenue cap.[30]

BNetzA did not apply any indexation for RPEs (and did not include any ex ante allowance for RPEs either).

24 ACM (2021) "Methodebesluit regionale netbeheerders gas 2022-2026" p.42
25 BNetzA serves as the federal regulator for electricity, gas, telecommunications, post and railway.
26 Non-controllable costs include concession fees, operating taxes, use of upstream network levels or works and staff council activities. See ARegV. §11 [online]
27 BNetzA: "The main tools of incentive regulation in Germany" [online]
28 BNetzA: "Revenue caps and revenue regulation" [online]
29 See Federal Statistical Office: Consumer Price Index [online]
30 Verordnung über die Anreizregulierung der Energieversorgungsnetze (Anreizregulierungsverordnung - ARegV) [online]

4.1.4 France

The Commission de régulation de l'énergie (CRE) regulates the tariffs that the gas and electricity network companies can charge customers in France. The current tariff for public electricity distribution grids (TURPE 6 HTA-BT) entered into effect on 1 August 2021 for a regulatory period of approximately four years. The current tariff for GRDF's public natural gas distribution networks (ATRD6) entered into effect on 1 July 2020 for a regulatory period of approximately four years.

For both electricity and gas DSOs, the projected allowed revenue for the regulatory period comprises net operating expenses, normative capital expenses and adjustments[31] as relevant.

CRE's calculations of actual allowed revenue take into account the difference between forecast and actual inflation. For year N, it is calculated as the reference value set out in the CRE's deliberation, divided by forecast inflation between 2019 and year N, and multiplied by the actual inflation between 2019 and year N.[32] Actual inflation is defined as the change in the average value of the consumer price index excluding tobacco[33] for (calendar) year N, compared to the average value of the same index for 2019.

CRE did not apply any indexation for RPEs (and did not include any ex ante allowance for RPEs either).

4.1.5 Ireland

The Commission for Regulation of Utilities (CRU), the regulator for energy markets, sets price controls for the gas and electricity network companies of Ireland. CRU published its most recent price control (PR5) for electricity distribution companies in December 2020 which covers the five-year period to 2025. The most recent price control for gas distribution companies (PC4) was published in August 2017, initially covering the five-year period to September 2022. However, due to delays associated with the Russia-Ukraine conflict, the final determinations for the next price control (PC5) have not been made.

Annual revenues and the regulatory asset base (RAB) for gas and electricity markets are indexed to the Irish Harmonized Index of Consumer Prices (HICP),[34] a measure of general inflation. The allowed revenue for the regulatory period is the sum of annual operational expenditure and k factor adjustments, along with the capital allowances for depreciation and return on the RAB.[35]

The CRU did not apply any indexation for RPEs (and did not include any ex ante allowance for RPEs either).

4.1.6 Great Britain

Ofgem, the regulator for energy markets, sets price controls for the gas and electricity network companies of Great Britain using the RIIO model.[36] The most recent price control for electricity distribution companies, RIIO-ED2, was determined in November 2022 and covers the five-year period from April 2023 to March 2028. The most recent price control for gas distribution companies, RIIO-GD2, was determined in December

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31 In the case of electricity, the relevant adjustments include a reconciliation of the balance of the expenses and revenues clawback account ("compte de régularisation des charges et des produits" or CRCP) as well as adjustments relevant to Enedis's smart metering project, while for the gas sector only CRCP reconciliation applies.

32 CRE (2021): Deliberation N°2021-13 "Deliberation of the French Energy Regulatory Commission of 21 January 2021 on the tariffs for the use of public distribution electricity grids (TURPE 6 HTA-BT)" p.118-119 [online]

33 Index "001763852" for all households published by INSEE, the French national statistics office.

34 HICP is a measure of inflation in the Eurozone and the European Union. It is "harmonised" because all the countries in the European Union follow the same methodology. This ensures that the data for one country can be compared with the data for another.

35 CRU (2020) "Distribution System Operator (DSO) Revenue for 2021-2025" pg. 80 [online]

36 RIIO stands for setting Revenues using Incentives to deliver Innovation and Outputs.

2020 and covers the five-year period from April 2021 to March 2026. This section summarises Ofgem's approach to indexation, including indexation for real price effects (RPEs), for RIIO-GD2 and RIIO-ED2.

Inflation index used to index allowed revenues
Ofgem used CPIH to index all aspects of companies' price control allowances (operating costs, depreciation and return) for RIIO-GD2 and RIIO-ED2.[37]

Indexation for real price effects
Ofgem's approach to RPEs for the most recent RIIO-2 price reviews was significantly different from its approach at the previous RIIO-1 price reviews, a decision influenced by the fact that the outturn value of the indices used to set ex ante RPE allowances for RIIO-T1 and GD1 were lower than the forecast RPEs Ofgem determined when setting fixed ex ante allowances.[38] One reason for this is that the historical data Ofgem had available to try to determine ex ante RPEs covered the years prior to the global financial crisis, which turned out to be a poor predictor of movements in input prices in the post-crisis period of RIIO-1.

The result of this was that the RPE allowances became a source of additional returns for the regulated companies during the RIIO-1 control period. Ofgem decided to introduce RPE indexation for RIIO-2, such that RPE allowances would be updated annually during the control period using the latest available figures for relevant indices, to manage the risk of inaccurate RPE forecasts. More details are provided below.

RIIO-GD2

Ofgem included a notional RPE allowance for DNOs to account for forecast differences between changes in CPIH and input prices, along with within-period true-ups each year of the control period based on outturn indices.

Ofgem applied RPEs to the following cost categories for GD:

- Labour (general and specialist)
- Materials

In line with Ofgem's previous approaches, where possible independent forecasts for a given index were used (which in practice only applied to labour costs), and the long-term historical average was applied where independent forecasts were not available. The indices Ofgem used for historical data are provided in the table below:

Cost category	Source	Index
Labour	ONS	Average Weekly Earnings (AWE) private sector
Labour	ONS	AWE Construction
Labour	BCIS	PAFI Civil Engineering
Labour	BEAMA	Electrical Engineering
Materials	BCIS	PAFI Steel Works
Materials	BCIS	PAFI Plastic Pipes
Materials	BCIS	PAFI Plant and Road Vehicles
Materials	ONS	Machinery and equipment output PPI
Materials	BCIS	Resource cost index of infrastructure (FOCOS): materials

ONS stands for Office for National Statistics; BCIS stands for Building Cost Information Service; BEAMA stands for British Electrotechnical and Allied Manufacturers Association

RPEs were based on the unweighted average of the indices within each cost category, net of forecasted general inflation, estimated using the Office for Budget Responsibility's (OBR's) forecast for CPI. For labour,

37 Ofgem (2022) "RIIO-ED2 Final Determinations Core Methodology Document" pg. 351 and Ofgem (2021) "RIIO-2 Final Determinations – Finance Annex" p.110
38 Ofgem (2018) "RIIO-2 Framework Consultation " [online] paragraph 4.7.

OBR's forecasts for average earnings were used where available, which was up to and including 2023/24.[39] Longer-term forecasts for labour RPEs were based on the historical average for the selected subsector indices. All of the RPEs for materials were based on the historical long-term average of the chosen indices.

RIIO-ED2

As with RIIO-T2, Ofgem included a notional RPE allowance for DNOs to account for forecast differences between changes in CPIH and input prices, along with within-period true-ups each year of the control period based on outturn indices.

Ofgem applied RPEs to the following cost categories for ED:

- General labour
- Specialist labour
- Materials

Ofgem's advisors, CEPA, identified two indices for general labour and three for specialist labour. At draft determination, CEPA favoured ONS' AWE Private Sector index over the ONS ASHE Median Hourly Earnings, on the grounds that public sector pay was less relevant to DNO costs. This was criticised in responses to the draft determination, and CEPA changed its approach for final determinations by using both ONS indices with a 50 per cent weighting on each. CEPA acknowledged that the two ONS indices both had advantages and disadvantages, as while the ASHE index includes both public and private sector workers, the AWE index does not differentiate between part-time and full-time workers.

For specialist labour there were three indices identified by CEPA for Ofgem's final determinations, each receiving a 33 per cent weighting. These were:

- BCIS PAFI civil engineering (4/CE/01)
- BCIS 4/CE/EL/01 Electrical Engineering Labour
- BEAMA Electrical Engineering Labour

For materials, CEPA selected four indices:

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

CEPA took the unweighted historical average of the indices over the period 2000 to 2021 in each cost category to get an RPE for each category, and then calculated an overall RPE for totex[40] by combining the RPEs based on a notional cost structure. For general labour, the RPE up to 2026 was based on the difference between OBR's forecast for earnings growth and its CPI forecast. Subsequent years used historical data from the indices listed above.

CEPA also considered if the high and uncertain inflationary environment in the UK at present justified changing its RPE forecasting approach.[41] CEPA looked at historical trends in growth rates for the materials indices for evidence that inflationary spikes tend to persist across multiple years. CEPA found that over the last 20 years, inflationary spikes tend to fall out of the data the following year, resulting in a one-time step change in the level of the index. CEPA therefore determined that its existing approach remained reasonable

[39] As with economy-wide inflation, this approach was revised between draft and final determinations. At draft determination, CEPA used HM Treasury's consensus forecast for whole economy earnings. The change to using OBR forecasts was to ensure consistency with the general inflation approach.

[40] "Totex" refers to total expenditure, the combination of operating expenditure (opex) and capital expenditure (capex).

[41] CEPA (2022) "RIIO-ED2 Final Determination: Frontier Shift methodology paper" p.49

given the information available, and noted that "the challenge of fixing inflation and input price forecasts in the current inflationary environment is mitigated by the indexation mechanism".

Cost of capital indexation

Under its RIIO model, Ofgem indexes the cost of debt element of the WACC by updating it each year of the price control in line with a trailing average of a market index of corporate bond yields. In its RIIO-2 price reviews, Ofgem extended cost of capital indexation by additionally indexing the risk-free rate element of the cost of equity to a market index of government bond yields.

The cost of capital figure to be used by VREG is outside our terms of reference and is being considered by separate contractors.

4.2 Assessment approaches to indexation in other jurisdictions

The table below summarises the indexation approach used by other European regulators.

Table 4.1: Summary of indexation approaches in other jurisdictions

Regulator	Inflation index used for indexation	In addition to indexation of operating costs, is indexation also applied to both the depreciation and return elements of allowed revenue?
CWaPE (Wallonia)	Health index	Yes
ACM (Netherlands)	CPI	Electricity: yes Gas: no, as ACM has now switched to nominal WACC approach
BNetzA (Germany)	CPI	Yes
CRE (France)	CPI excluding tobacco	Yes
CRU (Ireland)	HICP	Yes
Ofgem (Great Britain)	CPIH	Yes

Source: Europe Economics analysis.

As the table shows, regulators in other European jurisdictions generally apply indexation to all elements of allowed revenues (i.e. operating costs, depreciation and return). Of the jurisdictions considered, only ACM for the gas sector in the Netherlands does not apply indexation to the depreciation and return elements following a recent switch to a nominal WACC approach.

In terms of the index used, regulators use various measures of general price inflation to index allowed revenues. The general consumer price index (CPI) is used in both Germany and the Netherlands, CPI including owner occupiers' housing costs (CPIH) is used in Great Britain, and the Harmonised Index of Consumer Prices (HICP) is used in Ireland. The regulator in France uses CPI excluding tobacco as its measure of inflation, while CWaPE in Wallonia uses the health index which is determined by removing alcoholic beverages, tobacco products and motor fuels except for LPG from the CPI.

We consider that these regulatory precedents support the continued use of CPI indexation by VREG. CPI is the most commonly used index in these other jurisdictions, and even where other indices are used they are closely related to CPI. While VREG could theoretically switch to using the health index (as CWaPE does in Wallonia), we note that a key reason cited by CWaPE for continued use of the health index was regulatory stability. In the case of Flanders, a desire to maintain regulatory stability would by contrast point to the continued use of CPI by VREG, rather than a switch to the health index.

Of the other jurisdictions considered, only Ofgem applies indexation for RPEs. Ofgem's use of indexation for its latest RIIO-2 price controls appears to reflect circumstances that are specific to the context of energy regulation in Great Britain – namely, the fact that Ofgem significantly overestimated the ex ante allowances that it used in its previous RIIO-1 price controls and that it wished to avoid a repetition of this outcome. However, in the Flanders context this history does not apply, and VREG can instead seek to avoid the mistakes that Ofgem made in its RIIO-1 price reviews by applying robust criteria when determining whether RPE allowances should be provided (see next section of this report).

Hence, the overall lesson from these regulatory precedents is that in the majority of cases other regulators are applying indexation to all elements of allowed revenues and are not applying special indexation arrangements to take account of RPEs.

5 Real Price Effects

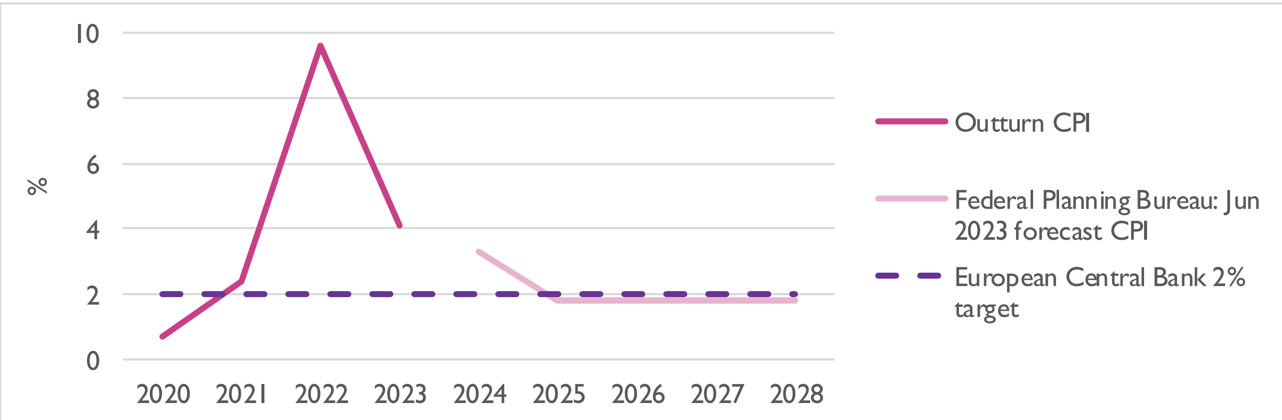
This chapter sets out our analysis of whether there are real price effects (RPEs) for any cost input type that need to be taken into account by VREG (whether through indexation or an ex ante allowance). We begin by describing the macroeconomic context in Belgium. We then set out our proposed RPE framework, which is followed by a detailed assessment of RPEs in each cost area. The chapter then concludes with our recommendations for each cost area on whether there are any material RPEs not captured by CPI indexation.

5.1 Current macroeconomic context

This section considers general price and wage inflation, as well as Federal Planning Bureau (FPB) forecasts of how they will evolve. FPB forecasts are taken from the latest Economic Outlook Report published in June 2023,[42] and cover the entirety of the next regulatory period (2025-2028).

The past two years represent a period of high inflation by recent historical standards. Inflation peaked at 12 per cent in October 2022, and has since come down to 2.4 per cent in September 2023.[43] Figure 5.1 shows outturn CPI inflation in recent years, along with the FPB's June 2023 forecasts of future CPI inflation.[44] The FPB forecasts suggest that inflation will be 3.9 per cent in 2023 and 3.3 per cent in 2024. From 2025, inflation is projected to fall back under 2 per cent and is expected to stay at 1.8 per cent

Figure 5.1: FPB's June 2023 annual CPI inflation forecast alongside the ECB 2% target rate and outturn CPI (%)



Source: FPB Economic Outlook Report and Statbel.

The FPB has identified energy price shifts as a key driver of inflation. In its latest June 2023 report, it states that "Energy prices will continue to put downward pressure on inflation until October 2023".[45] This is

42 Federal Planning Bureau, Economic Outlook Report, June 2023 - [online].

43 Federal Planning Bureau (2023). 'Consumer Price Index - Inflation forecasts. – [online]

44 In addition to CPI, other key measures of inflation in Belgium include the health index and the Harmonised Index of Consumer Prices (HICP). The health index is the national CPI, excluding specific alcoholic beverages (purchased in a shop or consumed in a bar), tobacco products, and motor fuels, except for LPG. The HICP takes a similar approach to the CPI for the purposes of measuring the change in the average level of prices paid for consumer goods and services, with some differences in the items used in the basket of goods. The purpose of the HICP is to enable comparisons of inflation rates between different Member States of the European Union.

45 Federaal Planbureau (2023). 'Economische vooruitzichten 2023-2028'. p.1. [online]

attributed to government efforts to reduce household energy expenses, including the extension of social tariffs and transfers provided to Belgian households to support their disposable income.[46] These have a calming effect on energy inflation, even though temporary support measures introduced in 2022 and 2023 will conclude in 2024 (these measures are discussed further below).

5.2 Approach to assessing RPEs

In this section we set out our framework for assessing RPEs including the cost categories used.

5.2.1 Framework for assessing RPEs

Our framework assesses the case for RPEs for individual cost items. The assessment is broken into two stages:

- Stage 1: Are there any material RPEs that are not captured by CPI indexation?
- Stage 2 (if relevant): What, if anything, should be done about these RPEs?

In this section we set out the criteria we apply in conducting Stage 1 of the assessment. If any cost items pass Stage 1 of the framework then they would advance to Stage 2 (discussed in Chapter 6).

Stage 1: Are there any material RPEs that are not captured by CPI indexation?

This stage is used to identify those cost items for which there may be a case for providing an RPE allowance (though it may later be determined in Stage 2 that not providing an RPE allowance is the best approach in practice). The criteria for this stage of the assessment are:

1. Are there sufficient and convincing reasons to think that CPI does not adequately capture the input price? To assess cost items against this criterion, we consider the share of a cost item in operating costs (opex) with the share of the most comparable cost item(s) in the CPI basket. The logic is that if the share of a cost item in opex is similar to the share of that cost item in CPI, then CPI indexation should already capture the evolution of that cost item in company costs.
2. Is there a significant likelihood that the value of the wedge between the input price and CPI will differ substantially from zero over the regulatory period? The wedge may differ substantially from zero over the course of a four-year regulatory period for either of two reasons: firstly, it may be because the expected value of the wedge is significantly different from zero; or, secondly, it may be because, even if in long-run expectation the wedge is not significantly different from zero, the cost exhibits sufficient variability such that over the course of a four-year regulatory period the wedge may differ substantially from zero. Therefore, we assess this criterion by analysing two separate sub-criteria, namely:
   A. Is the expected value of the wedge between the input price and CPI materially different from zero? To assess this sub-criterion, we assess the statistical significance of the wedge between the input price and CPI (based on historical values) as well as considering forecast data where available.
   B. Does the wedge between the input price and CPI exhibit high volatility over time? To assess this sub-criterion, we evaluate the volatility of the wedge over four-year periods (the length of the regulatory period), rather than looking at short-term (e.g. month-to-month) volatility that may average out over a regulatory period. We analyse this variability as a share of opex (or totex in the case of energy) by multiplying the wedge by the share of opex that the cost area accounts for. We consider that a wedge exhibits high volatility if the four-year rolling average wedge frequently exceeds 1 per cent of opex (or totex in the case of energy).

46 Federaal Planbureau (2023). 'Economische vooruitzichten 2023-2028'. p.8. [online]

For criterion 2 to be passed as a whole, only one of the above two sub-criteria need to be passed, i.e. either there is a material real price effect in expectation, or the rolling four-year average of the input price exhibits high volatility over time.

5.2.2 Cost categories for RPE assessment

To identify the cost categories for which an RPE assessment may be warranted, we investigated the composition of DSOs' costs between the years 2020 and 2022. The assessment focuses on operating costs, as it would not be appropriate to apply RPE indexation to either the depreciation or return element of revenues.[47]

Table 5.1 and Table 5.2 below provide a breakdown of Fluvius' opex into various cost categories for the years between 2020 and 2022 for the electricity and gas sectors, respectively. The cost categories are: labour (executive and general), materials, energy (costs and income), contractors, administration and other. As it can be seen from the tables, cost items exhibit some volatility over the time period examined, especially in the case of energy costs and income. To minimise the risk of double counting the price effect under criterion 2B of our analysis, we use the cost shares based on 2020 data throughout the criterion 2B analysis for each cost item. This is because if we used data for later years (e.g. 2022), then price effects would be included both through the cost shares changing over time and in the wedge we then apply, thus double-counting the impact.

Administration costs represent indirect costs (which are Fluvius' overhead costs) that have not been reallocated to the other cost categories. Most indirect costs have been reallocated into the other input cost categories based on a breakdown of Fluvius' overhead costs into labour, materials, contractors and other costs provided by Fluvius. While this breakdown relates to Fluvius' total overheads (including for non-regulated businesses), electricity and gas distribution are allocated over 90 per cent of overheads costs and hence we consider that this breakdown provides a good indication of how the overhead for gas and electricity is spread across these input costs.

Table 5.1: Breakdown of Fluvius' operating costs (%) by cost categories for electricity, 2020-2022

Cost category	2020	2021	2022
Labour (executive)	11	12	12
Labour (general)	38	37	36
Materials	2	2	2
Energy (costs)	17	14	19
Energy (income)	-7	-9	-13
Contractors	10	13	10
Administration	6	6	5
Other	22	25	28
Total	**100**	**100**	**100**

Note: 2023 cost shares are not included in the table as these are based on budgeted rather than outturn data.
Source: Europe Economics analysis of Fluvius accounts.

[47] Depreciation will reflect the historical costs of capital expenditure, and hence would not be expected to move in line with indices of current input prices.

Table 5.2: Breakdown of Fluvius' operating costs (%) by cost categories for gas, 2020-2022

Cost category	2020	2021	2022
Labour (executive)	14	13	14
Labour (general)	43	37	39
Materials	1	2	2
Energy (costs)	3	7	14
Energy (income)	-12	-19	-34
Contractors	7	8	7
Administration	7	5	5
Other	38	47	52
Total	**100**	**100**	**100**

Note: 2023 cost shares are not included in the table as these are based on budgeted rather than outturn data.
Source: Europe Economics analysis of Fluvius accounts.

In addition to assessing cost categories against the two criteria above, we also give some attention to the materiality of cost categories in our RPEs assessment. Drawing on regulatory precedents, we consider that it is disproportionate to apply an RPE allowance for cost categories that account for less than 5 per cent of opex. We consider that an RPE allowance should only be applied for cost categories accounting for between 5 and 10 per cent of costs if there is very strong evidence of a material wedge between input price inflation for that cost category and CPI inflation. Given the above data, we conduct our RPEs assessment for most of the cost items, namely: labour (general and executive), energy, contractors and administration. Focusing on outturn data between 2020 and 2022, materials is the only cost category which fails to pass our materiality test.[48]

Labour costs

Fluvius reports labour costs for four categories of workers: executive, white-collar workers, logistics employees and meter readers. Table 5.3 summarises the share of FTEs, labour costs and the hourly rate for each category in 2022. Our analysis of the data suggests that two distinct labour categories should be used for the assessment of RPEs. These are:

- General labour (made up of white-collar workers, logistics employees, and meter readers, together accounting for 68.6 per cent of labour costs); and
- Executive labour (made up of executives, accounting for 31.4 per cent of labour costs).

There are two key reasons for using these two categories compared to other options such as analysing all four categories separately. First, logistics employees and meter readers together constitute a small proportion of total FTEs and total labour costs (approximately 3 and 2 per cent, respectively). Therefore, using our materiality assessment above, they do not warrant a separate RPEs assessment based on their respective proportion of total DSO costs. Second, based on hourly rates, the three worker categories included in our "general labour" category are remunerated at a broadly similar rate per hour while executives are compensated at a materially higher rate (e.g. the hourly rate for executives is over 60 per cent higher than that of white-collar workers).

48 The low percentages for materials are likely to reflect the fact that most materials spending by Fluvius is likely to form part of capex rather than opex, and will therefore be capitalised and appear as part of the depreciation charge. We do not have any data on how much of depreciation represents historical spending on materials. Further, the deprecation associated with historical spending on materials will not vary over time in line with current materials prices, and hence it would not be appropriate to index this element of costs to a materials input price index.

Table 5.3: Share of FTEs, share of labour costs and hourly rates by worker category, 2022

	Share of FTEs (%)	Share of total labour costs (%)	Hourly rate (€)
Executive	21.7	31.4	105
White-collar workers	75.2	66.4	64
Logistics employees	0.8	0.6	59
Meter readers	2.3	1.6	49
Total	**100**	**100**	**N/A**

Note: The hourly rate was calculated by dividing the total costs reported in each worker category by the number of FTEs and then by 1,500 (the number of hours worked in a year by 1 FTE). This is consistent with the assumption used in Fluvius' Methodenota 2021, p.26.
Source: Europe Economics analysis of Fluvius cost allocation note, 2022.

We also understand that there is a shift ongoing within Fluvius from statutory personnel to contractual workers. In particular, as statutory personnel reach retirement age they are replaced by contractual personnel who do not enjoy the same beneficial labour conditions, which over time leads to a reduction in average wage rates (or to average wage rates rising less fast than they would otherwise do).

In the next section, we assess each cost item against our RPEs framework. In each case, we set out the evidence that we use in assessing the cost item against the criterion, and conclude by stating whether the criterion is passed or failed. A pass means that the cost area potentially qualifies for an RPE allowance, provided that other criteria are also met.

5.2.3 Selection of indices for assessing input price pressures

Our approach employed the following criteria to select the indices used for assessing input price pressures for Fluvius. The index for each cost area needs to be:

- Recognised as a robust index produced by an official, authoritative body or an organisation providing suitable assurances regarding the robustness of the index.
- Representative of the inputs used by Fluvius.
- Available for Belgium.
- Largely independent of the prices that Fluvius pays: if the prices that Fluvius itself pays for inputs have a material impact on the index, then this would reduce efficiency incentives for DSOs.[49]
- Published at a suitable frequency (e.g. annually, quarterly, etc.) and in a timely manner (i.e. avoiding long data publication gaps).

5.2.4 Time periods used for analysis

The table below summarises the time periods we use for our analysis of the different cost items for each criterion set out above.

[49] This perverse incentive can be avoided by using wider indices for input prices (e.g. economy-wide wage indices), although we note that these broader indices might be less representative of the specific inputs that Fluvius uses.

Table 5.4: Summary of time periods used for analysis

	Time period used for…			
	Labour	**Energy**	**Contractors**	**Administration**
Criterion 1	2022	2022 *with 2020 and 2021 as sensitivity*	2022	2022
Criterion 2A	Up to 2019 *with 2020 and 2021 as sensitivity*	Up to 2020 *with 2021 and 2022 as sensitivity*	Up to 2020 *with 2021 and 2022 as sensitivity*	Up to 2020*
Criterion 2B	Up to 2019	Up to 2022	Up to 2022	Up to 2020*

* EU KLEMS data is only available up to 2020.

- For criterion 1 assessing whether CPI adequately captures the input price, we use data from the latest year for which information for the full year is available (i.e. 2022). For energy, we include data from 2020 and 2021 as sensitivities given that 2022 was characterised by high energy prices due to the war in Ukraine.
- For criterion 2A looking at the expected value of the wedge between the input price and CPI, our analysis focuses on the years up to and including 2020 (with the exception of labour costs), with 2021 and 2022 data included as a sensitivity. We exclude 2021 and 2022 from our main wedge analysis as inflation was atypical in these years and hence the wedge for these years is unlikely to be representative of real price effects over the next regulatory period. For labour costs, our analysis also excludes data from 2020 due to potential impacts associated with the "furlough scheme" implemented in Belgium, as explained in section 5.3.1 below).
- For criterion 2B assessing the volatility of the wedge between the input price and CPI over time, our analysis includes the years up to and including 2022 (with the exception of labour costs) as all years are relevant for exploring the volatility of input prices. For labour costs, as above, our analysis also excludes data from 2020 due to potential impacts associated with the "furlough scheme" implemented in Belgium.
- To calculate the four-year rolling average wedge between the energy price index and CPI as a share of opex, our analysis uses the cost shares based on 2020 data. As explained in section 5.2.2 above, this is because if we used data for later years (e.g. 2022), then price effects would be included both through the cost shares changing over time and in the wedge we then apply, which would double-count the impact.

5.2.5 Differences from previous approach to assessing RPEs

At the last price review, VREG commissioned Oxera to provide an assessment of real price effects. In particular, Oxera assessed changes in input prices as part of its analysis to estimate the 'net frontier shift' (i.e. an estimate of frontier shift net of real input prices).[50]

Oxera's approach to assessing the evolution of input price pressures involved examining the historical evolution of input prices using a 'top-down' approach.[51] Oxera used the same comparator sectors to assess changes in input price pressures as it used to determine the frontier shift target, arguing that this would ensure that the analysis was consistent. These sectors were:

- Other manufacturing; repair and installation of machinery and equipment;
- Construction;

[50] Oxera (2020): "The necessity and magnitude of frontier shift for the Flemish electricity and gas distribution operators over 2021–24" [online]

[51] As Oxera's report noted, an alternative to this 'top-down' approach would be to use a combination of specific input price indices (and forecasts where possible) and the inputs used in Flemish DSOs' production process to build a 'bottom-up' index. See: Oxera (2020): "The necessity and magnitude of frontier shift for the Flemish electricity and gas distribution operators over 2021–24", p.18.

- IT and other information services;
- Professional, scientific, technical, administrative, and support service activities;
- Telecommunications (as a sensitivity); and
- Electricity, gas, steam, and air conditioning supply (as a sensitivity).

Using EU KLEMS data released in 2019,[52] Oxera used both value added and gross output measures for the comparator sectors listed above to calculate changes in input prices relative to CPI. The time periods (based on business cycles) that it used to assess input prices were the same as those used to derive frontier shift estimates, namely:

- 2003-2010 and 2010-2017 (core analysis); and
- 2001-2008 and 2008-2012 (sensitivity, based on alternative business cycles).

We prefer our approach set out in section 5.2.1 above to the approach used by Oxera for assessing the input price pressures faced by Flemish DSOs. In particular, using the same set of comparators that are used to derive a frontier shift estimate may distort the results of the RPEs analysis, as comparators may not use the same input mix as DSOs and therefore input price pressures in the comparator sectors may not reflect the input price pressure faced by DSOs. We note that our approach relies on a detailed breakdown of Fluvius' operating costs (summarised in section 5.2.2 above) which was not available at the time of Oxera's analysis.

5.3 RPE assessment by cost categories

In this section we assess each cost category against the criteria set out in section 5.2.1 above.

5.3.1 General labour

First, we assessed general labour costs against each criterion. Our approach to analysing general labour wage rate inflation for Fluvius involved evaluating data published by Statbel on Average Gross Monthly Salary (AGMS) of full-time workers by occupation.[53] As of August 2023, the data is published for the period between 2009 and 2021. Within the dataset, our analysis focused on a selection of series that represent activities similar to those performed by workers in the three categories that comprise our category of "general labour" costs. The selected series (based on ISCO-08 nomenclature) are:

- Engineering professionals (excluding electrotechnology)
- Database and network professionals
- Physical and engineering science technicians
- Technicians, management and control of industrial processes
- Office workers
- Electrical equipment installers and repairers
- Mobile plant operators

Are there sufficient and convincing reasons to think that CPI does not adequately capture the input price?

General labour costs account for over a third of overall operating costs (in 2022, the shares were 36 per cent for electricity and 39 per cent for gas). There is no discrete item for general labour in the CPI basket,[54]

[52] Stehrer, R., A. Bykova, K. Jäger, O. Reiter and M. Schwarzhappel. (2019) 'Industry level growth and productivity data with special focus on intangible assets, wiiw Statistical Report' No. 8. – [online]

[53] Statbel (2023). 'An overview of Belgian wages and salaries' - [online]

[54] We note that labour costs will feed indirectly into the price of consumer goods and services that comprise CPI. However, the inclusion of such indirect effects would require the VREG, for consistency, to net off productivity growth in other sectors when doing its frontier shift analysis, as CPI reflects both input price growth and productivity growth in comparator sectors. We therefore consider that the inclusion of such indirect effects is not appropriate.

and hence we conclude that CPI does not directly capture changes in general labour costs. Therefore, this cost category passes this criterion.

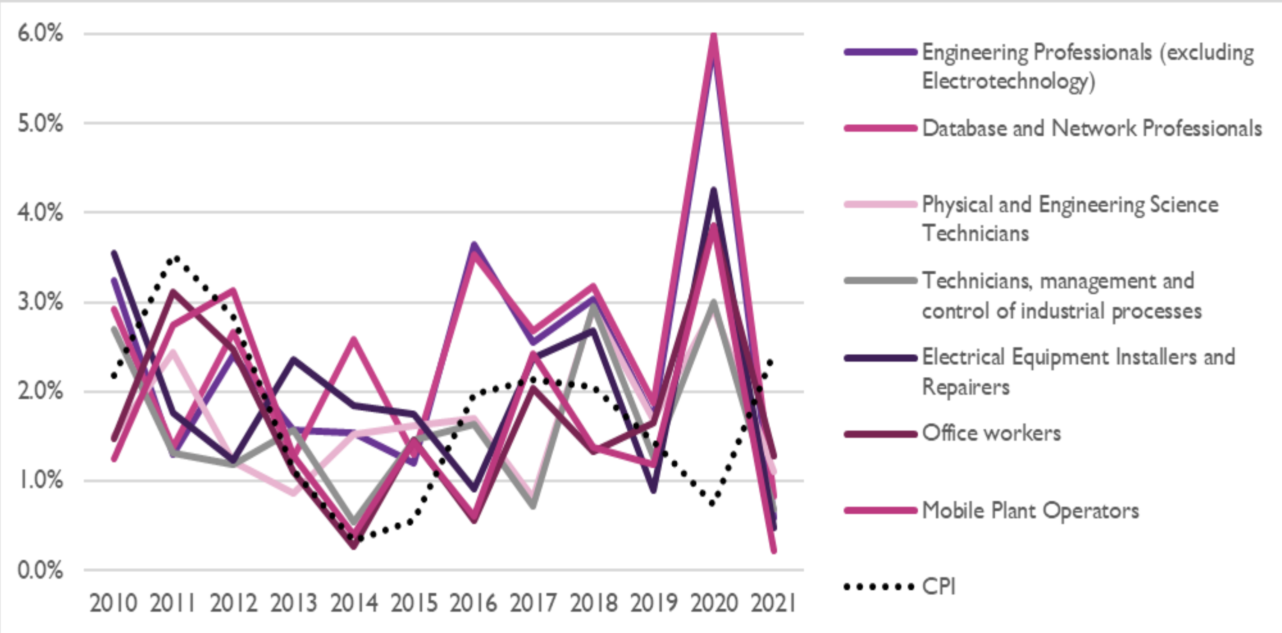
Criterion passed.

Is the expected value of the wedge between the input price and CPI materially different from zero?

To assess general labour costs against this criterion, we consider evidence on the difference between wage growth and CPI inflation (which we define as the 'wedge'). We believe that the seven series selected above represent activities similar to those performed by workers in the three categories comprising general labour in both the electricity and gas sector. For this reason, the results in this section hold for both sectors.

Figure 5.2 presents the annual percentage change for the eight wage indices and CPI. The graph shows that the wage indices selected generally move in line with CPI, although with a notable rise in the wage indices between 2019 and 2020. In response to the Covid-19 pandemic, like many other countries, Belgium implemented a "furlough scheme"[55] which is likely to have been distorted the data for 2020 and 2021. As a result, we have excluded data from 2020 and 2021 from our wedge analysis.

Figure 5.2: Annual percentage change in AGMS general labour indices and CPI, 2010 – 2021



Source: Europe Economics analysis.

Table 5.5 below shows the average annual wedge between growth in these wage indices and CPI inflation between 2010 and 2019. Our analysis indicates that none of the wedges are statistically significantly different from zero. This also remains the case when we include 2020 and 2021 data as sensitivities.

55 For further details on the furlough scheme, see Drahokoupil et al. (2021): "Job retention schemes in Europe - A lifeline during the Covid-19 pandemic' - Belgium (Annex)" [online].

Table 5.5: Average wedge (%) between annual change in general labour wage indices and CPI with T-statistics, 2010 - 2019

AGMS occupation indices – general labour	Average wedge	T-stat
Engineering Professionals (excluding Electrotechnology)	0.4	1.17
Database and Network Professionals	0.5	1.41
Physical and Engineering Science Technicians	-0.2	-0.58
Technicians, management and control of industrial processes	-0.3	-0.81
Office workers	-0.3	-1.38
Electrical Equipment Installers and Repairers	0.1	0.29
Mobile Plant Operators	-0.2	-1.07

Note: Statistical significance was tested at a 95 per cent confidence level (T-critical of +/- 2.262).
Source: Statbel, Europe Economics analysis.

Forecasts of future wage growth are also relevant when thinking about the future input price pressures that Fluvius faces. Here, we switch to a broader labour index as no occupation-specific forecasts are available.

Table 5.6 presents the FPB's forecasts for the Nominal Hourly Cost of Labour (NHCL) (which includes wage subsidies) and the implied real wage growth. As the table indicates, the independent forecasts for wage inflation published by the FPB suggest average real wage growth of 0.7 per cent over the next regulatory period (2025-2028).

Table 5.6: FPB's June 2023 forecasts for nominal hourly cost of labour and CPI (%)

	2023	2024	2025	2026	2027	2028	Average (2025-2028)
Nominal hourly cost of labour	7.4	3.3	2.9	2.4	2.4	2.4	2.5
CPI	3.9	3.3	1.8	1.8	1.8	1.8	1.8
Implied real growth in hourly cost of labour	3.4	0.0	1.1	0.6	0.6	0.6	0.7

Note: Implied real wage growth was calculated using Fisher formula.
Source: FPB Economic Outlook Reports

The FPB highlights inflation as the main factor driving wage growth in 2023, as Belgian worker wages (including bonuses and wage-related benefits) are legally tied to inflation to ensure their purchasing power remains steady.[56] The National Bank of Belgium (NBB), another body which also reports on wage growth, also shares the view that wage growth can be "entirely traced back to automatic indexation, as collectively negotiated wages remain constant and wage drift is limited".[57]

The FPB also acknowledges that increased wage growth in Belgium is expected due to both temporary and structural government measures. Notably, the government introduced a structural rise in the Guaranteed Average Monthly Minimum Income[58] for people aged 18-20 between 2022 and 2026. Furthermore, temporary measures like a purchasing power bonus[59] and social agreements for the care sector were implemented. The

56 The purpose of automatic wage indexation is to align wages and social benefits with the cost of living. Within the private sector, various indexation mechanisms exist, each unique to the collective agreements established within specific sectors. These indexation methods can differ between sectors or even between individual companies. The range of indexation approaches includes automatic adjustments triggered when a predefined pivot index is exceeded, as well as adjustments at specified intervals e.g. monthly or annually.

57 National Bank of Belgium (2023). 'Economic projections for Belgium – June 2023'. p.11 [online]

58 Revenu Minimum Mensuel Moyen Garantie (RMMMG): Progressive real increases in the RMMMG in the second quarter of 2022 by +€75, +€35 in 2024, and +€35 in 2026.

59 For firms achieving high profits in 2022, the government proposed a purchasing power bonus of up to €500 per employee (increasing to up to €750 for firms achieving exceptionally high profits) through collective bargaining agreements at sectoral or company level. The bonus is provided in the form of consumption vouchers that are fully tax-deductible for companies and tax-free for employees. Nonetheless, employers are liable for a contribution of

FPB estimates that these actions alone will lead to a 0.2 per cent increase in the nominal hourly labour cost in 2023, an increase of 0.1 per cent in 2024, and an average rise of 0.6 per cent from 2025 to 2028.[60]

However, a comparison between previous FPB forecasts and actual outturn data in Table 5.7 below indicates that the FPB has generally overestimated real hourly labour costs between 2011 and 2022 (with the exception of 2013 and 2020). For example, the difference between FPB's June 2022 forecast and the outturn real hourly cost of labour for 2022 was 1.6 per cent. This is a factor that VREG may wish to bear in mind when deciding how much weight to place on these forecasts.

Table 5.7: Amount by which forecast growth rate for real hourly cost of labour exceeded outturn growth rate, 2011 – 2022 (%)

	Amount by which forecast growth rate exceeded outturn growth rate											
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
June 2022 forecast												1.6
June 2021 forecast											1.2	4.2
June 2020 forecast										-2.7	2.9	4.1
June 2019 forecast									0.1	-3.9	3.2	5.1
June 2018 forecast								1.1	0.2	-3.7	3.4	5.2
June 2017 forecast							0.9	1.4	0.3	-3.8	3.1	5.0
June 2016 forecast						1.3	1.2	1.6	0.1	-3.8	2.7	
June 2015 forecast					0.0	1.7	0.0	1.0	0.6	-3.0	1.2	
June 2014 forecast				-0.5	1.1	3.4	1.6	1.5	0.1			
June 2013 forecast			-0.9	-0.7	1.0	2.8	1.2	1.1				
June 2012 forecast		0.2	-0.2	0.4	1.2	3.0	1.5					
June 2011 forecast	1.2	0.3	0.0	1.2	2.4	3.9						
Average	**1.2**	**0.3**	**-0.4**	**0.1**	**1.4**	**2.6**	**1.1**	**1.3**	**0.2**	**-3.3**	**2.8**	**4.2**

Note: The real hourly cost of labour for 2019 - 2022 was calculated using the Fisher formula as after 2018 the FPB shifted to reporting nominal figures. Pre-2019 figures are reported in real terms and relate to 'branches of market activity'.
Source: Europe Economic analysis of FPB Economic Outlook Reports.

At the same time, the ongoing shift within Fluvius from statutory personnel to contractual workers, who do not enjoy the same beneficial labour conditions, is expected to lead to a reduction in wage rates over time, thus potentially offsetting some of the expected real wage growth for the 2025-2028 period. Therefore, VREG will need to make a policy decision on whether to include an ex ante RPE allowance for labour in the net frontier shift estimate, and if so what the magnitude of that allowance should be.

Taken together, whether this cost category passes or fails this sub-criterion depends on how much weight is placed on the FPB's forecasts.

Sub-criterion passed if weight is placed on FPB forecast.

Does the wedge between the input price and CPI exhibit high volatility over time?

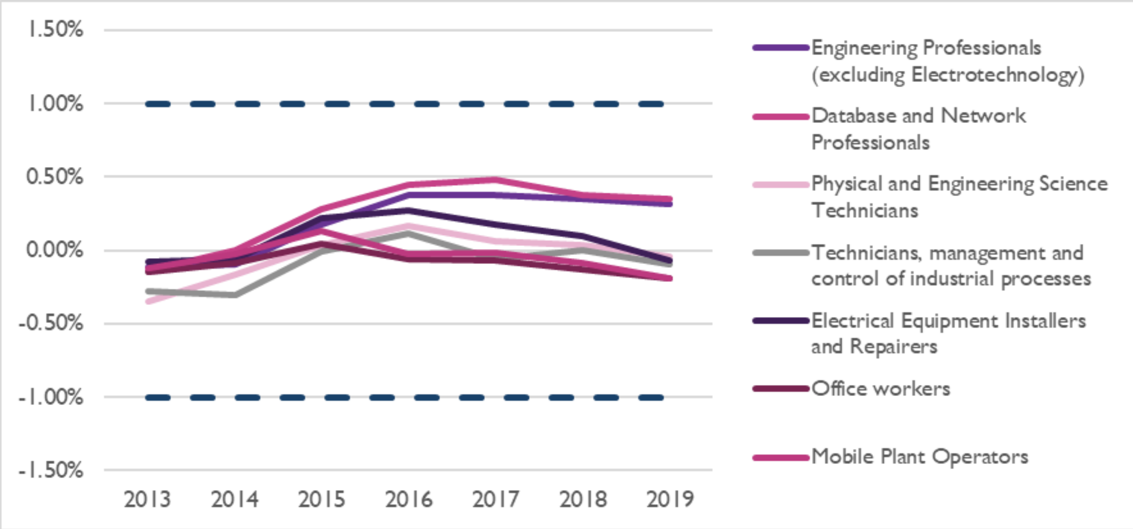
Figure 5.3 and Figure 5.4 below show the rolling four-year wedge multiplied by the share of general labour in opex, thus showing the potential impact on opex of variability in labour costs over a four-year period. Given that general labour takes up slightly different proportions of overall operating costs in the electricity and gas sectors, the results are presented separately for the two sectors.

For both the electricity and gas sectors, the indices for general labour exhibit moderate levels of volatility over the period examined, with the wedge varying from approximately -0.4 to +0.5 per cent of opex. Over the course of the time period analysed, at no point does the magnitude of the four-year rolling average wedge exceed ±1 per cent of opex (as denoted by the horizontal dashed lines).

16.5 per cent on the amount of the purchasing power bonus awarded to employees. For further details, see Ghysels, A et al (2023) "Purchasing power bonus" [online].

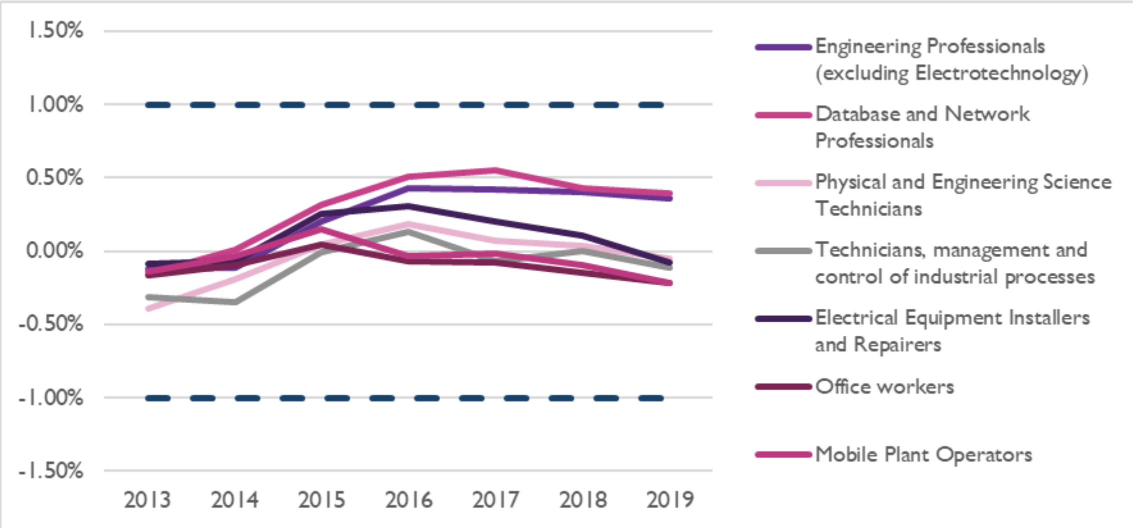
[60] Federaal Planbureau (2023). 'Economische vooruitzichten 2023-2028'. p.21-22. See Box 1 [online]

Figure 5.3: Four-year rolling average of general labour wage indices – CPI wedges as a share of opex for electricity, 2013 – 2019



Source: Europe Economics analysis.

Figure 5.4: Four-year rolling average of general labour wage indices – CPI wedges as a share of opex for gas, 2013 – 2019



Source: Europe Economics analysis.

Given the results shown above, this cost category fails this sub-criterion on the basis that there is no clear evidence that the wedge between the input price and CPI exhibits high volatility over time.

Sub-criterion failed.

5.3.2 Executive labour

Second, we assessed executive labour against each criterion. We took a similar approach to that for general labour, using the same occupation-based AGMS series published by Statbel. For the assessment of executive labour costs, we selected the following series:

- Company directors;
- Directors of administrative services; and

- Directors and executives in manufacturing, mining, construction, and distribution.

Are there sufficient and convincing reasons to think that CPI does not adequately capture the input price?

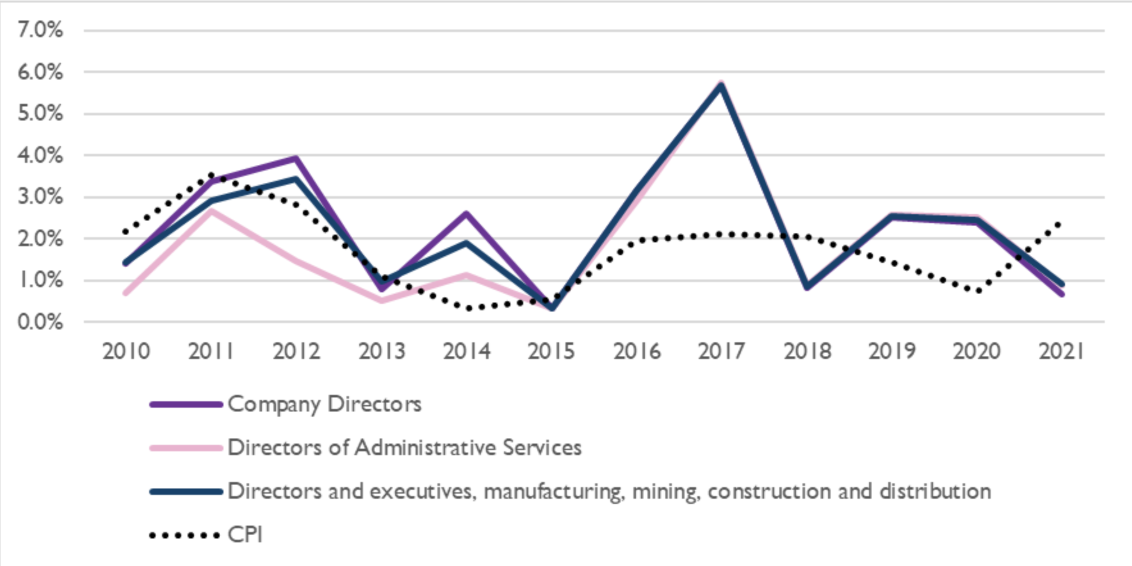
Executive labour costs accounted for approximately 12-15 per cent of overall operating costs in 2022 (12 per cent for electricity and 15 per cent for gas). As for our analysis of general labour costs, there is no discrete item for executive labour in the CPI basket, and hence we conclude that CPI does not directly capture changes in labour costs. Therefore, this cost category passes this criterion.

Criterion passed.

Is the expected value of the wedge between the input price and CPI materially different from zero?

Figure 5.5 presents the annual percentage changes in selected executive labour wage indices and the CPI. Between 2010 and 2013, there appears to be a small wedge between CPI and the wage indices for Company Directors and for Directors and executives in manufacturing, mining, construction, and distribution. After 2013, the wedge between CPI and all executive labour indices significantly widens. This persisted until 2017, after which the wage indices move more closely with CPI.

Figure 5.5: Annual percentage change in AGMS executive labour indices and CPI, 2010 – 2021



Source: Statbel, Europe Economics.

Table 5.8 presents the results of our wedge analysis. None of the observed wedges are statistically significantly different from zero. This also remains the case when we include 2020 and 2021 data as sensitivities.

Table 5.8: Average wedge (%) between annual change in executive labour wage indices and CPI, 2010 - 2019

AGMS occupation indices – executive labour	Average wedge	T-stat
Company directors	0.6	1.38
Directors of administrative services	0.1	0.16
Directors and executives, manufacturing, mining, construction and distribution	0.5	1.14

Note: Statistical significance was tested at a 95 per cent confidence level (T-critical of +/- 2.262).
Source: Europe Economics analysis.

As in the case of general labour costs, our assessment of the broader FPB wage forecasts suggests average real wage growth of 0.7 per cent over the next regulatory period. Although the FPB's forecasts are not specific to executive labour, they provide some indication of future wage inflation for all types of labour. However, as discussed in section 5.3.1 above, our analysis has found that past FBP forecasts have tended to overstate wage growth compared with subsequent outturn data. This is a factor that VREG may wish to bear in mind when deciding how much weight to place on these forecasts.

At the same time, the ongoing shift within Fluvius from statutory personnel to contractual workers, who do not enjoy the same beneficial labour conditions, is expected to lead to a reduction in wage rates over time, thus potentially offsetting some of the expected real wage growth for the 2025-2028 period. Therefore, VREG will need to make a policy decision on whether to include an ex ante RPE allowance for labour in the net frontier shift estimate, and if so what the magnitude of that allowance should be.

Sub-criterion passed if weight is placed on FPB forecast.

Does the wedge between the input price and CPI exhibit high volatility over time?

Figure 5.6 and Figure 5.7 below show the rolling four-year wedge multiplied by the share of executive labour in opex. For both the electricity and gas sectors, the indices for executive labour exhibit little volatility over the period examined, with the wedge varying between approximately -0.15 and +0.24 per cent of opex.

Figure 5.6: Four-year rolling average of wage indices – CPI wedges as a share of opex for electricity, 2013 – 2019

Source: Europe Economics analysis.

Figure 5.7: Four-year rolling average of wage indices – CPI wedges as a share of opex for gas, 2013 – 2019

Source: Europe Economics analysis.

Given the above, this cost category fails this sub-criterion on the basis that there is no evidence that the wedge between the input price and CPI exhibit high volatility over time.

Sub-criterion failed.

5.3.3 Energy

Fluvius' operating costs include both the cost of energy purchased as well as the income received by Fluvius. For criteria 1 and 2B we consider the net impact of energy costs and income, as we are interested in whether the net impact is reflected in CPI (for criterion 1) and whether the net impact could have a significant impact on opex (for criterion 2B). For criterion 2A we assess these two categories separately, as we consider that the energy indices that are relevant to assessment of the wedge may differ between energy costs and income.

Energy costs

Our approach to analysing energy costs involves assessing electricity and gas day-ahead wholesale prices. Data on day-ahead wholesale prices has been sourced from Refinitiv Eikon for the period between 2007 and 2022 for electricity and between 2014 and 2022 for gas. Data is available on a daily basis which has been converted to annual figures for the purposes of the analysis.

We also assess the output price index for the Electricity, Gas, Steam and Air conditioning supply sector reported by EU KLEMS for Belgium which is available on an annual frequency for the years between 1996 and 2020.

Energy income

Our approach to analysing energy income has involved evaluating data on the total annual bill for customers on Fluvius' network operator standard rate. The data were provided by VREG for the years 2012 to 2022. The focus on price data relating to households reflects our understanding that Fluvius' energy income mostly comes from households paying social supplier or supplier of last resort tariffs. *Are there sufficient and convincing reasons to think that CPI does not adequately capture the input price?*

Net energy costs (including both the cost of energy purchased by Fluvius and the income it receives) accounted for approximately 7 per cent of operating costs in the electricity sector in 2022, and -20 per cent of operating costs in the gas sector (please see Table 5.1. and Table 5.2 above).

We identified two read-across items in the CPI basket. The 'Electricity' item makes up 3.35 per cent of the CPI basket in 2022, with 'Natural gas and town gas' at 1.71 per cent. Collectively, the two items make up 5.06 per cent.

For electricity the criterion is partially met because net energy costs in electricity DSOs' opex are relatively close to the comparable items within the CPI (7 per cent versus 5.06 per cent). In the case of gas, the cost category passes the criterion. This is because the negative cost share implies that if energy prices go up, gas DSOs get more revenue through CPI indexation (this is because they get more energy income, outweighing the additional energy cost).

We also conducted a sensitivity analysis using CPI data from 2020 and 2021. Net energy costs in the electricity sector accounted for approximately 11 and 5 percent of operating costs in 2020 and 2021. For the gas sector, it accounted for -10 and -11 per cent of operating costs, respectively.

When assessing the weights of the same two items ('Electricity' and 'Natural gas and town gas'), we find that the weight of both items in the CPI basket is lower compared with 2022.

Table 5.9: Weights of comparable items in CPI basket, 2020-2022 (%)

	Weight of item in CPI basket		
	2020	**2021**	**2022**
Electricity	3.21	2.99	3.35
Natural gas and town gas	1.48	1.26	1.71
Total	**4.69**	**4.25**	**5.06**

Source: Europe Economic analysis of Statbel CPI data.

Our sensitivity analysis indicates that the criterion is partially passed for electricity in 2020 and 2021, as the share of energy in CPI is lower than the share of energy in Fluvius' operating costs for both years (and hence CPI inflation partially but not fully captures the effect of energy prices on Fluvius).

The sensitivity analysis confirms that the criterion is passed for gas.

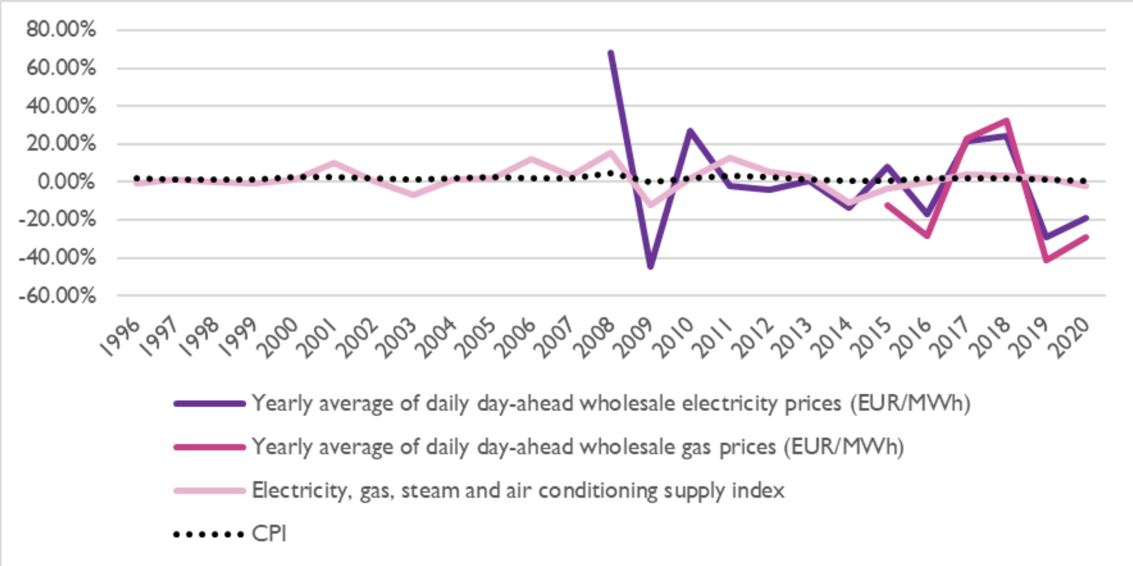
Criterion partially passed for electricity. Criterion passed for gas.

Is the expected value of the wedge between the input price and CPI materially different from zero?

Energy costs

Figure 5.8 presents the annual percentage change for energy cost indices and CPI. Since 2015, both electricity and gas day-ahead wholesale price indices have exhibited similar levels of volatility while the EU KLEMS Electricity, Gas, Steam and Air conditioning supply index has generally been less volatile throughout the period.

Figure 5.8: Annual percentage change in energy cost indices and CPI, 2008 – 2020



Source: Refinitiv Eikon, EU KLEMS and Europe Economics analysis.

Table 5.10 shows the results of our wedge analysis, which indicates that none of the wedges are statistically significantly different from zero. This remains the case when we include 2021 and 2022 data as sensitivities.

Table 5.10: Average wedge (%) between annual change in energy cost indices and CPI, 2009 - 2020

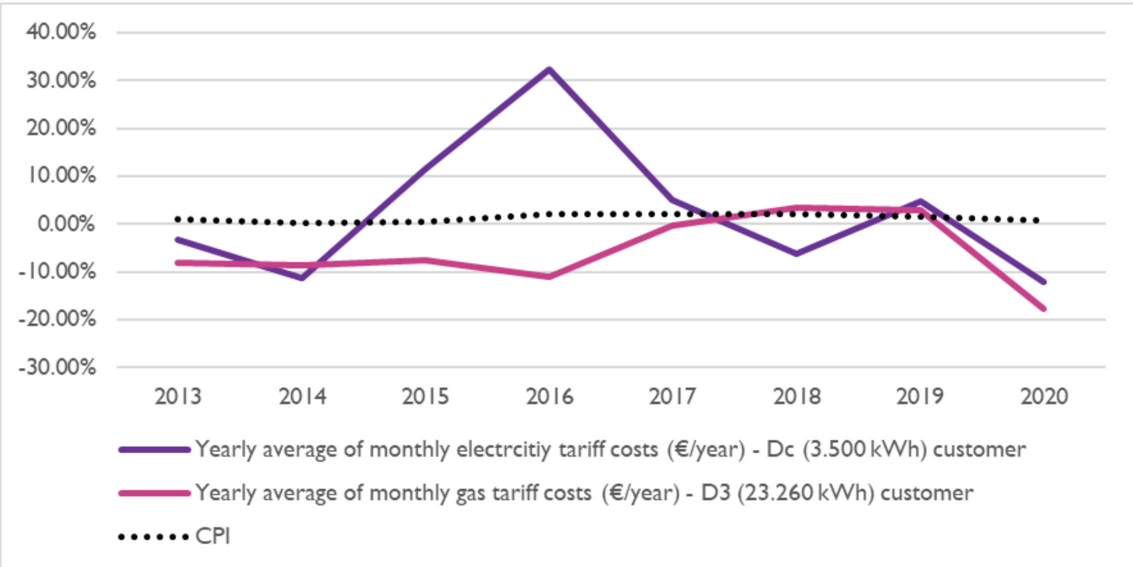
Electricity and gas price indices	Average wedge	T-stat
Yearly average of daily day-ahead wholesale electricity prices (EUR/MWh)	-0.15	-0.02
Yearly average of daily day-ahead wholesale gas prices (EUR/MWh)	-10.86	-0.89
Electricity, Gas, Steam and Air conditioning supply (1996-2020)	-0.17	-0.15

Note: Statistical significance was tested at a 95 per cent confidence level (T-critical of +/- 2.179 (Refinitiv Eikon) and +/-1.711 (EU KLEMS)).
Source: Refinitiv Eikon, EU KLEMS, Europe Economics analysis.

Energy income

Figure 5.9 presents the annual percentage change for energy income indices and CPI. Electricity prices have generally been more volatile than gas prices throughout the period.

Figure 5.9: Annual percentage change in energy income indices and CPI, 2013 – 2020



Source: Europe Economics analysis of annual bill (tariff prices) 'standaardtarief netbeheerder' provided by VREG

Table 5.11 presents the results of our wedge analysis which indicates that gas price wedge is statistically significantly different from zero, although this does not remain the case when we include 2021 and 2022 data as sensitivities.

Table 5.11: Average wedge (%) between annual change in energy income indices and CPI, 2013 – 2020

Electricity and gas indices	Average wedge	T-stat
Yearly average of monthly electricity tariff costs (€/year) - Dc (3.500 kWh) customer	1.28	0.25
Yearly average of monthly gas tariff costs (€/year) - D3 (23.260 kWh) customer	-7.13	-2.89

Note: Statistical significance was tested at a 95 per cent confidence level (T-critical of +/-2.365).
Source: Eurostat, Europe Economics analysis.

Based on the above, this cost category fails this sub-criterion for electricity, but passes for the gas sector as there is evidence that the expected wedge between the gas index and CPI differs significantly from zero.

Sub-criterion failed for electricity. Sub-criterion passed for gas (for energy income).

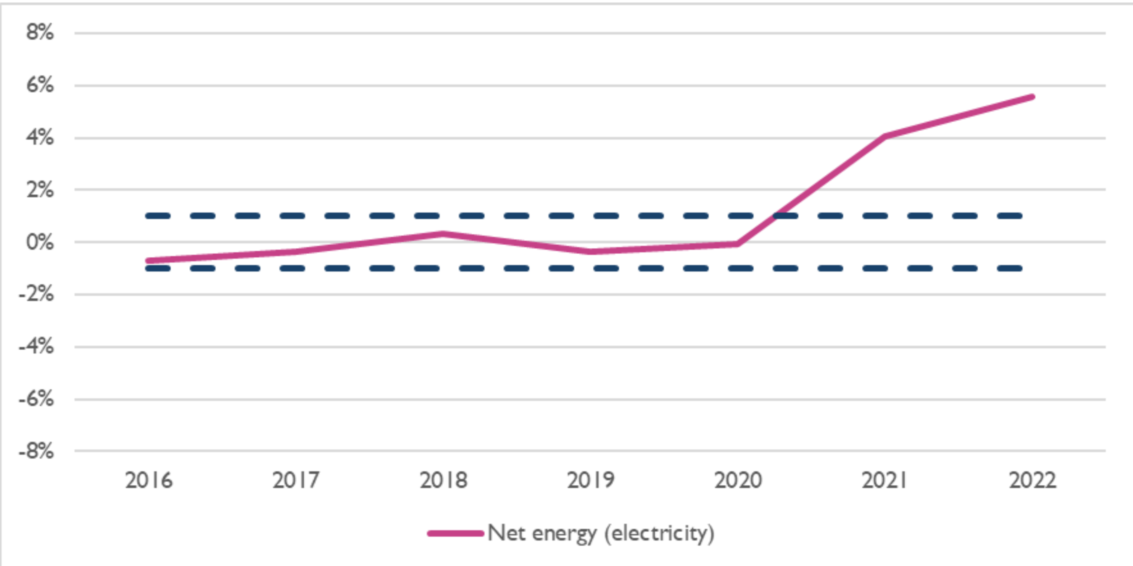
Does the wedge between the input price and CPI exhibit high volatility over time?

As energy costs and energy income for Fluvius partially offset each other, our assessment of the volatility of the wedge between input prices and CPI over time focuses on net energy. To take account of the different indices used for energy costs (day-ahead wholesale prices) and energy income (annual bill for customers on Fluvius' network operator standard rate), we calculate the rolling net energy figures using the following steps:

1. Calculate the rolling energy income wedge by multiplying the share of energy income in totex by the rolling wedge of the regulated tariff.
2. Calculate the rolling energy cost wedge by multiplying the share of energy cost in totex by the rolling wedge of the wholesale price.
3. Calculate the rolling net energy wedge as a percentage of totex by combining (1) and (2).

Following this approach, Figure 5.10 below shows the rolling four-year wedge for net energy in the electricity sector. The rolling four-year wedge exceeds the threshold of 1 per cent of totex in 2020 and 2021.

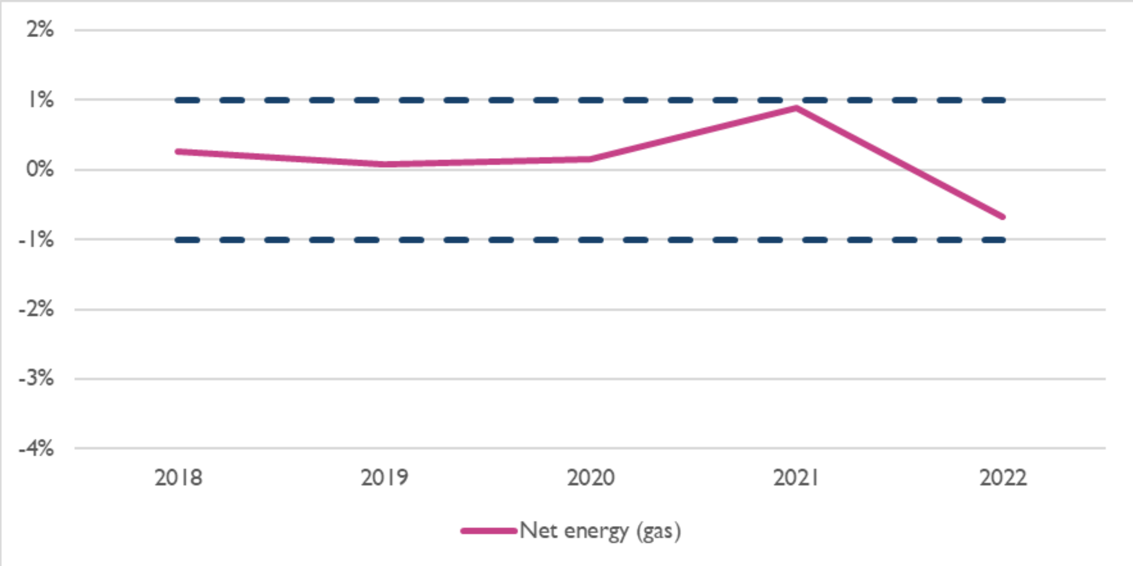
Figure 5.10: Four-year rolling average wedge of net energy indices – CPI wedges as a share of totex for electricity, 2016 – 2022



Source: Refinitiv Eikon, annual bill (tariff prices) 'standaardtarief netbeheerder' provided by VREG, Europe Economics analysis.

Figure 5.11 below presents the results for the gas sector. The four-year rolling wedge stays within the threshold of 1 per cent of totex for the entire period between 2018 and 2022.

Figure 5.11: Four-year rolling average wedge of net energy indices – CPI wedges as a share of totex for gas, 2018 - 2022



Source: Refinitiv Eikon, annual bill (tariff prices) 'standaardtarief netbeheerder' provided by VREG, Europe Economics analysis.

Given the above, energy passes this sub-criterion in the electricity sector on the basis that the wedge between the input price and CPI exhibits high volatility, but fails this sub-criterion in the gas sector.

Sub-criterion passed for electricity. Sub-criterion failed for gas.

5.3.4 Contractors

Our approach to assessing contractor costs[61] involved analysing the construction output price index published by the Statbel. While in our view this index represents the closest comparator for the inputs used by Fluvius for this category, we note that the index focuses on the development of housing excluding commercial buildings and therefore may not necessarily capture well the precise inputs used by Fluvius. Quarterly data is available for this index since 2010.

Are there sufficient and convincing reasons to think that CPI does not adequately capture the input price?

Contractor costs accounted for between 7 and 10 per cent of operating costs in 2022 (10 per cent for electricity and 7 per cent for gas in 2022).

There is no direct read across from contractor to items in the CPI basket. The closest parallel that can be drawn is with items such as services for plumbers, electricians, painters, carpenters, removal and storage, etc. As shown in Table 5.12, these items collectively comprise 0.62 per cent of the CPI basket.

[61] Contractor costs include activities related to earthmoving, maintenance and repairs, transport, logistic services, different types of demolition, order processing, lease and management of vehicles, cables and tubes to be scraped, etc.

Table 5.12: Share of items potentially comparable to contractor in CPI basket (%)

Cost item	Share of CPI 2022
Services of plumbers	0.04
Services of electricians	0.11
Maintenance services for heating systems	0.17
Services of painters	0.06
Services of carpenters	0.08
Other services for maintenance and repair of the dwelling	0.01
Repair, leasing and rental of major tools and equipment	0.04
Removal and storage services	0.11
Total	**0.62**

Source: Statbel, Europe Economics.

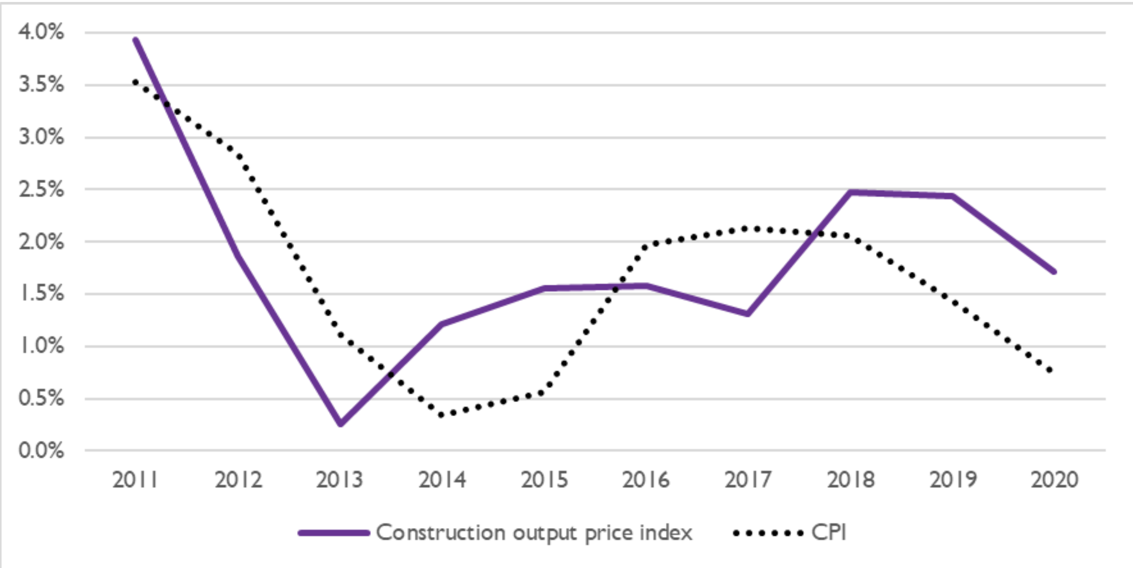
Given that the share of contractor costs in Fluvius' electricity and gas opex is significantly higher than the share of the closest equivalent items within CPI, we consider that this cost category passes this criterion.

Criterion passed.

Is the expected value of the wedge between the input price and CPI materially different from zero?

Figure 5.12 presents the annual percentage changes for the index and CPI.

Figure 5.12: Annual percentage change in construction price index and CPI (2011 – 2020)



Source: Statbel, Europe Economics.

Table 5.13 presents the results of our wedge analysis. For the period 2011-2020, the observed wedge between the construction output price index and CPI is not statistically significantly different from zero. This wedge remains not statistically significantly different from zero when 2021 and 2022 data are included as sensitivities.

Table 5.13: Average wedge (%) between annual change in construction output price index and CPI, 2011 – 2020

Index	Average wedge	T-stat
Construction output price index	0.2	0.61

Note: Statistical significance was tested at a 95 per cent confidence level (T-critical of +/- 2.262).
Source: Europe Economics analysis.

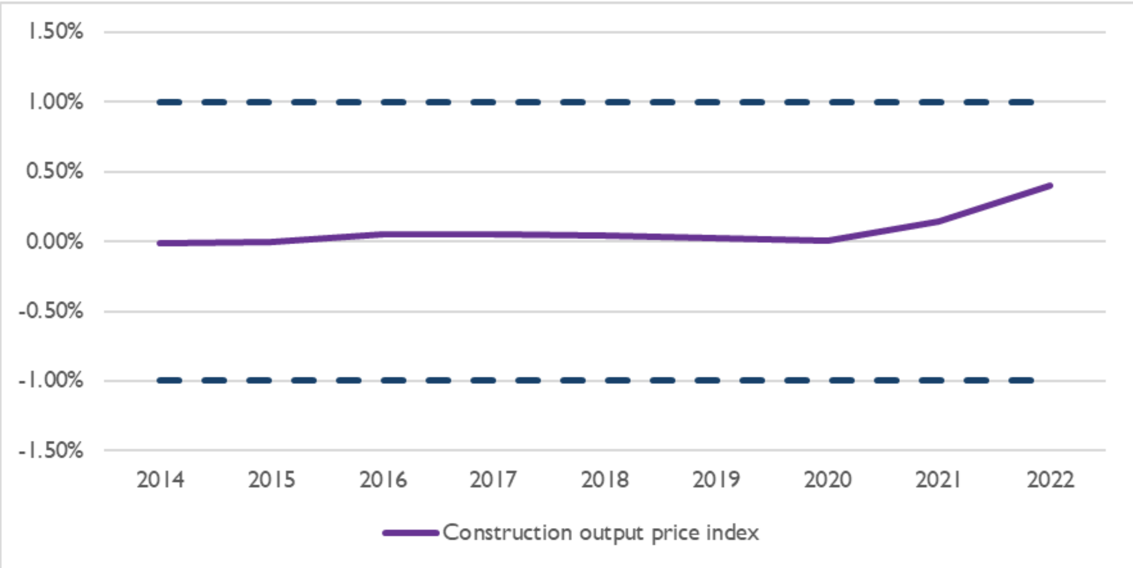
Based on these results, this cost category fails this sub-criterion as there is no evidence that the expected wedge between the index and CPI significantly differs from zero.

Sub-criterion failed.

Does the wedge between the input price and CPI exhibit high volatility over time?

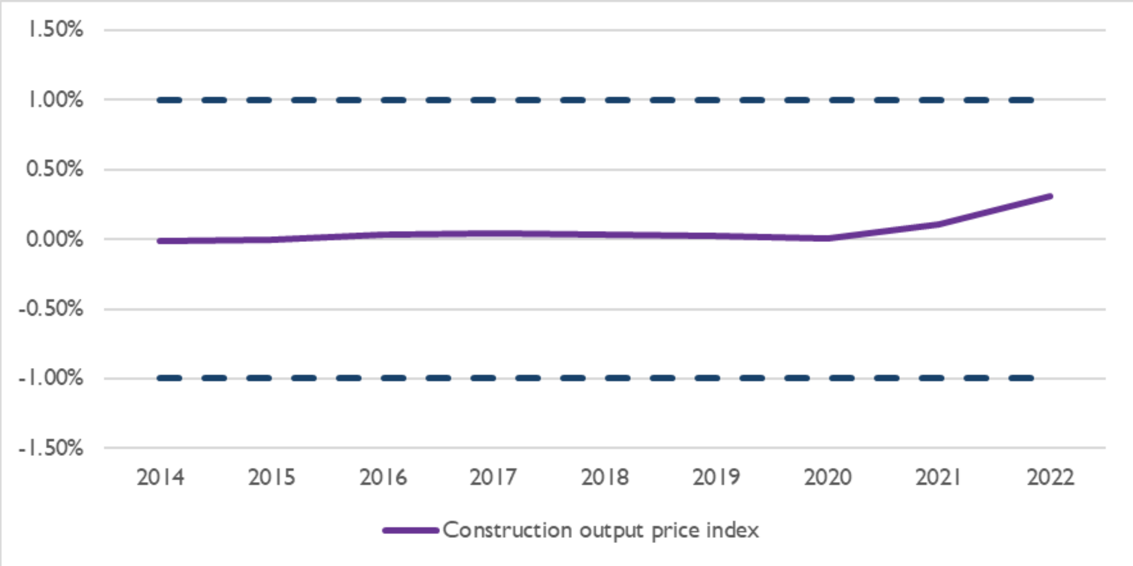
Figure 5.13 and Figure 5.14 below show the rolling four-year wedge multiplied by the share of contractors in opex. The index for both electricity and gas exhibits a similar volatility over the period examined and remains within the threshold of ±1 per cent of opex.

Figure 5.13: Four-year rolling average of construction output price index – CPI wedge as a share of opex for electricity, 2014 – 2022



Source: Europe Economics analysis of Statbel data.

Figure 5.14: Four-year rolling average of construction output price index – CPI wedge as a share of opex for gas, 2014 – 2022



Source: Statbel, Europe Economics analysis.

Given the above results, this cost category fails this sub-criterion on the basis that there is no clear evidence that the wedge between the input price and CPI exhibits high volatility over time.

Sub-criterion failed.

5.3.5 Administration

Our approach to assessing administration costs involved analysing the EU KLEMS price index for gross output in Belgium of the sector entitled "Professional, scientific, and technical activities; administrative and support service activities" (which in our view reflects the types of activities conducted in this input cost category). Annual data is available between 1995 and 2020.

Are there sufficient and convincing reasons to think that CPI does not adequately capture the input price?

Administration costs account for approximately 5 per cent of overall operating costs (5 per cent for both electricity and gas in 2022). While there is no direct read across from administration costs to items in the CPI basket, a parallel could be drawn with 'Administrative fees' and 'Legal services and accountancy' which collectively account for 0.67 per cent of the CPI basket.

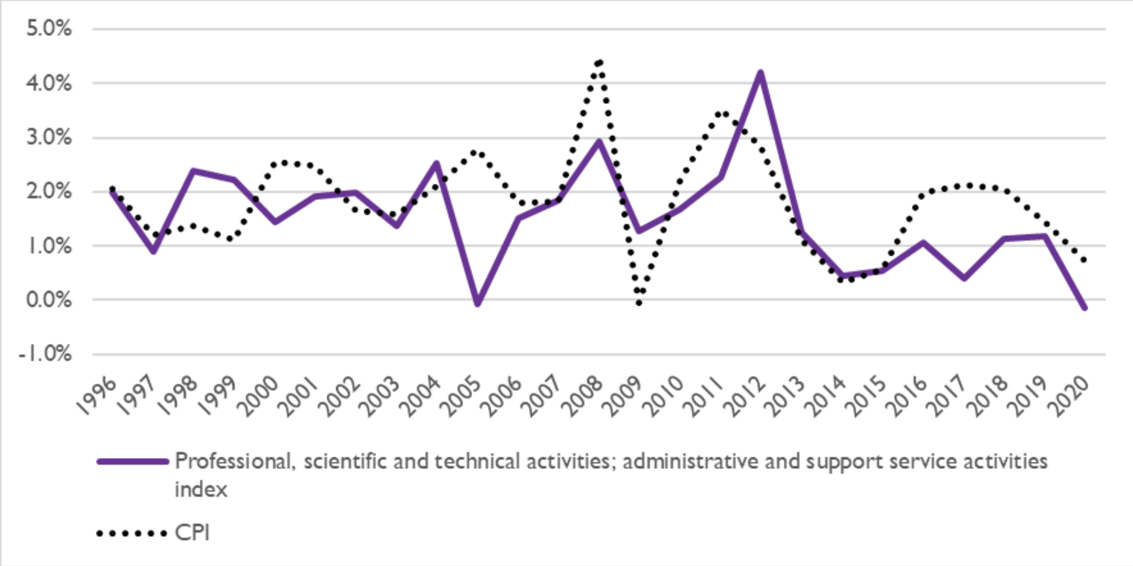
Given that the share of administration costs in Fluvius' operating costs for both electricity and gas is significantly higher than the share of the closest equivalent items within CPI, we consider that this cost category passes this criterion.

Criterion passed.

Is the expected value of the wedge between the input price and CPI materially different from zero?

Figure 5.15 presents the annual percentage changes for the "Professional, scientific, and technical activities; administrative and support service activities" price index and CPI. The index shows a wedge with CPI (albeit showing some common patterns at different places of the period).

Figure 5.15: Annual percentage change in "Professional, scientific and technical activities; administrative and support service activities" price index and CPI, 1996-2020



Source: EU KLEMS, Europe Economics analysis.

Table 5.14 presents the results of our wedge analysis which shows that the observed wedge is not statistically significantly different from zero. Based on this result, we conclude that this cost category fails this sub-criterion because there is no evidence that the expected wedge between electricity prices and CPI differs significantly from zero.

Table 5.14: Average wedge (%) between annual change in index and CPI, 1996 - 2020

Index	Average wedge	T-stat
Professional, scientific, and technical activities; administrative and support service activities	-0.31	-1.54

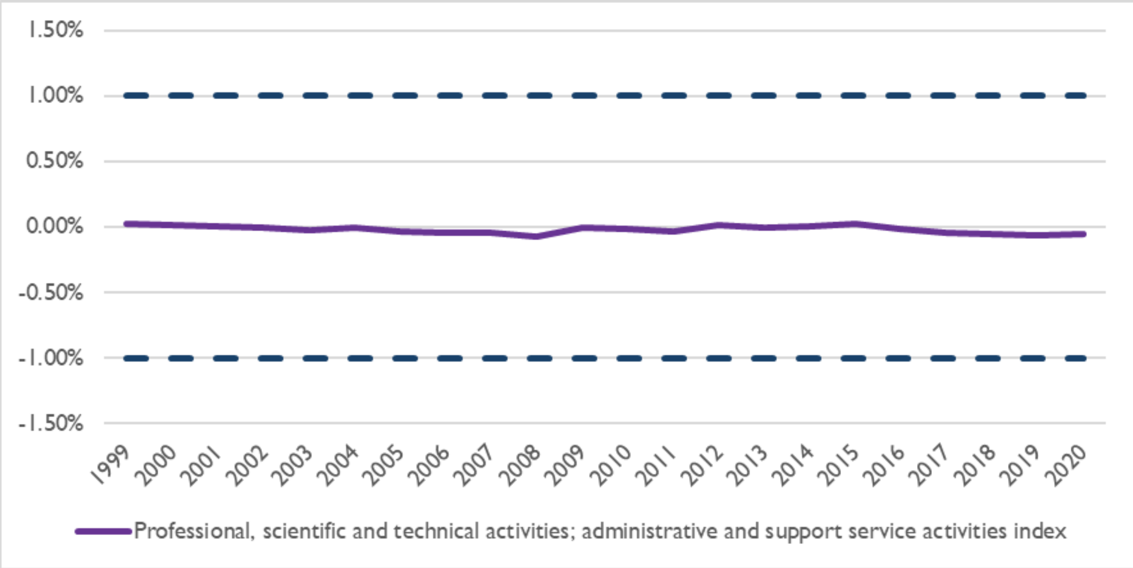
Note: Statistical significance was tested at a 95 per cent confidence level (T-critical of +/- 1.711).
Source: EU KLEMS, Europe Economics analysis.

Criterion failed.

Does the wedge between the input price and CPI exhibit high volatility over time?

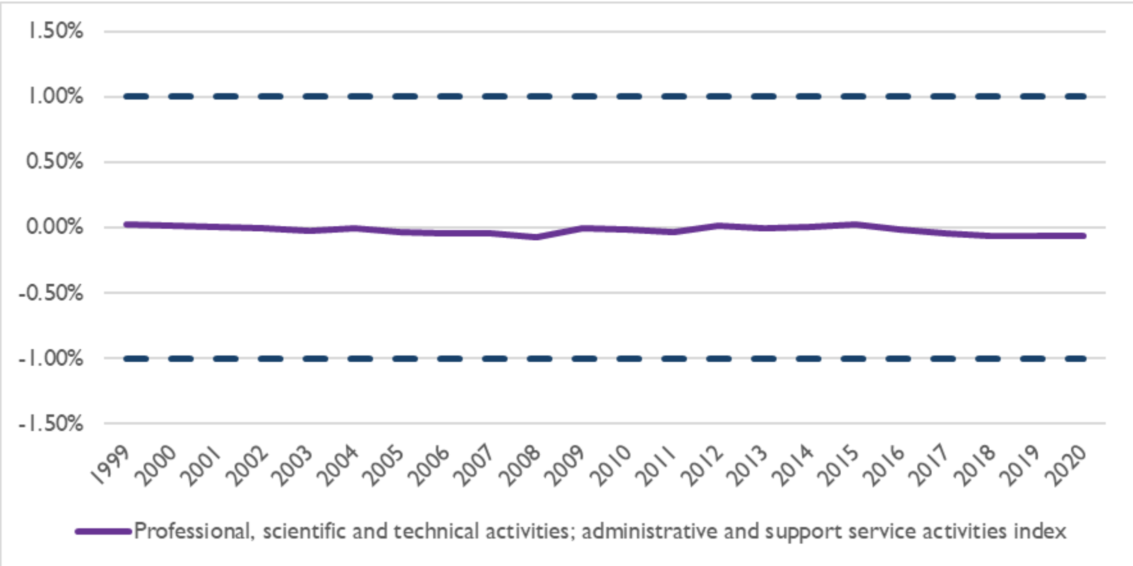
Figure 5.16 below shows the rolling four-year wedge multiplied by the share of administration in opex. The index for both electricity and gas exhibits a similar volatility over the period examined of -0.10 to -0.01 per cent. Therefore, over the course of the time period analysed, the magnitude of the four-year rolling average of the index remains well within the threshold of ±1 per cent of opex.

Figure 5.16: Four-year rolling average of annual changes in "Professional, scientific, and technical activities; administrative and support service activities" index – CPI as a share of opex (electricity), 1999-2020



Source: EU KLEMS, Europe Economics analysis.

Figure 5.17: Four-year rolling average of annual changes in "Professional, scientific, and technical activities; administrative and support service activities" index – CPI as a share of opex (gas), 1999-2020



Source: EU KLEMS, Europe Economics analysis.

Given the above, this cost category fails this sub-criterion on the basis that there is no conclusive evidence that the wedge between the input price and CPI exhibits high volatility over time.

Sub-criterion failed.

5.3.6 Other costs

In addition to the cost items analysed above using our framework for assessing RPEs, we have also considered the "other" cost category.

In 2022, the latest year for which outturn data is available, operating costs in the "other" category amounted to around €119m in the electricity sector (equating to 28 per cent of opex) and €86m in the gas sector (equating to 52 per cent of opex), with these totals including a combination of costs and income for Fluvius. Table 5.15 below summarises the activities with a share of 10 per cent or more within "other costs" in either the electricity or gas sector.

Table 5.15: Percentage of "other" costs accounted for by selected activities, 2022

	Electricity	Gas
Loss on tangible fixed assets (MVA)	42	46
Management costs	28	20
Non-recurring operating expenses	27	19
Personnel third parties	12	8
Fees	11	7
Staff recoveries	-14	-9
Internal usage fees	-19	-3
Non-recurring operating income	-27	-19

Source: Europe Economics analysis of Fluvius data.

This "other" category does not lend itself easily to RPEs analysis, since it is not clear what input prices may be relevant for the various cost and income items included in this category.

As a result, the fact that Fluvius has allocated a significant proportion of its costs to this category limits the percentage of opex that can be covered by our RPEs analysis for individual cost areas. In the absence of relevant input price indices for these costs, our framework assumes that no RPEs apply to this category and that CPI indexation would capture the evolution of items included in this cost category.

5.4 Summary of RPEs assessment and recommendations

The results of our assessment for the electricity sector are shown in Table 5.16 below.

Table 5.16: Summary of RPEs assessment – electricity sector

Criteria		General labour	Executive labour	Energy (costs and income)	Contractors	Administration
1. Are there sufficient and convincing reasons to think that CPI does not adequately capture the input price?		Pass	Pass	Partial pass	Pass	Pass
2. Is there a significant likelihood that the value of the wedge between the input price and CPI will differ substantially from zero over the period of the price control?	A. Is the expected value of the wedge between the input price and CPI materially different from zero	Depends on weight placed on FPB forecasts	Depends on weight placed on FPB forecasts	Fail	Fail	Fail
	B. Does the wedge between the input price and CPI exhibit high volatility over time?	Fail	Fail	Pass	Fail	Fail
Overall		**Depends on weight placed on FPB forecasts**	**Depends on weight placed on FPB forecasts**	**Pass**	**Fail**	**Fail**

Source: Europe Economics analysis.

The results of our assessment for the gas sector are shown in Table 5.17 below.

Table 5.17: Summary of RPEs assessment – gas sector

Criteria		General labour	Executive labour	Energy (costs and income)	Contractors	Administration
1. Are there sufficient and convincing reasons to think that CPI does not adequately capture the input price?		Pass	Pass	Pass	Pass	Pass
2. Is there a significant likelihood that the value of the wedge between the input price and CPI will differ substantially from zero over the period of the price control?	A. Is the expected value of the wedge between the input price and CPI materially different from zero	Depends on weight placed on FPB forecasts	Depends on weight placed on FPB forecasts	Pass (for energy income)	Fail	Fail
	B. Does the wedge between the input price and CPI exhibit high volatility over time?	Fail	Fail	Fail	Fail	Fail
Overall		**Depends on weight placed on FPB forecasts**	**Depends on weight placed on FPB forecasts**	**Pass**	**Fail**	**Fail**

Source: Europe Economics analysis.

6 Indexation of Allowed Revenue

This chapter sets out our assessment and recommendations regarding the indexation of allowed revenue for the next regulatory period, including how the potential presence of RPEs for two cost categories could be incorporated into the regulatory framework.

6.1 Indexation of total endogenous costs

The approach to indexation is an important part of the methodology for calculating allowed income for the next regulatory period. This includes the question of whether all elements of endogenous costs (operating costs, depreciation and return) should be indexed. We examined whether there are potential RPEs for specific types of operating costs in the previous chapter and set out our conclusions in the light of VREG's broader regulatory framework in section 6.2 below.

In terms of the depreciation and return elements, investors can be compensated for inflation in two ways:

- Use of a nominal WACC and no indexation of the RAB nor of the depreciation and return components of allowed revenue; or
- Use of a real WACC and indexation of both the RAB and the depreciation and return components of allowed revenue.

VREG uses a nominal WACC in line with its approach to valuing the RAB at its residual historical acquisition value (i.e. no indexation is applied).

However, when calculating the trend in endogenous costs under its tariff methodology, VREG first deflates all of the components of allowed revenue (i.e. opex, depreciation and return on RAB) using CPI. Therefore, CPI indexation needs to be applied to all components of allowed revenue (including depreciation and return) to offset this and thus ensure that the firm receives the appropriate amount of nominal revenue.[62] Hence, within each price control period VREG indexes total endogenous costs to CPI, including the depreciation and return elements.[63]

In the light of the above considerations, we recommend that VREG continues to apply CPI indexation to all endogenous costs, including depreciation and return. This approach also aligns with the findings from our review of the approaches used by regulators in other jurisdictions in Chapter 4.

6.2 Incorporating RPEs into the regulatory framework

Our analysis of RPEs in the previous chapter indicated the potential presence of RPEs for two cost categories: labour (general and executive) and energy.

There are two potential approaches to address this:

- Setting an ex ante RPE allowance (reflected in a net frontier shift estimate); or
- Using ex post indexation.

[62] VREG (2021): "Tariff methodology for electricity and natural gas distribution during the regulatory period 2021-2024", p.45-46 [online]

[63] VREG (2021): "Tariff methodology regulatory period 2021-2024 Appendix 2 Capital cost allowance report", p.18 [online]

For regulatory consistency and to avoid undue complexity, we recommend using either ex ante allowances for all cost areas with an RPE or indexation for all cost areas with an RPE (i.e. not a mix of both approaches). Indeed, a mixed approach could itself create perverse incentives — for example, through Fluvius shifting costs over time to areas covered by indexation to reduce risk exposure.

The choice between these two approaches depends on a number of factors, including the availability of suitable indices, any perverse incentives these approaches may give rise to, and consistency with the broader regulatory framework. In the sections below we discuss each of these factors in turn, before providing our recommendation on the way forward regarding RPEs for the next regulatory period.

6.2.1 Availability of suitable indices

The availability of robust price indices is essential for ex post indexation,[64] In particular, for an indexation approach to be feasible there needs to be an index for each cost area with an RPE that is:

- Largely independent of the prices that Fluvius pays: if the prices that Fluvius itself pays for inputs have a material impact on the index, then this would reduce efficiency incentives for DSOs. This perverse incentive can be avoided by using wider indices for input prices (e.g. economy-wide wage indices), although we note that these broader indices might be less representative of the specific inputs that Fluvius uses.
- Representative of the inputs that Fluvius uses.
- Recognised as a robust index: this includes indices produced by an official, authoritative body or an organization providing suitable assurances regarding the robustness of the index.
- Published periodically and in a timely manner: to ensure that RPE allowances can be updated e.g. annually, indices should be published at regular intervals (e.g. annually, quarterly, etc.) and in a timely enough way for indexation purposes (as long data publication lags could impact the feasibility of an indexation approach).

When selecting suitable indices (whether for ex ante analysis to set an ex ante allowance, or for ex post indexation), consideration needs to be given as to how much of Fluvius' operating costs should be linked to a particular index. Robust data to answer this question may not be available for aggregated cost areas which involve a range of inputs (e.g. materials) and/or in cases where the share of the item in Fluvius' operating costs may evolve significantly through time for reasons other than changes in input prices in ways that cannot easily be forecast. For example, it is unlikely to be possible to predict changes in the volume of energy purchased or sold as part of Fluvius' role as supplier of last resort.

In the case of general and executive labour costs, as discussed in the previous chapter, occupation-specific data on the average gross monthly salary of full-time workers are published by Statbel. While in our view these indices can be regarded as robust and independent and reflective of the labour costs incurred by Fluvius, the series is published with a considerable time lag (e.g. 2021 data was published by Statbel in September 2023) which calls into question the feasibility of ex post indexation for labour costs.

For energy cost, our analysis focused on day-ahead wholesale prices sourced from Refinitiv Eikon as a proxy for the price paid by Fluvius as a large industrial consumer of energy. While these indices can be regarded as robust and independent, they may not be fully representative of the price paid by Fluvius which could call into question the feasibility of ex post indexation for energy costs.

In addition to these considerations, a further timing issue may also arise in relation to ex post indexation. An approach involving annual indexation with a lag could increase the year-by-year mismatch between costs and

[64] This is because Fluvius' revenue would be mechanically linked to the indices. By contrast, the availability of suitable indices is simply an ideal situation for setting an ex ante RPE allowance but not necessarily essential, as an ex ante allowance can be determined based on forecasts or on historical data for input price indices which are relevant but imperfect (e.g. by reaching a judgment in the round based on evidence from a number of sources).

revenues when input prices are volatile compared with the use of a reliable forecast (although Fluvius would expect to recover its costs over time). An alternative approach to indexation would be to apply indexation ex post at the next price review for the entire price control period, with an adjustment for the time value of money. While this approach would mean lower administrative costs for VREG within the control period (as indexation would only need to be applied at each price review), the issue around a mismatch between costs and revenues as a result of volatile input prices would still remain to some extent. This is because high/low input prices during the previous control period would lead to high/low ex post RPE allowances in the next control period, by which time the relevant input prices might have moved in the opposite direction. By contrast, no such issues arise under an ex ante RPE allowance approach as a forward-looking RPE allowance (based on either forecast data or extrapolation of historical data) is incorporated into the net frontier shift assumption for the next control period.

Overall, the practical and timing issues around input price indices suggest that an ex post indexation mechanism may not be feasible for labour and energy RPEs. While the lack of fully reflective energy price index to analyse may also cause problems for an ex ante approach, this is mitigated by the fact that an ex ante approach allows greater scope for judgment in interpreting data, and would not involve linking allowances mechanistically to an unsuitable index.

6.2.2 Incentive impacts of approaches

The incentive effects of the two possible approaches to addressing RPEs depend on:

- Whether index weights are updated annually or only at each price review;
- Whether all of Fluvius' operating costs are linked to an RPE index or only some of the costs; and
- How reflective the indices are of the input price pressures faced by Fluvius.

We assess the impact of each of these factors on incentives under both an ex ante RPE allowance and ex post indexation in turn.

Assuming for the sake of analysis that all Fluvius' costs are indexed to appropriate RPE indices, annual updating of the index weights would mean that Fluvius would be indifferent about how its costs break down between different cost areas. For example, Fluvius would not care if more of its spending was on inputs with fast-increasing prices, as the additional cost would be offset by additional revenue under the indexation mechanism. This indifference would dampen Fluvius' incentive to respond efficiently to input price movements by re-optimizing its mix of inputs. By contrast, in the absence of an indexation approach, Fluvius would re-optimise its costs to a new, cheaper mix of inputs when the relative price of inputs changes (e.g. by substituting an input which has not seen price increases for one which has increased a lot in price).

By contrast, updating the index weights only at price reviews means that within period Fluvius now has an incentive to re-optimise costs to a cheaper mix of inputs as it would keep any savings for rest of the period. This incentive to re-optimise, however, gets weaker as Fluvius gets closer to the next price review when weights are updated to reflect any changes in cost shares. In this case, the incentive effects of using ex ante RPE allowances and ex post indexation are the same. In light of these impacts, we recommend that index weights are updated only at price reviews rather than on an annual basis.

Nonetheless, an approach where all costs are linked to appropriate RPE indices is unlikely to be feasible in practice given the challenges involved in identifying suitable price indices for some cost areas (and also our materiality threshold[65] for assessing RPEs). Therefore, we next consider the incentive impacts of a case in which only some of Fluvius' costs are linked to appropriate RPE indices. In line with our recommendation above, we continue to assume that index weights are updated only at price reviews. In this case, under both

[65] As set out in the previous chapter, we consider that it is disproportionate to apply an RPE allowance for cost categories that account for less than 5 per cent of opex.

an ex ante allowance or ex post indexation, once again Fluvius has an incentive to re-optimise costs within the control period as changes in the breakdown of its costs do not have an impact on its within-period revenues. However, with the next price review in mind, Fluvius may have a slight incentive to prefer to incur spending in cost areas for which a positive RPE allowance is provided (whether through indexation or an ex ante allowance) compared with cost areas for which an RPE allowance was not possible (e.g. because there were no suitable indices to use for indexation or the cost area did not pass the materiality threshold).[66] This is because the cost areas without indexation may still have positive RPEs but Fluvius does not get any compensation for them. In addition, ex post indexation creates a small additional perverse incentive over the long-term for Fluvius to shift its spending to costs areas for which RPE indexation applies to protect the firm against input price volatility.

To investigate a potential policy response to the perverse incentive identified above, let us consider a case in which all cost areas have RPE indices, but some of these are less reflective of Fluvius' actual input prices. (This is likely to be the case in practice if VREG decided to make sure that all cost areas are covered an RPE allowance or indexation.) Under the assumption that index weights are updated only at price reviews, the incentive effects of both approaches are similar to those outlined above when only some of the costs are linked to appropriate RPE indices. In particular, Fluvius would have an incentive to move costs to areas with RPEs that over-compensate for actual input price rises and away from areas with RPEs that under-compensate for actual input price rises. Similarly, an additional perverse incentive would also exist in the case of indexation as Fluvius would have an incentive to shift spending to areas with the most cost-reflective indices. This is because the less cost-reflective indices being used for other cost areas would be less effective at reducing the risk associated with volatile input prices since Fluvius' revenues will not necessarily move in line with its costs. Overall, the use of indices that do not closely capture the actual type of input that Fluvius is using does not mitigate the perverse incentives associated with only having RPE allowances or indexation for some cost areas, whilst also contradicting good regulatory practice.

To mitigate the additional perverse incentives arising under an indexation approach discussed above, VREG could in theory monitor Fluvius' cost breakdown to try to make sure Fluvius' behaviour was not being distorted (i.e. that Fluvius was not inappropriately increasing over time the proportion of its spending that is covered by RPE indexation). However, such monitoring is unlikely to be very effective in practice, as other factors could legitimately affect Fluvius' cost breakdown. Further, it would be challenging to identify any distortion in cost breakdowns as several years data may be required before any conclusion can be reached that Fluvius' behaviour in terms of moving costs from one area to others was indeed inappropriate. Consequently, we would recommend that VREG does not create any (further) perverse incentive where these can be avoided through the use of ex ante RPE allowance.

Taken together, while both approaches could give rise to some perverse incentives relating to the mix of inputs, ex post indexation also creates an additional perverse incentive over the long-term, indicating that an ex ante allowance could be regarded as more appropriate based on this analysis of incentive effects.

6.2.3 Consistency with regulatory framework

Finally, it is also crucial that any approach to address the presence of RPEs for some of the cost areas examined is also consistent with the broader regulatory framework. As described in detail in Phase 1 above, VREG calculates endogenous costs for DSOs based on the linear historical cost trend.

In our view, indexation would not be consistent with the regulatory framework and the trend analysis used for setting Fluvius' allowed income. This is because under an indexation approach long-term RPE wedges would be included both in the trend analysis as well as in indexation, leading to double counting. For example, if we assume that over the long-term RPE effects place upwards pressure on costs, then this will reduce the

66 In the case of negative RPEs, Fluvius would prefer to incur costs in areas without RPE indexation.

trend applied to allowed income for the next control period. At the same time, Fluvius would also benefit from RPE allowances during the next price control period through indexation. In order to avoid this issue with double counting, RPE effects would need to be stripped out from historical data which would be very hard to do in practice, and would represent a significant move away from the simple trend methodology currently employed by VREG.

Ex ante RPE allowances do not give rise to concerns regarding double counting as these can be incorporated into the net frontier shift assumption for the next regulatory period, followed by an assessment of whether net frontier shift is already captured by the linear cost trend (this is described in further detail in Phase 3).

6.3 Recommendations

In this section we provide our recommendations regarding the indexation of endogenous costs and the way to address the RPEs identified in the previous chapter for labour and energy costs.

6.3.1 Indexation of endogenous costs

Although VREG uses a nominal WACC, its trend methodology deflates depreciation/return which means that CPI indexation needs to be applied to depreciation/return to offset this and ensure that firm receives the appropriate amount of nominal revenue. We recommend that VREG continues to apply CPI indexation to all endogenous costs, including depreciation and return.

6.3.2 Recommendations for RPEs

Based on our analysis in section 6.2 above, our conclusion is that ex ante RPE allowances would be more suitable for the following reasons:

- Practical issues around input price indices (the time lag present for wage data and the lack of a suitable index for energy costs that is representative of the price paid by Fluvius as a large industrial customer) suggest that an ex post indexation mechanism may not be feasible for labour and energy RPEs.
- While both approaches could give rise to small perverse incentives relating to the mix of inputs, ex post indexation creates a small additional perverse incentive over the long-term.
- Ex post indexation would not be consistent with the wider regulatory methodology due to double counting long-term RPE wedges, as these would be captured in both the efficiency trend and in indexation.

Below we set out our recommended allowances for labour and energy costs.

Labour

For labour costs, our analysis would support an ex ante RPE allowance if weight is placed on forecast FPB data on expected wage growth for the next control period. The table below summarises the expected real wage growth for the period 2025-2028 based on FPB forecasts, which implies a labour RPE of 0.7 per cent over the next regulatory period for both the electricity and gas sectors.

Table 6.1 : FPB forecasts for nominal hourly cost of labour and CPI for next regulatory period (%)

	2025	2026	2027	2028	Average (2025-2028)
Nominal hourly cost of labour	2.9	2.4	2.4	2.4	2.5
CPI	1.8	1.8	1.8	1.8	1.8
Implied real growth in hourly cost of labour	1.1	0.6	0.6	0.6	0.7

Note: Real implied growth was calculated using Fisher formula.
Source: FPB Economic Outlook Report, June 2023.

The table below calculates what this labour wedge of 0.7 per cent equates to as a share of total endogenous costs, to feed into our calculation of a net frontier shift estimate (covered later in the report). The share of labour in endogenous costs is calculated as the total share of labour within opex (i.e. the sum of the cost shares for general and executive labour) multiplied by the share of opex within total endogenous costs (corrected for merger savings and Covid-19 costs). As the last row of Table 6.2 shows, our calculations imply that over the next regulatory period the labour wedge as a share of endogenous costs is 0.16 per cent for the electricity sector and 0.14 per cent for the gas sector.

Table 6.2: Calculation of labour wedge as share of opex for next regulatory period (%)

	Electricity	Gas
Labour RPE	0.7	0.7
Labour share of endogenous costs	23	20
Labour wedge as share of endogenous costs	**0.16**	**0.14**

Note: The labour share of endogenous costs is calculated as an average of shares for the years 2020-22, with budgeted data for 2023 excluded.
Source: Europe Economics analysis.

As noted in Chapter 5, our analysis has found that past FBP forecasts have tended to overstate wage growth compared with subsequent outturn data. This is a factor that VREG may wish to bear in mind when deciding how much weight to place on these forecasts.

At the same time, the ongoing shift within Fluvius from statutory personnel to contractual workers, who do not enjoy the same beneficial labour conditions, is expected to lead to a reduction in wage rates over time, thus potentially offsetting some of the expected real wage growth for the 2025-2028 period. Therefore, VREG will need to make a policy decision on whether to include an ex ante RPE allowance for labour in the net frontier shift estimate, and if so what the magnitude of that allowance should be.

Energy

For net energy (taking account of both the costs incurred and the income received by Fluvius), we are not aware of any publicly available forecast of wholesale or other energy prices for Belgium. In the absence of clear evidence of regarding the future energy price pressure faced by Fluvius, we recommend an energy RPE of 0 per cent over the next regulatory period for both the electricity and gas sectors. We note that this assumption is in line with our analysis of historical energy price data[67] up to 2020, which found no statistically significant wedge. In our view, this figure also represents the upper bound for any energy RPE assumption as the significant spike in energy prices observed in 2022 may well imply a negative wedge for the next regulatory period as energy prices continue to come down from their recent peak.

[67] For the assessment of energy costs.

PHASE 3: ESTIMATING THE SCOPE FOR FRONTIER SHIFT

Europe Economics

7 Estimating the Scope for Frontier Shift

In this chapter we estimate Fluvius' scope for frontier shift in the next regulatory period, 2025-2028. Frontier shift relates to the ability of even the most efficient firms in the sector (i.e. those on the "efficiency frontier") to become more efficient over time. In the current context, the aim is to derive a frontier shift estimate which reflects the pressures to become more efficient that firms face in competitive sectors, so that price regulation of Fluvius mimics competition.

At the end of this chapter we combine our recommended frontier shift estimate with our RPE recommendations (from Phase 2 of our study) to derive our net frontier shift assumption.

7.1 Approach to frontier shift analysis

To estimate Fluvius' scope for frontier shift in the next regulatory period, we conducted a Total Factor Productivity (TFP) analysis. TFP growth captures the change in output that is not explained by changes in inputs, calculated as the residual of the growth in outputs less the weighted average growth in different inputs – labour, capital and (in the case of gross output TFP) intermediate inputs. While partial measures of productivity can be defined — such as labour productivity and LEMS (labour, energy, material and services) productivity — we consider that a TFP measure is the most appropriate choice to estimate an efficiency challenge that will be applied to Fluvius' total endogenous costs (opex, depreciation and capital costs) , since it takes into account all measurable factors of production.

In the remainder of this section, we discuss the following aspects of our TFP analysis:

- The EU KLEMS database
- The choice of countries for which to analyse TFP growth
- The choice of comparator sectors
- The choice of time period.
- The choice of gross output TFP or gross value added TFP.

For each instance where an aspect of our approach differs from the approach taken by Oxera when estimating frontier shift for the previous tariff methodology, we have set out our reasoning for taking a different approach.[68]

7.1.1 The EU KLEMS database

Our TFP analysis is based on the growth accounting database EU KLEMS. This dataset is widely regarded as a credible source of TFP estimates for European countries, and analysis of EU KLEMS is commonly used in regulatory settings to estimate potential productivity growth.

The EU KLEMS database contains growth accounting datasets for all 27 European Union member states and for three non-Eu countries (UK, USA and Japan), as well as datasets for various aggregates of EU countries (e.g. Eurozone countries). The most recent iteration of the EU KLEMS data was released in February 2023. The February 2023 release covers the period 1995-2020 and disaggregates the growth accounting data into 40 industries using the NACE II industrial classification. Older iterations of the EU KLEMS database cover the period 1970-2007 and disaggregate the data using the NACE I industrial classification.

[68] Oxera (2020) "The necessity and magnitude of frontier shift for the Flemish electricity and gas distribution operators over 2021–24"

We note that Oxera also used the EU KLEMS dataset in its 2020 study.

7.1.2 The choice of countries for which to analyse TFP growth

To estimate Fluvius' scope for frontier shift we have used the EU KLEMS datasets for four countries – Belgium and its three largest neighbours, the Netherlands, France and Germany. The TFP data for Belgium is naturally the starting point for estimating the scope for Fluvius to achieve frontier shift. However, the Belgium dataset in the February 2023 release is incomplete, with the data only covering the period 1999-2020 rather than the entire NACE II period of 1995-2020. Therefore, we include data for the Netherlands in our core analysis, so that we can analyse TFP growth over the entire NACE II period. We also include data for France and Germany for sensitivity analyses. The scope for frontier shift in all three countries is likely to be similar to the scope for frontier shift in Belgium, given that all three are developed EU Member States that share a border with Belgium and that are part of the same monetary union. We consider the Netherlands the most comparable country to Belgium of the three, given that it is the most closely matched in size (both in terms of geographic size and economic size), and therefore it is included in the core analysis while France and Germany are used for sensitivity analysis.

In its 2020 report, Oxera focused its analysis on the TFP data for Belgium, with data for the Netherlands only used as a sensitivity analysis. As explained above, we focus on TFP data for the Netherlands, rather than Belgium, due to the TFP data for Belgium being incomplete. In Oxera's report, this incompleteness was not relevant as Oxera's time period of analysis (2003-2017) was covered by the Belgium data. We explain in Section 7.1.4 why we prefer our approach.

7.1.3 The choice of comparator sectors

To estimate Fluvius' scope for frontier shift, we have identified a set of comparator sectors from the sectors contained in the EU KLEMS dataset. Our choice of comparators is guided by two principal criteria:

- whether the sector is competitive (i.e. a predominantly private non-price regulated sector); and
- whether the sector is similar to the energy distribution sector in terms of the nature of activities undertaken.

The competitiveness criterion is important because it limits the catch-up[69] component of TFP growth, so that TFP estimates more accurately reflect true frontier shift. In competitive sectors, TFP growth is primarily driven by frontier shift, as firms behind the frontier would be driven out by the market. In sectors that are predominately public, there is a greater risk of TFP estimates being driven by catch-up efficiency, rather than frontier shift.

It is also important to identify sectors with predominantly comparable activities to electricity and natural gas distribution companies. Our focus was on identifying firms that are involved in activities such as: the operation and maintenance of some network for delivering a product; data collection, processing and hosting; and/or manufacturing processes likely to involve large scale plant and equipment.

The table below reports the sectors we have selected as our comparators to generate a frontier shift estimate for Fluvius, alongside Oxera's comparator sectors from its efficiency study for VREG's previous tariff methodology.

[69] Catch-up efficiency is productivity growth achieved by an inefficient firm (i.e. a firm that is lagging behind the productivity frontier), such that is moves closer to (or "catches up" with) the productivity frontier. Catch-up efficiency is a form of productivity growth that is distinct from frontier shift, which is productivity growth achieved by efficient firms that are already on the productivity frontier (and which hence "shifts" the frontier outwards)

Table 7.1: Comparator sectors used for this study and previous Oxera study

Sector	Our chosen comparators	Oxera[70]
Computer programming, consultancy, and information service activities	✓	✓
Construction	✓	✓
Electricity, gas, steam and air conditioning supply		✓*
Information and communication	✓	
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	✓	✓
Manufacture of machinery and equipment n.e.c. (not elsewhere classified)	✓	
Manufacturing	✓	
Professional, scientific and technical activities; administrative and support service activities	✓	✓
Telecommunications		✓*
Transportation and storage	✓	

*The sectors "Electricity, gas, steam and air conditioning supply" and "Telecommunications" were used in sensitivity analyses by Oxera, but were not included in its "base case" comparator set.

Each of the sectors we have selected as a comparator is predominately competitive. More specific considerations for each sector are set out below:

- "Computer programming, consultancy, and information service activities" – this sector is similar in nature to Fluvius' activities relating to data collection, processing and hosting, such as the provision of a web portal for consumers to monitor their energy consumption.
- "Construction" – this is similar in nature to the building of new infrastructure in the electricity and natural gas distribution sectors, such as laying new cables and pipes or connecting new customers to the grid.
- "Information and communication" – this broad category contains many elements similar in nature to Fluvius' activities, including the production and distribution of information and data processing. This category also includes telecommunications activities, which involves the operation and maintenance of a network.
- "Manufacturing" – this is a broad category containing many elements which will be reflective of activities undertaken by Fluvius, including building and maintaining plant, equipment and machinery and distributing an end product.
- "Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment" – this category includes the repair and installation of machinery and equipment, which shares similarities with Fluvius' grid maintenance activities.
- "Manufacture of machinery and equipment n.e.c." – similar logic applies here as for "Manufacturing".
- "Professional, scientific and technical activities; administrative and support service activities" – this sector includes a variety of activities that support general business operations and which are relevant to Fluvius day-to-day activities, such as cleaning and security. It also includes more specialised professional, scientific and technical activities that are relevant to Fluvius' overhead activities, such as legal, accounting and head office activities.
- "Transportation and storage" – transport networks can be seen as having similarities to the building and operation of networks for transporting electricity and gas.

There are two sectors that Oxera used in its analysis (as sensitivities) that we have not included in our comparator set. We have not included "Telecommunications" because there is no gross output (or gross value added) data for this sector in Belgium's dataset in the most recent EU KLEMS release. Moreover, it is

[70] Oxera (2020) "The necessity and magnitude of frontier shift for the Flemish electricity and gas distribution operators over 2021–24"

included within the wider "Information and communication" sector that we have included. We have not included "Electricity gas, steam and air conditioning supply" because it is predominately a public (or regulated) sector, and therefore TFP estimates for this sector are more likely to include a substantial catch-up efficiency component.

NACE I comparators

In producing our TFP estimates, we have made use of the NACE I version of the EU KLEMS database to provide additional evidence to support our NACE II analysis. For comparators, we have used the NACE I sectors that are most closely matched to our chosen NACE II comparators, where a sufficiently similar option exists. The table below reports the NACE I sectors that we have used in our analysis.

Table 7.2: Comparator sectors for NACE I analysis

Selected NACE II sectors	NACE I closest equivalent
Computer programming, consultancy, and information service activities	*(No NACE I equivalent)*
Construction	Construction
Information and communication	Post and telecommunications
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	*(No NACE I equivalent)*
Manufacture of machinery and equipment n.e.c.	Machinery, nec
Manufacturing	Total manufacturing
Professional, scientific and technical activities; administrative and support service activities	*(No NACE I equivalent)*
Transportation and storage	Transport and storage

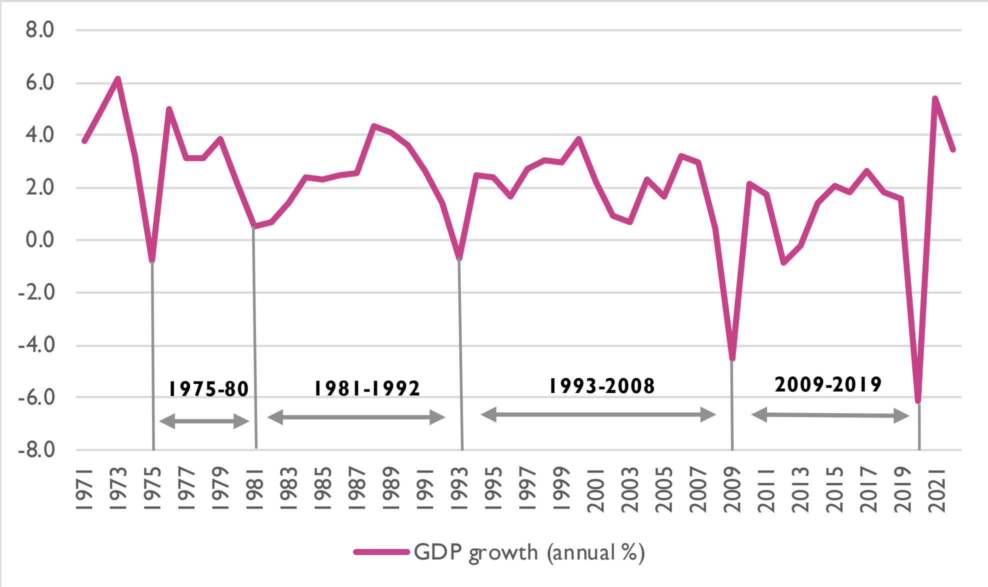
Source: Europe Economics' comparator selection from EU KLEMS dataset.

7.1.4 Choice of time period

According to economic theory and literature, productivity is typically procyclical. This means that productivity growth tends to be higher during times of strong economic growth, and slower during times of economic recession. Therefore, the choice of time period over which TFP analysis is conducted can have a substantial effect on the resulting TFP estimates.

To identify the most suitable time periods for estimating TFP growth we have used business cycle analysis. It would be inappropriate for our TFP estimates to be upwardly (or downwardly) biased because they are derived from historical data that covers only the "boom" (or "bust") section of a business cycle. Therefore, it is optimal to analyse TFP growth over full business cycles. We have used trough-to-trough analysis of Eurozone GDP growth to identify four full business cycles over the last 50 years in the Euro area. As seen in the figure below, there are troughs in GDP growth in 1975, 1981, 1993, 2009 and 2020. Starting at the year of each GDP trough, the corresponding business cycles we have identified are 1975-1980, 1981-1992, 1993-2008 and 2009-2019.

Figure 7.1: Euro Area GDP growth, 1971-2021 (annual %)



Source: GDP growth data from World Bank "World Development Indicators" [online] [last accessed 25/07/2023], EE analysis

However, the time periods that can be used are restricted by the years of data available in the NACE I and NACE II periods, which differ by country. For the four countries we have selected, the years of TFP growth data available in the NACE I and NACE II datasets are shown below.

Table 7.3: Years where TFP growth data is available in EU KLEMS, by country (NACE I and NACE II)

	NACE II years available	NACE I years available
Belgium	2000-2020	1981-2006
The Netherlands	1996-2020	1980-2007
France	1996-2020	1981-2007
Germany	1996-2020	1992-2007

Source: EU KLEMS

The NACE II TFP data for the Netherlands, France and Germany starts in 1995, which means that TFP *growth* can be estimated from 1996-2020. For Belgium, data is not available before 1999, meaning TFP growth can only be measured from 2000-2020. The NACE I TFP data starts in 1980 for Belgium and France and 1979 for the Netherlands, but is only available for Germany from 1991. 2007 data is not available for Belgium in the NACE I dataset.

Impact of the global financial crisis on historical figures and future predictors of productivity

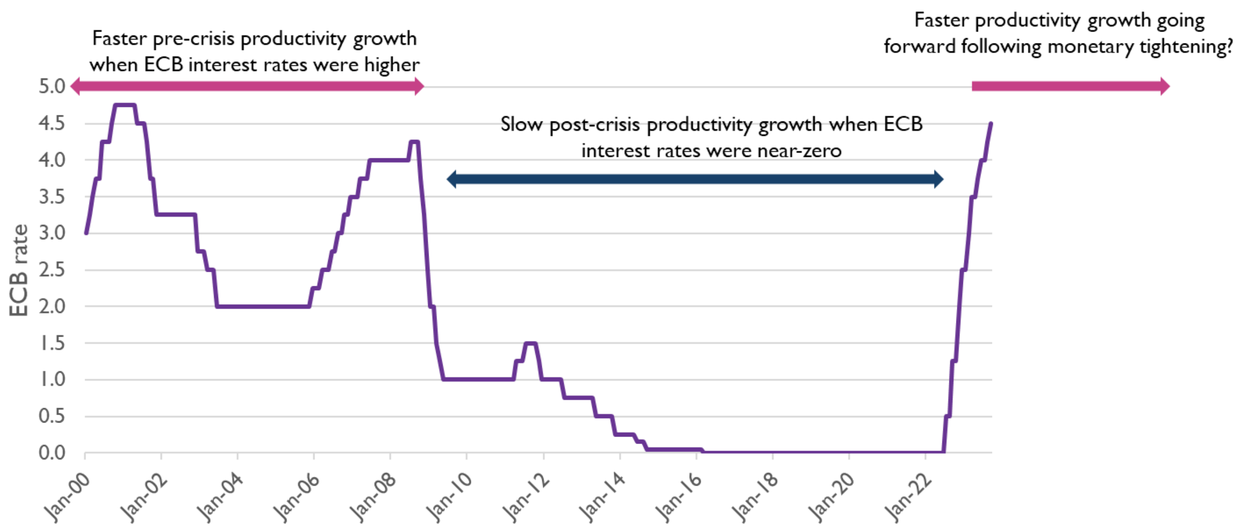
The evidence in the latest version of the EU KLEMS dataset indicates that since the global financial crisis (2008-2009), TFP growth has been weaker in our chosen countries than its pre-crisis trend. In the years 2010-2020, average annual TFP growth in the total economy across the four countries was 0.2 per cent, compared with 0.5 per cent pre-crisis. This structural break in productivity growth can also be observed in the TFP growth estimates for our chosen comparator sectors in each of our chosen countries.

Our view is that the focus of productivity growth analysis should not be solely on post-crisis TFP estimates. There are reasons why we might expect TFP growth in the next regulatory period to revert towards pre-crisis growth rates, rather than continuing the post-crisis productivity stagnation.

One reason for holding this view is based on the dramatic increase in interest rates that has recently been observed. The years since the financial crisis in Europe have featured a prolonged period of loose monetary policy, with the European Central Bank setting historically low interest rates and undertaking quantitative easing. Some economists argue that such policies serve to impede productivity growth by enabling inefficient firms to survive longer than would be possible if interest rates were higher. By continuing to survive despite being inefficient, these firms, sometimes referred to in economics literature as "zombie firms",[71] take up productive resources that would otherwise be reallocated to more efficient companies. By hampering the reallocation of resources to the most efficient firms in the economy, the loose monetary policy serves to reduce productivity growth.

As shown in the figure below, the recent inflationary spike has led to the ECB and other central banks rapidly increasing interest rates. It is possible that this will lead to a reversion to productivity growth rates seen before 2008, where interest rates were at a similar level. Therefore, the TFP estimates for those years (1996-2007 in NACE II datasets) might be more relevant to the frontier shift that Fluvius can achieve in the net regulatory period than the TFP estimates for 2010-2019.

Figure 7.2: ECB interest rates from 2000-2022



Source: European Central Bank "Key ECB interest rates" [online] – see main refinancing options series.

Another reason to be careful in interpreting post-crisis TFP estimates is that the increased prevalence of "zombie firms" means there was increased productivity dispersion in Europe in the post-crisis period. Increased productivity dispersion occurs when the gap between frontier firms and laggard firms (i.e. inefficient firms) in an economy, or a sector, increases. As EU KLEMS TFP estimates are based on all firms in a particular sector, rising productivity dispersion means that frontier firms will have increased their productivity faster than the sectoral averages calculated from the EU KLEMS data. This means TFP estimates will understate frontier shift.

Our chosen time periods

For the NACE II dataset, we assess TFP growth over four time periods:

- The full period excluding 2020 (i.e. 1996-2019 for the Netherlands, France and Germany, 2000-2019 for Belgium)
- A pre-crisis period from 1996-2007 (or 2000-2007 for Belgium)
- A post-crisis period from 2010-2019
- A sensitivity analysis using the full period including 2020

Our preferred NACE II time period is the full period excluding 2020. For the Netherlands, France and Germany, this period includes nearly two full business cycles. We exclude 2020 because the Covid-19

[71] For example, see: Adalet McGowan, M., D. Andrews and V. Millot (2017), "The Walking Dead?: Zombie Firms and Productivity Performance in OECD Countries", OECD Economics Department Working Papers, No. 1372, OECD Publishing, Paris, https://doi.org/10.1787/180d80ad-en.

lockdowns may have distorted TFP estimates through large reductions in the utilisation of factors of production during lockdowns. However, we have also analysed TFP over the entire NACE II period, including 2020, as a sensitivity check.

The pre-crisis and post-crisis time periods that we use exclude the years of data most heavily impacted by the global financial crisis itself (2008 and 2009). As discussed earlier, there are reasons to believe that productivity growth in the next regulatory period could revert back to the higher levels seen before the financial crisis, rather than continuing the post-crisis stagnation. However, we consider that a pragmatic approach is to place most weight on figures for the full NACE II period (excluding 2020), with the pre- and post-crisis estimates serving as additional evidence.

For NACE I, we analyse three time periods:

- The full period of available data (which varies by country as reported in Table 7.3)
- The period 1981-1992 (for Belgium, the Netherlands and France only)
- The period 1993-2007 (1993-2006 for Belgium due to missing 2007 data)

The second and third time periods correspond to the business cycles that we have identified. We note that none of the selected countries have data covering the business cycle 1975-1980. The NACE I dataset is included in our analysis because it allows the TFP analysis to cover a longer historical period and a greater number of business cycles. Moreover, the NACE I dataset covers a time period before the financial crisis, which, as discussed, led to a structural break in productivity growth. Given the possibility that post-crisis TFP growth may not necessarily be representative of the scope for future TFP growth, the NACE I dataset is a useful cross-check of pre-crisis TFP growth.

Our chosen time periods differ from those used in Oxera's report, which were 2003-2010 and 2010-2017 (for the core analysis). Oxera's selection of time periods was derived from its own business cycle analysis, which was based on "growth-cycle" business cycles, rather than the trough-to-trough analysis we use. While both types of business cycle analysis are theoretically valid, we prefer our approach to Oxera's approach in this context as Oxera's approach leads to business cycles that cut off all TFP data from before 2003. Moreover, we note that the business cycles identified by our trough-to-trough analysis are closely aligned to the business cycles reported by the Euro Area Business Cycle Network (EABCN, involving over 20 central banks), with the exception that we do not separate out the 2009-2013 business cycle given it would involve too few years for robust TFP analysis.[72]

7.1.5 Gross output versus gross value added TFP

Growth in TFP can be measured in two ways, as value added TFP growth or alternatively as gross output TFP growth. The two measures are closely linked to each other, but are conceptually different. Gross output captures all inputs that go into production in a sector, including those intermediate inputs purchased from other sectors. TFP in gross output terms represents the residual growth in output once growth in capital, labour and intermediate inputs have been taken into account. Value-added TFP on the other hand is related to only capital and labour as inputs, thus omitting the effect of intermediate inputs. The differences between the two measures can be quite significant, with the value added measure systematically higher in magnitude than the gross output measure.

In our view, the most appropriate measure of TFP growth for the regulatory purpose of estimating frontier shift is TFP growth in gross output terms. This is because VREG intend to apply the frontier shift estimates to total endogenous costs, which includes expenditure on intermediate inputs. Therefore, our analysis primarily focuses on TFP growth in gross output terms.

[72] Chronology of Euro Area Business Cycles | EABCN.

EU KLEMS only reports TFP estimates in value added terms. However, these measures can be converted to gross output TFP through the following formula:

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

This formula states that TFP growth in value added terms is equal to TFP growth in gross output terms divided by the share of value added in gross output. As value added (VA) is a subset of gross output (GO), TFP growth in gross output terms is always lower in magnitude than TFP growth in value added terms. We apply this formula by sector and by year to obtain TFP growth estimates in gross output terms.

While the gross output TFP measure is generally preferred, we acknowledge that it cannot be assumed in all cases to be the superior measure.[73] Therefore, we suggest that some lesser weight be placed on the figures for TFP growth in value added terms as well.

Oxera's report placed equal weight on gross output and gross value added TFP estimates. We prefer our approach, as gross output captures all inputs that go into production in a sector, including those intermediate inputs purchased from other sectors, and VREG intend to apply the frontier shift estimates to total endogenous costs, which includes expenditure on intermediate inputs.

7.2 Results using EU KLEMS data

In this section, we present our gross output TFP growth estimates for each of our comparator sectors for the selected time periods. We present value added TFP growth estimates in Appendix 2.

TFP growth estimates are calculated as arithmetic averages of annual TFP growth values over the time period in question. As discussed in Section 7.1.2, our core analysis uses TFP estimates for Belgium and the Netherlands.

7.2.1 Gross output TFP growth for Belgium and the Netherlands

In Table 7.4, we present gross output TFP growth rates for Belgium calculated using the NACE II dataset.

[73] Economic theory suggests that gross output TFP growth represents technical change when technical progress affects all factors of production proportionally. However, if instead technical change only affects primary inputs and not intermediate goods, then value added TFP growth becomes the true measure of technical change.

Table 7.4: Gross output TFP growth in Belgium (NACE II, %)

Comparator sectors	Average (2000-2019)	Pre-crisis average (2000-2007)	Post-crisis average (2010-2019)	Sensitivity with 2020 (2000-2020)
Manufacturing	0.4	0.6	0.4	0.3
Manufacture of machinery and equipment n.e.c.	0.1	1.1	0.2	0.1
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	0.6	0.2	0.4	0.5
Construction	0.1	0.3	0.1	0.1
Transportation and storage	0.1	0.3	0.2	-0.0
Information and communication	0.7	0.8	0.7	0.7
Computer programming, consultancy, and information service activities	-0.3	-0.3	-0.2	-0.3
Professional, scientific and technical activities; administrative and support service activities	-0.2	-0.4	0.1	-0.1
Average	**0.2**	**0.3**	**0.2**	**0.2**

Source: Europe Economics' analysis of EU KLEMS data. NB. All figures are rounded to 1 decimal place. Averages are calculated using exact values for individual sectors, then rounded to 1 decimal place.

In Table 7.5, we present gross output TFP growth rates for the Netherlands calculated using the NACE II dataset.

Table 7.5: Gross output TFP growth in the Netherlands (NACE II, %)

Comparator sectors	Average (1996-2019)	Pre-crisis average (1996-2007)	Post-crisis average (2010-2019)	Sensitivity with 2020 (1996-2020)
Manufacturing	0.4	0.8	0.4	0.4
Manufacture of machinery and equipment n.e.c.	1.0	1.4	1.6	1.1
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.1	0.6	-0.5	-0.2
Construction	-0.1	-0.1	0.1	-0.1
Transportation and storage	0.4	1.1	0.1	0.2
Information and communication	1.1	1.9	0.6	1.1
Computer programming, consultancy, and information service activities	1.0	1.6	0.9	1.0
Professional, scientific and technical activities; administrative and support service activities	-0.4	-0.3	-0.6	-0.5
Average	**0.4**	**0.9**	**0.3**	**0.4**

Source: Europe Economics' analysis of EU KLEMS data.

In Table 7.6, we present gross output TFP growth rates for Belgium calculated using the NACE I dataset.

Table 7.6: Gross output TFP growth in Belgium (NACE I, %)

Comparator sectors	Business cycle 1 (1981-1992)	Business cycle 2 (1993-2006)	NACE I full period (1981-2006)
Total manufacturing	0.4	0.3	0.3
Machinery, nec	0.1	0.6	0.4
Construction	0.1	0.3	0.2
Transport and storage	1.2	-0.3	0.4
Post and telecommunications	1.5	-1.3	-0.0
Average	**0.7**	**-0.1**	**0.3**

Source: Europe Economics' analysis of EU KLEMS data.

In Table 7.7, we present gross output TFP growth rates for the Netherlands calculated using the NACE I dataset.

Table 7.7: Gross output TFP growth in the Netherlands (NACE I, %)

Comparator sectors	Business cycle 1 (1981-1992)	Business cycle 2 (1993-2007)	NACE I full period (1980-2007)
Total manufacturing	0.4	0.7	0.5
Machinery, nec	0.7	0.8	0.7
Construction	0.5	-0.4	-0.1
Transport and storage	0.3	0.7	0.6
Post and telecommunications	0.5	2.3	1.5
Average	**0.5**	**0.8**	**0.7**

Source: Europe Economics' analysis of EU KLEMS data.

7.2.1 Gross output TFP growth for France and Germany

As explained above, our core analysis uses TFP data for Belgium and the Netherlands. In this section we report TFP growth estimates for our comparator sectors in France and Germany as additional sensitivity analysis to support our core analysis.

In Table 7.8, we present gross output TFP growth rates for France calculated using the NACE II dataset.

Table 7.8: Gross output TFP growth in France (NACE II, %)

Comparator sectors	Average (1996-2019)	Pre-crisis average (1996-2007)	Post-crisis average (2010-2019)	Sensitivity with 2020 (1996-2020)
Manufacturing	0.5	0.8	0.3	0.4
Manufacture of machinery and equipment n.e.c.	0.5	1.4	0.1	0.4
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	0.6	1.5	-0.2	0.6
Construction	-0.4	0.0	-0.5	-0.5
Transportation and storage	0.1	0.6	0.0	-0.1
Information and communication	0.9	1.5	0.7	0.9
Computer programming, consultancy, and information service activities	0.2	0.3	0.3	0.2
Professional, scientific and technical activities; administrative and support service activities	-0.4	-0.4	-0.2	-0.4
Average	**0.3**	**0.7**	**0.1**	**0.2**

Source: Europe Economics' analysis of EU KLEMS data.

In Table 7.9, we present gross output TFP growth rates for Germany calculated using the NACE II dataset.

Table 7.9: Gross output TFP growth in Germany (NACE II, %)

Comparator sectors	Average (1996-2019)	Pre-crisis average (1996-2007)	Post-crisis average (2010-2019)	Sensitivity with 2020 (1996-2020)
Manufacturing	0.5	0.9	0.7	0.4
Manufacture of machinery and equipment n.e.c.	0.1	0.7	0.4	-0.1
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	0.6	1.5	0.2	0.5
Construction	-0.1	-0.2	0.1	-0.1
Transportation and storage	0.4	1.1	-0.2	0.2
Information and communication	1.9	2.6	1.2	1.7
Computer programming, consultancy, and information service activities	1.5	1.8	1.6	1.4
Professional, scientific and technical activities; administrative and support service activities	-0.9	-1.4	0.3	-0.8
Average	**0.5**	**0.9**	**0.6**	**0.4**

Source: Europe Economics' analysis of EU KLEMS data.

In Table 7.10, we present gross output TFP growth rates for France calculated using the NACE I dataset.

Table 7.10: Gross output TFP growth in France (NACE I, %)

Comparator sectors	Business cycle 1 (1981-1992)	Business cycle 2 (1993-2007)	NACE I full period (1981-2007)
Total manufacturing	0.2	0.6	0.5
Machinery, nec	1.6	1.5	1.6
Construction	0.9	-0.4	0.2
Transport and storage	0.7	0.8	0.7
Post and telecommunications	4.8	3.2	3.9
Average	**1.7**	**1.1**	**1.4**

Source: Europe Economics' analysis of EU KLEMS data.

In Table 7.11, we present gross output TFP growth rates for Germany calculated using the NACE I dataset.

Table 7.11: Gross output TFP growth in Germany (NACE I, %)

Comparator sectors	Business cycle 2 (1993-2007)	NACE I full period (1981-2007)
Total manufacturing	0.7	0.7
Machinery, nec	0.7	0.6
Construction	-0.4	-0.4
Transport and storage	1.3	1.2
Post and telecommunications	2.8	2.7
Average	**1.0**	**1.0**

Source: Europe Economics' analysis of EU KLEMS data.

7.2.2 TFP growth in the "Electricity, gas, steam and air conditioning supply" sector

In this section we report TFP growth estimates for the NACE II sector "Electricity, gas, steam and air conditioning supply" and the closest NACE I equivalent "Electricity, gas and water supply" for the Netherlands, France and Germany. (The Belgium results for this sector will be heavily influenced by Fluvius itself, and therefore are not suitable data for determining Fluvius' scope for frontier shift.) This sector is not included in our comparator set because a large amount of the activity in the sector is undertaken by regulated monopolies or public sector organisations. However, this sector involves activities that are the most similar to the activities Fluvius undertakes and VREG has requested that we present these results as a sensitivity. The estimates reported here are for gross output TFP growth.

Table 7.12: Gross output TFP growth estimates for the "Electricity, gas, steam and air conditioning supply" sector (NACE II, %)

	Full period (excluding 2020) (1996-2019)	Pre-crisis average (1996-2007)	Post-crisis average (2010-2019)	Full period (including 2020) (1996-2020)
The Netherlands	0.1	0.6	-0.4	0.2
France	0.5	1.5	-0.3	0.4
Germany	0.9	1.2	0.2	0.8

Source: Europe Economics' analysis of EU KLEMS data.

Table 7.13: Gross output TFP growth estimates for the "Electricity, gas, and water supply" sector (NACE I, %)

	Business cycle 1 (1981-1992)	Business Cycle 2 (1993-2007)	NACE I full period
The Netherlands	0.3	0.3	0.3
France	1.4	1.2	1.3
Germany	N/A	0.9	0.8

Source: Europe Economics' analysis of EU KLEMS data

7.2.3 Interpreting the gross output TFP estimates

In this section we derive a frontier shift range for Fluvius. To do so, we consider which of our gross output TFP estimates above can be interpreted as a lower bound and which can be interpreted as an upper bound. This involves determining how much weight should be given to the various TFP estimates we have calculated. Later, in Section 7.3.3, we consider the implications of the TFP growth estimates in value added terms for the choice of a point estimate from within this range.

As already discussed, our core analysis uses TFP data for the Netherlands and Belgium. More weight is given to the TFP data for these two countries than for France and Germany when considering our frontier shift range. Additionally, we place greater weight on the TFP estimates for the Netherlands than the TFP estimates for Belgium because the Belgium NACE II data is incomplete.

We place the more weight on NACE II estimates than NACE I estimates. This is because we have identified a greater number of comparator sectors in the NACE II dataset than the NACE I dataset. In addition, the NACE II dataset covers a more recent time period.

In addition, we place most weight on the TFP estimates for the entire NACE II period (excluding 2020). In our view, the primary focus should not be on the post-crisis TFP estimates, for the reasons discussed in Section 7.1.4.

Lower bound

Our recommended lower bound for frontier shift is 0.3 per cent. This recommendation is based on the average TFP growth over the the full NACE II period across all comparators, across the Netherlands and Belgium. This value is further supported by the average across all comparators for the same period in France (0.3 per cent) and Germany (0.5 per cent)

In our view, it is inappropriate to have a frontier shift challenge set at a level below the average TFP growth of comparators. Fluvius should, at a minimum, be challenged to achieve productivity growth at the rate that has been achieved, on average, over the last two business cycles by firms in comparable sectors. A frontier shift challenge set below this level would not be sufficiently stretching.

Upper bound

Our recommended upper bound for frontier shift is 1.1 per cent. In determining an upper bound, we focus on the TFP growth performance of the stronger performing comparator sectors (rather than taking an average across all comparator sectors as we do for determining the lower bound).

Our recommendation is primarily justified by the data for the best-performing sectors in the Netherlands over the full NACE II time period (1996-2019). The best performing sector, "Information and communication", achieved average TFP growth of 1.1 per cent over the period, and two other sectors ("Manufacture of machinery and equipment n.e.c." and "Computer programming, consultancy, and information service activities") achieved TFP growth of 1.0 per cent. These three sectors also achieved these TFP growth rates over the sensitivity time period (1996-2020). Further pieces of evidence supporting the achievability of 1.1 per cent TFP growth are as follows:

- The "Manufacture of machinery and equipment n.e.c." sector in Belgium achieved 1.1 per cent TFP growth in the pre-crisis period.
- Four sectors achieved 1.1 per cent TFP growth or higher in the Netherlands in the pre-crisis period.
- The "Manufacture of machinery and equipment n.e.c." sector in the Netherlands achieved 1.6 per cent **TFP** growth in the post-crisis period.
- Two sectors in Germany achieved over 1.1 per cent TFP growth over the full NACE II period (excluding 2020) and in the post-crisis period.
- Three sectors in France and four sectors in Germany achieved 1.1 per cent TFP growth or higher in the pre-crisis period.
- The NACE I sector "Post and telecommunications" in the Netherlands achieved over 1.1 per cent TFP growth over the full NACE I period, and over the 1993-2007 business cycle.
- Two NACE I sectors in Belgium achieved over 1.1 per cent TFP growth over the 1981-1992 business cycle.
- Two NACE I sectors in France achieved over 1.1 per cent TFP growth over the full NACE I period and over both NACE I business cycles.
- Two NACE I sectors in Germany achieved over 1.1 per cent TFP growth over the 1993-2007 business cycle

Therefore, our proposed range for frontier shift is **0.3 to 1.1 per cent.**

Oxera's report took a different approach to interpreting TFP estimates. As discussed in Section 7.1.5, Oxera gave equal weight to gross output and gross value-added measures of TFP, whereas we prefer to place more weight on gross-out measures of TFP. Furthermore, Oxera based both its upper and lower bounds for frontier shift on cross-sector averages. This approach could reflect a view that different comparator sectors may represent different elements of Fluvius' cost base. By contrast, we view each comparator sector as potentially being a complete comparator in its own right for the entirety of Fluvuis' cost base. Hence, we prefer not to base the upper bound on a cross-sector average, because this does not reflect the best productivity growth performance that Fluvius can feasibly achieve given that some comparator sectors will have performed better than the cross-sector average. Instead, an upper bound based on TFP estimates for the best-performing comparator sectors gives a better indication of the maximum feasible productivity improvement Fluvius can achieve in the next regulatory period.

7.3 Other considerations

In this section, we set out three additional considerations that lead us to recommend selecting a point estimate for frontier shift at the upper end of our recommended range.

7.3.1 Expected reversion to pre-crisis TFP growth rates

As discussed in Section 7.1.4, there are strong reasons to believe that TFP growth rates could revert to pre-crisis levels in the next regulatory period. A return to tighter monetary policy could increase the rate at which resources in the economy are reallocated to the most productive uses, reducing the prevalence of zombie firms.

In addition, the post-crisis TFP estimates in EU KLEMS (which are captured in part of our preferred NACE II time period of 1996-2019) are likely to understate the frontier shift achieved by efficient firms. As previously discussed, in the post-crisis period Europe has seen a rise in productivity dispersion, with laggard firms falling further behind frontier firms. As EU KLEMS TFP estimates are based on all firms in a particular sector, rising productivity dispersion means that frontier firms will have increased their productivity faster than the sectoral averages calculated from the EU KLEMS data. Selecting a point estimate for frontier shift at the upper end of our recommended range can mitigate this bias.

7.3.2 Embodied technical change

Changes in the quality of inputs over time can contribute to frontier shift by allowing firms to make cost savings. This is referred to as embodied technical change, because the technical shift is "embodied" in the inputs used in the production process. The other component of frontier shift, disembodied technical change, relates to improvements in the way a given set of inputs are used to produce output (e.g. through better management processes).

TFP growth estimates are intended to capture only disembodied technical shift. This is because TFP is computed as the residual change in output after taking account of changes in both the quantity and the quality of inputs. EU KLEMS uses quality-adjusted inputs for capital and labour. In the case of capital, changes in quality are taken into account through the use of quality adjusted price deflators. The EU KLEMS documentation (Jager, 2018)[74] specifically states, for example, that ICT investment (the type of capital goods where quality changes are likely to have been more important) reflects quality adjusted price changes. For labour, the EU KLEMS dataset makes use of the European Labour Force Survey (EULFS) to get information on changes in the composition of the labour force, in terms of age, gender and education levels, which are used to quality adjust labour inputs. For both capital and labour, it is probable that some embodied technical change may "leak" into TFP estimates due to the challenges of fully adjusting all inputs for quality. Overall, however, the TFP growth estimates contained in the EU KLEMS database are primarily measuring disembodied technical change.

For regulatory purposes, it is important to ensure that the cost saving effects of both embodied and disembodied technical change are taken into account. Failure to account for the technical change "embodied" in intermediate inputs, capital and labour would omit key sources of cost savings, and could therefore lead to overly generous cost allowances. This point has been recognised in recent regulatory decisions in the UK, including in Ofwat's PR19 determination and the subsequent redetermination by the CMA, and by Ofgem at RIIO-ED2, the most recent price control for UK electricity distribution companies.[75,76]

The literature on embodied technical shift provides limited evidence as to the potential scale of embodied technical change, though the evidence that is available suggests that the appropriate adjustment to TFP estimates could be substantial.[77] Given the lack of quantitative evidence on the appropriate adjustment to make to TFP growth estimates, we recommend that embodied technical change is treated as a qualitative factor that justifies selecting a point estimate for frontier shift at the upper end of our recommended range.

7.3.3 Value added estimates of TFP growth

As discussed in Section 7.1.5, while in general we consider gross output TFP estimates to be a more appropriate measure of the frontier shift that Fluvius can achieve than value added TFP estimates, we nonetheless consider that some lesser weight should also be placed on value added TFP growth. Value added TFP growth estimates are always higher than gross output TFP growth estimates. Therefore, we take account of the value added TFP estimates (presented in Appendix 2) by using it as an additional qualitative factor that

74 Jager (2018), "EU KLEMS Growth and Productivity Accounts: 2017 Release, Statistical Module". Available at http://euklems.net/TCB/2018/Metholology_EUKLEMS_2017_revised.pdf .

75 CMA (2021) "Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations" Final Report paragraph 4.553 – 4.556 [online].

76 Ofgem (2022) "RIIO-ED2 Draft Determinations – Core Methodology Document" paragraph 7.464 and 7.469 [online].

77 Key sources include: Uri (1983), "Embodied and disembodied technical change and the constant elasticity of substitution production function". Journal of Applied Mathematical Modelling, Vol. 7(6), pp. 399-404; Hulten (1992), "Growth Accounting When Technical Change is Embodied in Capital", The American Economic Review, Vol. 82, No. 4 (Sep., 1992), pp. 964-980; and Greenwood, Hercowitz, Krusell (1997) "Long-Run Implications of Investment-Specific Technological Change". The American Economic Review, Vol. 87, No. 3 (Jun 1997), pp. 342-362.

justifies our recommendation for selecting a point estimate for frontier shift at the upper end of our recommended range.

7.4 Interaction with quality incentives

In this section we consider the potential interaction between setting a frontier shift challenge for Fluvius and implementing financial incentive mechanisms for Fluvius based on deliverables relating to the quality of service that Fluvius provides.

In theory, there could be some overlap between setting a frontier shift challenge for Fluvius's costs and setting financial incentives for quality that involve stretching performance targets, as doing both of these things could in theory mean that frontier shift is "double counted" in the overall regulatory framework. This double counting would arise if the TFP estimates used to set the frontier shift challenge already capture changes in the quality of comparator sectors' outputs.

However, this overlap only exists in practice if the performance stretching element of the financial quality incentives relates to frontier shift, rather than catch up efficiency. If the reference value for a financial incentive mechanism is based on Fluvius catching-up to the historical or current frontier for a particular aspect of performance (e.g. by improving performance to a level that Fluvius itself has historically achieved), then there is no overlap with the frontier shift challenge.

For 26 out of the 30 deliverables we recommend for security of supply, connections, customer service and smart metering information in our financial incentives study, the reference values are set at a level Fluvius has historically achieved, with no further stretch applied. Therefore, there is no overlap with the frontier shift challenge in the case of these deliverables. For the innovation incentive, the mechanism is reward-only, so there is no possibility of double-counting since Fluvius does not have to do anything to avoid a penalty under this incentive scheme.

For a small number of deliverables, we apply a stretch to the reference values over the course of the next regulatory period, such that the reference value increases each year of the regulatory period. The rate of increase is based on the historical trend rate at which performance by Fluvius has improved. In such cases, there is potentially an overlap with the frontier shift challenge. However, the overall size of this theoretical overlap is small, given it is only applicable to a small subset of the financial incentives package.

The small theoretical overlap will only exist in practice if the TFP growth estimates for comparator sectors capture improvements in the quality of output. The literature on productivity measurement indicates that quality adjustments to price deflators for output tend to be limited to outputs for innovative sectors, such as computing – Murray (2016) notes that "In practice, statistical offices do not measure output in quality-adjusted terms except for certain goods and services (e.g. computers) for which quality change is believed to be of particular importance".[78]. This means that only two of our comparator sectors, "Information and communication" and "Computer programming, consultancy, and information service activities" are likely to have quality adjusted outputs. This means that the overlap in practice will be even smaller than the small theoretical overlap that could exist.

Overall, we consider that any overlap between frontier shift and financial incentives for quality stretch is likely to be very small in practice.

78 Murray (2016), "Partial versus Total Factor Productivity Measures: An Assessment of their Strengths and Weaknesses", International Productivity Monitor [online].

7.5 Conclusions on scope for frontier shift

Our assessment of frontier used an approach based on TFP growth analysis in comparator sectors. Based on that analysis we have derived a recommended frontier shift range of 0.3 – 1.1 per cent for both electricity and natural gas.

We recommend selecting a point estimate for frontier shift from the upper end of this range. This is due to three reasons:

1. The expected reversion to pre-crisis TFP growth rates in the next regulatory period.
2. Embodied technical change that is not captured in TFP estimates.
3. Some weight being placed on value added measures of TFP growth.

With this in mind, we recommend a selected point estimate for frontier shift of 1.1 per cent.

To derive our net frontier shift assumption, we combine our frontier shift point estimate with the RPE recommendations from Phase 2 of our study. To recap, our RPE recommendations are:

- 0.16 per cent for electricity if VREG decides to apply a labour RPE, zero otherwise
- 0.14 per cent for gas if VREG decides to apply a labour RPE, zero otherwise

Combining these recommendations with our frontier shift recommendation yields the following conclusions. If VREG makes the decision to apply a labour RPE:

- Our net frontier shift assumption for electricity is 0.94 per cent.
- Our net frontier shift assumption for gas is 0.96 per cent.

If VREG makes the decision **not** to apply a labour RPE, our net frontier shift assumption for both electricity and gas is 1.1 per cent.

8 Extent to which frontier shift is captured by the linear cost trend

It is possible that by extrapolating the cost trend forward, the methodology is already accounting for frontier shift (or at least an element of frontier shift). If this were the case, applying a frontier shift assumption (as we estimated above) could double-count the frontier shift requirement. VREG has asked us to investigate this possibility as part of the requirements for this study. To answer this question, we have used two different approaches: unit cost analysis and Data Envelopment Analysis (DEA). These are described further below.

The analysis builds on a previous analysis of the frontier shift parameter for Flemish gas and electricity DSOs for the regulatory period 2021–2024.[79] In both cases, the underlying approach involves identifying the most efficient DSOs and investigating whether these have increased their efficiency over time. If the efficient DSOs are becoming more efficient, this may indicate that frontier shift is happening (in which case frontier shift might be accounted for, or partially accounted for, in the linear cost trend). Conversely, it could be that the most efficient DSOs are not becoming more efficient over time (in this case, an additional performance challenge would be required as the linear cost trend would not incorporate frontier shift).[80]

Our analysis uses data from 2019 to 2023. We use endogenous costs, corrected for the merger using VREG's methodology (see Chapter 2). To exclude the effect of inflation, costs are in real 2024 prices. We use two DSO output measures: users (numbers) and length (km). Data on volumes (MWh) are not available for 2023, so our results exclude this variable from the analysis.

8.1 Identifying efficient DSOs: with DEA and unit costs

DEA can estimate levels of efficiency for each DSO, based on the costs and the mix of outputs that the DSO produces. As a result, DEA can identify which are the most efficient firms. These firms are said to be at the efficiency frontier, and provide a benchmark against which the other companies' efficiencies can be compared.

The DEA analysis identified, for 2019, the following efficient DSOs in the electricity and gas sectors:

- **Electricity:** Fluvius Limburg.
- **Gas:** Fluvius Limburg and Sibelgas.

We have also looked at simple unit costs measures to find the most efficient DSOs in 2019. The analysis is presented in Table 8.1 and shows that:

- **For electricity**, Fluvius Limburg is the most efficient operator for any of the outputs provided: cost per users, or cost per length (km) in 2019.
- **For gas**, Sibelgas has the lowest cost per user in 2019 and Fluvius Limburg has the lowest cost per length (km).

The results from the unit cost analysis are therefore consistent with the DEA findings.

[79] Oxera (2020) "The necessity and magnitude of frontier shift for the Flemish electricity and gas distribution operators over 2021–24".

[80] Section 8.4 also considers whether any of the other firms has achieved the expected net frontier shift (in addition to catch-up efficiency) by the end of the period, despite not being the frontier firm at the start of the period.

Table 8.1: DSOs unit costs in 2019 (€ constant 2024 prices)

DSO	Cost/Users	Cost/Length (km)
Electricity		
Fluvius Antwerpen-Iveka †	257.37	7,890.83
Fluvius Limburg	236.13*	5,420.17*
Fluvius West	286.85	7,019.55
Gaselwest	344.66	7,313.89
Imewo	297.56	8,279.51
Intergem	267.96	7,884.90
Iverlek	295.32	8,221.25
PBE	345.29	7,033.02
Sibelgas	292.47	10,301.70
Gas		
Fluvius Antwerpen-Iveka †	207.60	10,711.43
Fluvius Limburg	241.28	5,736.77*
Fluvius West	234.92	7,934.58
Gaselwest	233.57	8,061.30
Imewo	230.74	9,992.24
Intergem	208.04	8,613.27
Iverlek	234.80	8,965.21
Sibelgas	174.66*	8,949.49

Note: * Denotes the minimum value in the electricity sector and the gas sector, respectively. † This DSO is a combination of the two separate existing DSOs. This has been done to ensure consistency over the years as there have been multiple area exchanges between both DSOs in the time period we have considered.
Source: Europe Economics analysis, Data provided by VREG (data accounts for merger savings).

In the light of these results, the efficient DSOs in 2019 are those shown in Table 8.2.

Table 8.2: Efficient DSOs in 2019

Electricity	Gas
Fluvius Limburg	Fluvius Limburg Sibelgas

Source: Europe Economics analysis, Data provided by VREG.

8.2 Measuring productivity improvements 2019-2023

DEA improvements

To assess the efficiency progressions of DSOs we compare DEA efficiency scores in time. To assess the change in efficiency we have proceeded as follows:

- We take the DSOs which are at the efficiency frontier in 2019. These are the DSOs listed in Table 8.2.
- For the 2019 frontier DSOs, we shift their 2019 real endogenous costs downwards annually by 0.94 per cent for electricity and 0.96 per cent for gas. These values are obtained from the frontier shift analysis in Chapter 7[81] and represent an approximate 3.7 per cent cost reduction in the electricity sector and 3.8

[81] In Chapter 7 we presented net frontier shift numbers with and without the application of a labour RPE, with the net frontier shift figure being lower when a labour RPE is applied. In this section, we test whether the linear trend includes the lower of these net frontier shift numbers (i.e. including a labour RPE). The logic of this is that if the linear trend does not incorporate the lower net frontier shift figure, then it will not incorporate the higher net frontier shift figure either.

in the gas sector, in total between 2019 and 2023.[82] The new shifted costs represent the "hypothetical DSO-efficient 2023 frontier" and show the expected costs for the 2019 frontier DSOs with frontier shift efficiency improvement between 2019 and 2023.

- We finally calculate the DEA efficiency of the "hypothetical DSO-efficient 2023 frontier" in the database which includes all 2023 DSOs.
- The comparison of the efficiency scores for the "hypothetical DSO-efficient 2023 frontier" and the observed 2023 DEA score provides an indication of whether the frontier firms are outperforming or underperforming the "hypothetical DSO-efficient 2023 frontier".

The results are presented in Table 8.3. A score of 1 indicates that a firm is on the efficiency frontier, whereas a score below one indicates that a firm is below the frontier. The results show the following:

- **Electricity:** the efficient firm (Fluvius Limburg) obtains a worse efficiency score in 2023 than the "hypothetical DSO-efficient 2023 frontier". This means that the firm that was efficient in 2019 (Fluvius Limburg) has not improved its score in the way it would have been expected (using our frontier shift estimate).
- **Gas:** Fluvius Limburg obtains an efficiency score in 2023 which is the same as "hypothetical DSO-efficient 2023 frontier". Sibelgas, however, does worse than the "hypothetical DSO-efficient 2023 frontier", denoting that it has not improved as would be expected in the light of our frontier shift estimate.

Table 8.3: Efficiency scores improvements by efficient DSOs: 2019-2023

	"Hypothetical DSO-efficient 2023 frontier"*	Observed DEA efficiency 2023	Performance of firm relative to frontier shift assumption
Electricity			
Fluvius Limburg	1	0.84	Underperforms
Gas			
Fluvius Limburg	1	1	The same
Sibelgas	1	0.72	Underperforms

Note: * "Hypothetical DSO-efficient 2023 frontier" shows the efficiency scores for the 2019 frontier DSOs, with our net frontier shift assumption applied over the period 2019-2023.
Source: Europe Economics analysis, data provided by VREG.

Unit cost analysis

We also use unit cost analysis to examine the performance of DSOs across time. The results show mixed results for different firms between 2019 and 2023 (Table 8.4).

- In electricity, the time evolution of performance is very different, across firms and also between indicators. In terms of indicators, it is worth noticing that total costs have increased significantly across the period for all firms but Gaselwest. The change is particularly large for Fluvius Limburg which shows a 20 per cent increase. Unit costs based on users and length all increased during the period with just a few exceptions.
- In gas the results show a mix of increases and decreases for all costs metrics. Two major exceptions can be observed in the case of Fluvius Limburg and Sibelgas. Fluvius Limburg experienced a negligible increase in costs and significant decreases in unit costs. Sibelgas experienced significant increases in all cost indicators, in the order of 34 per cent or more.

The findings provided by the unit cost analysis are consistent with the DEA results discussed above. The DEA found a worsening of the performance of the frontier firm in electricity (Fluvius Limburg), which is in line

[82] The cumulative cost reduction over four years is calculated as $(1 - (1 - 0.94\%)^4)$ for electricity and $(1 - (1 - 0.96\%)^4)$ for gas, where the reduced cost is raised to the fourth power to account for four years' change (from 2019 to 2023). This results in a 3.7 per cent cost reduction in the electricity sector and a 3.8 per cent reduction in the gas sector.

with the observed increase in unit costs for this firm. The improvement of the performance of Fluvius Limburg in gas that we found in our DEA analysis is consistent with the reduction in the firm's unit costs. Sibelgas shows a significant underperformance in its 2023 DEA score and this is in line with its worsening performance for all cost indicators.

Table 8.4: Electricity and gas unit cost changes by DSOs, 2019-23 (% change in real terms)

DSO	Cost	Cost/Users	Cost/Length (km)
Electricity			
Fluvius Antwerpen-Iveka †	6.9%	3.3%	5.0%
Fluvius Limburg *	20.2%	14.5%	14.4%
Fluvius West	6.8%	2.3%	0.7%
Gaselwest	-5.3%	-8.8%	-8.3%
Imewo	2.8%	-1.0%	-0.6%
Intergem	5.8%	1.8%	2.3%
Iverlek	6.8%	2.8%	3.1%
PBE	0.5%	-3.7%	-3.7%
Sibelgas	4.3%	1.1%	-0.4%
Gas			
Fluvius Antwerpen-Iveka †	3.3%	-0.1%	2.0%
Fluvius Limburg *	0.1%	-11.2%	-2.0%
Gaselwest	-2.1%	-8.2%	-3.3%
Sibelgas *	39.5%	34.0%	37.6%
Fluvius West	-15.3%	-20.8%	-17.6%
Imewo	1.4%	-3.9%	-0.1%
Intergem	3.0%	-3.9%	1.9%
Iverlek	3.4%	-2.9%	2.0%

Note: * Denotes frontier DSO in 2019. † This DSO is a combination of the two separate existing DSOs. This has been done to ensure consistency over the years as there have been multiple area exchanges between both DSOs in the time period we have considered.
Source: Europe Economics analysis, Data provided by VREG (data accounts for merger savings).

8.3 Sensitivity analysis

We undertake some additional sensitivity analysis to see how the results change under different assumptions and when different data are used. We have analysed productivity improvements for the following periods:

- Base case: 2019-2023 (this is the case previously analysed).
- Sensitivity scenario 1: 2020-2023.
- Sensitivity scenario 2: 2019-2022.
- Sensitivity scenario 3: 2020-2022.

8.3.1 Electricity

In the electricity sector we found that the efficiency frontier in 2019 is determined by one firm only, Fluvius Limburg, which then underperforms in 2023 (in comparison with the "hypothetical DSO-efficient 2023 frontier"). The analysis we now undertake starts by identifying the efficient DSO at the beginning of the different periods of analysis: 2019 and 2020. In both cases we found the same efficient firm as before: Fluvius Limburg. For that firm we then shift its real endogenous costs downwards annually by 0.94 per cent across four different periods. This represents the "hypothetical DSO-efficient end-period frontier" and shows the expected costs for the frontier DSOs with frontier shift efficiency improvement between the different periods: 2019-2023, 2020-2023, 2019-2022 and 2020-2022. We finally calculate the DEA efficiencies of the "hypothetical DSO-efficient end-period frontier" in the database compared to the observed DEA efficiency scores of Fluvius Limburg at the end of the periods.

The analysis indicates that results are very much influenced by the inclusion of 2023 data. For the periods ending in 2022 the observed DEA score is higher (for the period starting in 2020) or only slightly lower (2019). This does not show the firm falling significantly behind the frontier and hence does not allow us to conclude that frontier shift did not take place. However, when using data periods which include 2023, the analysis shows significant underperformance for starting years of both 2019 and 2020.

Table 8.5: Efficiency scores improvements by efficient DSOs: electricity (different periods)

Scenario	Efficient firm	"Hypothetical DSO-efficient end-period frontier"*	Observed DEA efficiency end-period	Performance of firm relative to frontier shift assumption
Base	Fluvius Limburg (2019-2023)	1	0.84	Underperforms
1	Fluvius Limburg (2020-2023)	1	0.89	Underperforms
2	Fluvius Limburg (2019-2022)	1	0.98	Underperforms slightly
3	Fluvius Limburg (2020-2022)	0.97	1	Overperforms

Note: * "Hypothetical DSO-efficient end-period frontier" shows the efficiency scores for the initial period (2019 and 2020) frontier DSOs, with our assumed net frontier shift improvement (for different periods: 2019-2023, 2020-2023, 2019-2022, 2020-2022).
Source: Europe Economics analysis, data provided by VREG.

Firms' costs

Our analysis has identified Fluvius Limburg as the only frontier firm based on variables related to total costs, users and length. By looking at the unit costs we were able to see that the firm had lower values for these metrics than the rest of the sample (Table 8.1). To be able to determine the origin of such differences we now look at the total costs of the different firms.

The DSOs' endogenous costs display a wide disparity across the firms, reflecting the fact that the firms differ in size. However, when comparing the evolution of costs across time there are some important differences worth noting. There are significant cost increases in 2023, and this is shown by the percentage changes for periods 2019-2023 and 2020-2023. However, when excluding 2023 there are reductions in costs for many of the firms: for example, in the period 2020-2022 all firms reduced their costs (with the exception of Sibelgas, which experienced a one per cent increase in costs). The results again suggest that the findings are strongly influenced by the 2023 value, as when this is excluded we observe cost reductions. In addition, Fluvius Limburg has very low costs in 2019, and this could also be explaining the underperformance found in the DEA analysis.

Table 8.6: Electricity endogenous cost by DSOs, 2019-23 (€ million constant 2024, and % change)

DSO	Endogenous costs (€ million constant 2024)					Percentage change over period			
	2019	2020	2021	2022	2023*	2019-2022	2019-2023	2020-2022	2020-2023
Fluvius Antwerpen-Iveka †	207.8	211.0	197.5	204.4	222.1	-1.6%	6.9%	-3.1%	5.3%
Fluvius Limburg	102.6	109.4	104.2	105.8	123.3	3.1%	20.2%	-3.3%	12.7%
Fluvius West	39.4	41.4	38.9	39.5	42.1	0.3%	6.8%	-4.6%	1.6%
Gaselwest	152.3	149.7	135.1	141.9	144.3	-6.8%	-5.3%	-5.2%	-3.6%
Imewo	187.7	186.8	180.4	185.1	192.9	-1.4%	2.8%	-0.9%	3.3%
Intergem	84.1	82.8	78.2	81.1	89.1	-3.7%	5.8%	-2.1%	7.5%
Iverlek	158.6	158.8	148.6	157.0	169.4	-1.0%	6.8%	-1.1%	6.7%
PBE	31.9	29.7	29.2	28.9	32.1	-9.4%	0.5%	-2.7%	7.9%
Sibelgas	18.6	18.5	16.8	18.6	19.4	0.4%	4.3%	0.8%	4.7%
TOTAL FLUVIUS	**983.1**	**988.2**	**929.0**	**962.3**	**1,034.6**	**-2.1%**	**5.2%**	**-2.6%**	**4.7%**

Note: * Budgeted data. † This DSO is a combination of the two separate existing DSOs. This has been done to ensure consistency over the years as there have been multiple area exchanges between both DSOs in the time period we have considered.
Source: Europe Economics analysis, data provided by VREG (data accounts for merger savings).

8.3.2 Gas

As for electricity, we have undertaken additional sensitivity analysis for the gas sector over four different periods: 2019-2023, 2020-2023, 2019-2022 and 2020-2022.

We previously found that the efficiency frontier in 2019 is determined by Fluvius Limburg and Sibelgas. Fluvius Limburg's efficiency score remained the same across the period 2019-2023, but Sibelgas underperformed in 2023 (in comparison with the "hypothetical DSO-efficient 2023 frontier"). As for the electricity sector, we have started assessing the DSO-efficient firms at the beginning of the different periods of analysis (2019 and 2020) and found that these are the same as before: Fluvius Limburg and Sibelgas. For both firms we then shifted its real endogenous costs downwards annually by 0.96 per cent across the different periods. We finally calculate the DEA efficiencies of the "hypothetical DSO end-period efficient frontiers" in the database compared to the observed DEA efficiency scores of Fluvius Limburg and Sibelgas, at the end of the periods.

In this case the results show a significant difference between the efficient DSOs. Fluvius Limburg outperforms the hypothetical DSO-efficient end-period frontier in all cases (except for the Base case in which it performs in line with it), but Sibelgas always underperforms (Table 8.7).

Table 8.7: Efficiency scores improvements by efficient DSOs: gas (different periods)

Scenario	Efficient firm	"Hypothetical DSO-efficient end-period frontier"*	Observed DEA efficiency end-period	Performance of firm relative to frontier shift assumption
Base	Fluvius Limburg (2019-2023)	1	1	The same
1	Fluvius Limburg (2020-2023)	0.97	1	Overperforms
2	Fluvius Limburg (2019-2022)	0.92	1	Overperforms
3	Fluvius Limburg (2020-2022)	0.88	1	Overperforms
Base	Sibelgas (2019-2023)	1	0.72	Underperforms
1	Sibelgas (2020-2023)	1	0.52	Underperforms
2	Sibelgas (2019-2022)	1	0.81	Underperforms
3	Sibelgas (2020-2022)	1	0.59	Underperforms

Note: * "Hypothetical DSO-efficient end-period frontier" shows the efficiency scores for the initial period (2019 and 2020) frontier DSOs, with our assumed net frontier shift improvement (for different periods: 2019-2023, 2020-2023, 2019-2022, 2020-2022).
Source: Europe Economics analysis, Data provided by VREG.

Firms' costs

We have seen that the most remarkable finding in the gas sector is related to the efficiency indicators obtained for Sibelgas. We therefore investigate all firms' costs across the period. The analysis shows some very low values for Sibelgas at the beginning of the period: the difference between 2019 and 2023 is close to 40 per cent (or 91 per cent when comparing 2020 and 2023). This is a striking difference from the rest of firms in the sample (many of these also see a reduction in costs in 2022, Table 8.8). We therefore conclude that Sibelgas is probably an exception in the period and that its results should not affect the conclusions we have obtained for Fluvius Limburg and the rest of the sample.

Table 8.8: Gas endogenous cost by DSOs, 2019-23 (€ million constant 2024, and % change)

DSO	Endogenous costs (€ million constant 2024)					Percentage change over period			
	2019	2020	2021	2022	2023*	2019-2022	2019-2023	2020-2022	2020-2023
Fluvius Antwerpen-Iveka †	122.5	122.8	120.9	115.6	126.5	-5.6%	3.3%	-5.9%	3.0%
Fluvius Limburg	61.0	63.7	58.1	55.4	61.0	-9.1%	0.1%	-13.1%	-4.2%
Fluvius West	13.1	12.9	10.8	10.0	11.1	-23.3%	-15.3%	-22.1%	-14.0%
Gaselwest	69.1	67.9	64.3	64.4	67.7	-6.9%	-2.1%	-5.2%	-0.3%
Imewo	97.0	98.8	94.5	90.9	98.3	-6.2%	1.4%	-8.0%	-0.5%
Intergem	42.3	42.1	41.7	40.5	43.6	-4.4%	3.0%	-3.8%	3.6%
Iverlek	82.8	83.4	80.8	82.1	85.6	-0.9%	3.4%	-1.6%	2.7%
Sibelgas	8.1	5.9	10.2	10.1	11.3	25.0%	39.5%	71.3%	91.1%
TOTAL FLUVIUS	**495.9**	**497.5**	**481.3**	**469.0**	**505.2**	**-5.4%**	**1.9%**	**-5.7%**	**1.5%**

Note: * Budgeted data. † This DSO is a combination of the two separate existing DSOs. This has been done to ensure consistency over the years as there have been multiple area exchanges between both DSOs in the time period we have considered.
Source: Europe Economics analysis, data provided by VREG (data accounts for merger savings).

8.4 Assessing the appropriate frontier shift challenge

We have seen that, in the electricity sector, Fluvius Limburg in 2023 shows efficiency scores that are below the expected score that would be achieved with the "hypothetical DSO-efficient end-period frontier". This implies that a frontier shift challenge should be applied. We have also noted that the results seen for Fluvius Limburg depend on the data used, and are strongly influenced, in particular, by the high costs budgeted for this DSO in 2023 and very low costs reported in 2019. We recommend VREG repeats the analysis with 2023 outturn data..

If the frontier shift challenge is corroborated in the electricity sector, the shift should be implemented in the following way. We explain this for the Base case, but similar calculations can be done for the other scenarios.

We shall start by defining the following variables, which should be calculated using the sample of all 2023 DSOs, including the "hypothetical DSO-efficient end-period frontier" and the 2019 DSO-efficient firm:

- X = efficiency score of the DSO found to be at the frontier in 2019, using costs and outputs from that year (i.e. no shift in costs).
- Y = efficiency score of the "hypothetical DSO-efficient end-period frontier" for 2023. This is the score of the DSO found to be at the frontier in 2019, with costs shifted by the estimated frontier shift.
- Z = efficiency score of the most efficient firm in 2023. It is important to note that this may or may not be the same DSO as the frontier firm in 2019 (with an efficiency score equal to X).

Then, it can be noted that:

- Y – X is the difference between the "hypothetical DSO-efficient end-period frontier" and the efficient DSO in 2019. This would be the frontier shift required for the 2019 efficient frontier DSO.

- Y – Z is the difference between the "hypothetical DSO-efficient end-period frontier" and the most efficient DSO in 2023. It shows the additional efficiency gains required for the sector to achieve the full amount of frontier shift implied by our net frontier shift estimate.

We can note that if Z > Y, we can conclude that some other firms in the database have been able to outperform the "hypothetical DSO-efficient end-period frontier". This will be a reflection of firms being able to catch up and achieve the efficiency performance of the "hypothetical DSO-efficient end-period frontier". This would imply frontier shift has been achieved and that no additional adjustment is required.

If X < Z < Y, then the sector has achieved some of the frontier shift but not all of it. In this case, the frontier shift challenge that should be applied is the unachieved difference between the "hypothetical DSO-efficient end-period frontier" and the most efficient DSO in 2023, this is (Y – Z). This can be expressed in relation to the total difference between the "hypothetical DSO-efficient end-period frontier" and the efficiency estimated for the efficient DSO in 2019 (Y – X), to give the percentage of our net frontier shift assumption that should be applied. In other words:

Percentage of net frontier shift that should be applied = $100 * (Y – Z) / (Y – X)$.

It should be noted that if Z = X then the most efficient firm in 2023 has not achieved any frontier shift over the period. In this case, our full frontier shift assumption should be applied.

The required frontier shift challenge (as a percentage of our net frontier shift assumption) has been calculated for all the scenarios in the electricity sector and can be seen in Table 8.9. The difference between the "hypothetical DSO-efficient end-period frontier" and the 2019 DSO-efficient firm can be obtained from Y and X, and shows the total difference in efficiency required under the assumed expected costs with frontier shift efficiency improvement (in the different periods). The difference between the "hypothetical DSO-efficient end-period frontier" and the 2023 most efficient firm can be obtained from Y and Z, showing the additional requirement for the sector to achieve frontier shift. The results show that a full shift would be required in the Base case and Scenario 1 (as Z < X in both cases). In the case of Scenario 2, the partial shift can be calculated as 65%. As the "hypothetical DSO-efficient end-period frontier" is the same as the observed DEA, there is no efficiency challenge required for Scenario 3.

Table 8.9: Efficiency scores improvements by efficient DSOs: electricity (different periods)

Scenario	Efficient firm	Y "Hypothetical DSO-efficient end-period frontier"*	X DSO efficient firm at end-period (no cost shift)	Z Score of most efficient firm end-period	Shift
Base	Fluvius Limburg (2019-2023)	1	0.96	0.85	Full (Z < X)
1	Fluvius Limburg (2020-2023)	1	0.97	0.91	Full (Z < X)
2	Fluvius Limburg (2019-2022)	1	0.97	0.98	65%
3	Fluvius Limburg (2020-2022)	1	1	1	No shift

Note: * "Hypothetical DSO-efficient end-period frontier" shows the efficiency scores for the initial period (2019 and 2020) frontier DSOs, with our assumed net frontier shift improvement (for different periods: 2019-2023, 2020-2023, 2019-2022, 2020-2022).
Source: Europe Economics analysis, data provided by VREG.

8.5 Results with upper bound estimate of net frontier shift

Our analysis has used the net frontier shift assumption for electricity of 0.94 per cent and 0.96 for gas, which have been estimated in Chapter 7. In the event that VREG decides not to apply a labour RPE, we also estimated a net frontier shift, for both electricity and gas, at 1.1 per cent. The results of using a 1.1 per cent estimate are similar to the ones reported above, both for electricity and gas.

- In the electricity sector, the DEA reveals similar results to those presented in Table 8.5, with identical efficiency scores (up to two decimal places). They indicate underperformance of Fluvius Limburg in the Base case and Scenario 1.
- In the gas sector, the DEA reveals similar results to those presented in Table 8.7, with identical efficiency scores (up to one decimal place). Fluvius Limburg outperforms the hypothetical DSO-efficient end-period frontier in all cases (except for the Base case in which it performs in line with it), but Sibelgas underperforms in all scenarios.

8.6 Conclusions

We have found that the efficient firm in the electricity sector tends to underperform in 2023, compared with our expectations for productivity improvements. However, we have noticed that the results are very much dependent on the values observed in 2023 data. We also note that 2023 is budgeted data and we would therefore recommend that the VREG repeats the analysis with outturn data, when these are available.[83]

For the gas sector we found that one of the firms identified as efficient in 2019 and 2020 always outperforms the improvement implied by our net frontier shift assumption. This is an indication that frontier shift is already captured in the linear trend in the gas sector, implying that no additional frontier shift challenge should be imposed. The other firm identified as efficient tends to underperform but we have shown that this is a very small firm with very low recorded costs at the beginning of the period. We have concluded that this firm is probably an outlier and that its results do not affect the conclusions we have obtained for the rest of the sample. In the same way as for the electricity sector, however, we recommend that the analysis is updated when outturn 2023 data become available, to make sure that the results are not affected.[84]

[83] This would not be necessary if the outturn data for 2023 show that all electricity DSOs have higher costs than in the budgeted 2023 data used in our analysis. In this case, it would be clear that we would continue to find that none of the DSOs have achieved frontier shift, even without updating the analysis. However, if any one of the DSOs has (materially) lower costs than in the budgeted data, then updated analysis would be appropriate to check whether some or all of our net frontier shift assumption has been achieved in the sector.

[84] This would not be necessary if the outturn data for 2023 show that the frontier gas DSO (Fluvius Limburg) has lower costs than in the budgeted 2023 data used in our analysis. In this case, there would be even stronger evidence that the frontier firm has achieved frontier shift, even without redoing the DEA and unit cost analysis.

9 Conclusions

In the first phase of the study we have analysed the evolution of costs and unit costs in different costs categories across time. Throughout the period 2019-2023, endogenous costs of electricity and gas have shown a steady increase, in nominal terms. However, when expressed in constant 2024 prices the results show a real decrease in endogenous costs in the period 2019-2023 for both sectors: a drop of around 1 per cent in electricity and 4 per cent in gas.

We have also calculated the evolution of costs by different cost breakdowns (activities and types). It is worth noting a downward trend in indirect costs (i.e. costs not directly attributable to any activity) for both electricity and gas which runs persistently over each of the four years of the period; and a big drop in labour costs taking place after 2020. A significant increase can also be observed, for both gas and electricity, in energy costs and also an increase in energy income. The results did not find any other clear upward or downward trend in other cost categories.

Throughout the study, we described how some of our findings are preliminary as they are based on 2023 budgeted data.

Our study has also described how, despite annual reporting data being available, we needed to ask Fluvius for additional data, and also for additional levels of breakdown, for certain parts of our study.[85] There were also a significant number of calculations and transformations to the data that were necessary to make it suitable for the analysis. In addition, we found problems in proper delimitation of some cost categories and a lack of consistency in the data across time and across DSOs. The data reporting would benefit from a more rigorous and documented approach, so that the analysis can be replicated in the future with greater ease and certainty. Finally, the data recording would benefit from a proper data auditing process so that any potential errors are corrected.

Phase 2 of the project assessed the indexation parameter(s) used in the tariff methodology for the upcoming regulatory period, including the case for any real price effects.

Our review of regulatory precedents found that most regulators in other European jurisdictions apply indexation to all elements of allowed revenues (including operating costs, depreciation and return) using CPI or a closely related index. Only one of the regulators we reviewed (Ofgem) included any indexation arrangements for RPEs.

The first stage of our framework used a set of criteria to assess the case for RPEs for individual cost items including labour (general and executive), energy, contractors and administration. Our results indicated the presence of potential RPEs for two cost categories: labour (general and executive) and energy. In particular, labour qualifies for an RPE mechanism if weight is placed on FPB forecasts of real wage growth. In the case of energy, the volatility of the wedge between input prices and CPI indicated that consideration should be given to an energy RPE in the second stage of our analysis.

The second stage of our framework then investigated what, if anything, should be done about these RPEs.

Taking account of the availability of suitable indices, the possibility of creating perverse incentives and consistency with the broader regulatory framework, we recommend setting an ex ante RPE allowance (reflected in a net frontier shift estimate) rather than using ex post indexation.

Our recommendations are as follows

[85] These data issues only relate to the disaggregated cost breakdowns. These issues do not impact the conclusions of Phase 3 as the analysis in Phase 3 uses total costs.

- For labour costs, our analysis would suggest an ex ante RPE allowance of 0.7 per cent per annum over the next regulatory period for both the electricity and gas sectors, if VREG places weight on FBP forecasts of future wage growth. We then calculate the labour wedge as a share of total endogenous costs to arrive at a net frontier shift estimate (see below).
- Given the absence of publicly available forecasts regarding the future energy price pressure faced by Fluvius, we recommend an energy RPE of 0 per cent over the next regulatory period for both the electricity and gas sectors.

At the same time, our analysis has found that past FBP forecasts have tended to overstate wage growth compared with subsequent outturn data. This is a factor that VREG may wish to bear in mind when deciding how much weight to place on these forecasts.

At the same time, the ongoing shift within Fluvius from statutory personnel to contractual workers, who do not enjoy the same beneficial labour conditions, is expected to lead to a reduction in wage rates over time, thus potentially offsetting some of the expected real wage growth for the 2025-2028 period. Therefore, VREG will need to make a policy decision on whether to include an ex ante RPE allowance for labour in the net frontier shift estimate, and if so what the magnitude of that allowance should be.

In Phase 3, we analysed TFP data and recommended a frontier shift range of 0.3 – 1.1 per cent for both electricity and natural gas.

We recommend selecting a point estimate for frontier shift from the upper end of this range. This is due to three reasons:

1. The expected reversion to pre-crisis TFP growth rates in the next regulatory period.
2. Embodied technical change that is not captured in TFP estimates.
3. Some weight being placed on value added measures of TFP growth.

With this in mind, we recommend a selected point estimate for frontier shift of 1.1 per cent. Combining this recommendation with our RPE recommendations (discussed above) yields the following conclusions for the net frontier shift figure, if VREG puts weight on FBP forecasts of future wage growth:

- A net frontier shift assumption for electricity of 0.94 per cent.
- A net frontier shift assumption for gas of 0.96 per cent.

If VREG makes the decision **not** to apply a labour RPE, our net frontier shift assumption for both electricity and gas is 1.1 per cent.

It is possible that by extrapolating the cost trend forward, the methodology is already accounting for frontier shift (or at least an element of frontier shift). If this were the case, applying a frontier shift assumption could double-count the frontier shift requirement. To investigate this possibility, we have used two different approaches: unit cost analysis and Data Envelopment Analysis (DEA). In both cases, the underlying approach involves identifying the most efficient DSOs and investigating whether these have increased their efficiency over time.

We have found that the efficient firm in the electricity sector tends to underperform in 2023, compared with our expectations for productivity improvements. Our results suggest that a full frontier shift challenge should be applied in the electricity sector (either 0.94 or 1.1 per cent per annum, depending on whether or not VREG decides to apply a labour RPE). However, we have noticed that the results are very much dependent on the values observed in 2023 data. We also note that 2023 is budgeted data and we would therefore recommend that the VREG repeats the analysis with outturn data, when these are available.

For the gas sector we found that one of the firms identified as efficient in 2019 and 2020 always outperforms the improvement implied by our net frontier shift assumption. This is an indication that frontier shift is already captured in the linear trend in the gas sector, implying that no additional frontier shift challenge should be imposed. The other firm identified as efficient tends to underperform but we have shown that this is a very small firm with very low recorded costs at the beginning of the period. We have concluded that this firm is probably an outlier and that its results do not affect the conclusions we have obtained for the rest of the sample. Hence, our overall conclusion is that no frontier shift challenge should be applied in the gas sector. However, in the same way as for the electricity sector, we recommend that the analysis is updated when outturn 2023 data become available, to make sure that the results are not affected.

Appendices

Europe Economics

Appendix 1 – Trends by cost activity using the original data

The tables below show the trends by cost activity using the original data i.e. reported costs without correcting for merger savings.

Table A.1: Electricity cost trends by activity, 2020-2023 (data not corrected for merger savings)

	Share of cost (%)	Trend excluding 2023		Trend including 2023	
		CAGR (%)	Slope gradient	CAGR (%)	Slope gradient
Overhead	10.73	-0.01	-0.01	-11.78	-9.87
Netlosses	10.71	-5.81	-3.24	45.81	27.16
Low-Voltage Network	10.16	-2.61	-1.97	-0.98	-0.74
Measuring Device	8.71	16.21	9.81	12.83	7.72
Projects	8.39	-5.61	-3.39	1.04	0.65
Medium-Voltage Network	7.95	-3.01	-1.78	-1.41	-0.84
Cabin	7.96	-1.78	-1.07	-2.52	-1.51
Branches	5.11	-3.75	-1.48	-5.97	-2.33
Market Operations	5.04	28.03	9.30	21.29	7.03
Public Lighting Grid	4.11	-10.74	-3.40	-9.54	-3.04
General Depreciation	2.41	-49.08	-8.22	-31.03	-6.04
Customer Service	2.40	2.80	0.49	1.99	0.35
Public Service Obligations	2.12	10.52	1.64	4.56	0.70
Network Management	2.04	-9.57	-1.43	-3.06	-0.47
Studies	2.03	-163.60	-12.23	-44.30	-7.10
Vehicles	1.94	8.72	1.28	0.71	0.10
Head Office Finance Functions	1.15	2.24	0.20	-5.15	-0.45
Switching Station	1.66	-4.30	-0.53	-2.06	-0.26
Other (negligible)	1.29	-19.00	-1.69	-1.78	-0.17
General	1.12	8.09	0.68	1.38	0.11
Logistics	1.15	-18.90	-1.62	-11.14	-1.00
Buildings	1.02	74.71	4.12	41.27	2.42
Teletransmission Network	1.02	1.62	0.12	6.93	0.51
Energy Delivery	0.77	-211.68	-9.51	2.62	0.15
Transformer Station	0.72	-159.85	-3.64	-24.62	-1.43
Dispatching	0.74	-26.30	-1.42	-13.54	-0.79
ICT	0.60	-192.83	-8.94	-165.86	-5.37
Prevention	0.28	-3.54	-0.07	0.58	0.01
Communication	0.12	-1.29	-0.01	-2.50	-0.02
Facility Management	0.10	-17.02	-0.12	-0.63	0.00
Purchase	0.09	47.25	0.28	20.44	0.12
HR	0.03	-16.56	-0.04	-15.04	-0.04
Customer Cabin	0.00	-300.00	0.00	58.74	0.00
Finance	-3.70	-20.22	4.70	9.02	-2.36

Source: Fluvius data, Europe Economics analysis

Table A.2: Gas cost trends by activity, 2020-2023 (data not corrected for merger savings)

	Share of cost (%)	Trend excluding 2023		Trend including 2023	
		CAGR (%)	Slope gradient	CAGR (%)	Slope gradient
Low Pressure Network	17.21	4.10	2.38	1.57	0.91
Measuring Device	15.98	21.12	10.65	14.16	7.07
Service Management	15.61	-13.95	-7.56	-10.06	-5.56
Overhead	9.94	-0.36	-0.13	-10.24	-3.60
Projects	9.16	-5.08	-1.55	-0.61	-0.19
Medium Pressure Network	6.78	-4.46	-1.04	-3.81	-0.89
Market Operations	5.68	28.60	4.85	21.89	3.70
Customer Service	2.69	3.65	0.33	2.88	0.26
Network Management	2.67	-9.26	-0.81	-0.47	-0.04
Studies	2.05	-164.69	-5.79	-47.01	-3.43
Distribution Cabin	2.04	2.95	0.21	-4.22	-0.30
Head Office Finance Functions	1.40	-10.93	-0.50	-0.82	-0.04
General Depreciation	1.83	-22.41	-1.41	-14.16	-0.93
Energy Delivery	1.59	-237.76	-12.93	-382.24	3.92
Logistics	1.29	-18.39	-0.81	-10.68	-0.49
General	1.15	4.65	0.17	10.81	0.40
Pressure Reducing Station	0.91	-14.24	-0.47	-15.35	-0.50
Receiving Station	0.86	2.09	0.06	3.42	0.10
Public Service Obligations	0.85	-131.53	-1.64	-30.81	-0.96
Customer Cabin	0.78	-4.17	-0.11	3.35	0.09
Dispatching	0.74	-26.41	-0.64	-13.07	-0.34
ICT	0.43	-192.83	-2.91	-165.86	-1.75
Active Protection	0.42	-7.51	-0.10	-0.33	0.00
Facility Management	0.33	-24.19	-0.30	-27.43	-0.33
Vehicles	0.22	-37.59	-0.30	-36.17	-0.29
Buildings	0.20	16.29	0.11	6.75	0.04
Communication	0.13	-0.79	0.00	-2.03	-0.01
Purchase	0.10	47.69	0.14	20.88	0.06
HR	0.03	-14.67	-0.02	-13.83	-0.02
Other (negligible)	0.00	N/A	0.00	-251.83	0.00
Finance	-0.48	-263.86	-1.69	-263.71	-1.71
Netlosses	-2.57	-161.76	6.00	-23.66	2.23

Source: Fluvius data, Europe Economics analysis.

Appendix 2 – Value added TFP growth estimates

In this appendix we present value added TFP growth estimates for our comparator sectors, calculated from the EU KLEMS datasets for Belgium, the Netherlands, France and Germany.

9.1.1 Value added TFP growth for Belgium and the Netherlands

As explained in the main body of the report, we believe that in most cases the most appropriate measure of frontier shift is gross output TFP growth. However, we also place some weight on estimates of value added TFP growth for the comparator sectors.

In Table A2.1, we present value added TFP growth rates for Belgium calculated using the NACE II dataset.

Table A2.1: Value added TFP growth in Belgium (NACE II, %)

Comparator sectors	Average (2000-2019)	Pre-crisis average (2000-2007)	Post-crisis average (2010-2019)	Sensitivity with 2020 (2000-2020)
Manufacturing	1.4	2.2	1.6	1.3
Manufacture of machinery and equipment n.e.c.	0.4	3.1	0.4	0.3
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	1.6	0.8	1.0	1.4
Construction	0.4	1.1	0.3	0.3
Transportation and storage	0.4	0.7	0.4	0.0
Information and communication	1.5	1.6	1.4	1.6
Computer programming, consultancy, and information service activities	-0.6	-0.6	-0.4	-0.5
Professional, scientific and technical activities; administrative and support service activities	-0.4	-0.8	0.1	-0.3
Average	**0.6**	**1.0**	**0.6**	**0.5**

Source: Europe Economics' analysis of EU KLEMS data.

In Table A2.2, we present value added TFP growth rates for the Netherlands calculated using the NACE II dataset.

Table A2.2: Value added TFP growth in the Netherlands (NACE II, %)

Comparator sectors	Average (1996-2019)	Pre-crisis average (1996-2007)	Post-crisis average (2010-2019)	Sensitivity with 2020 (1996-2020)
Manufacturing	1.6	2.6	1.7	1.5
Manufacture of machinery and equipment n.e.c.	2.8	3.9	4.3	2.9
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.2	1.3	-1.2	-0.4
Construction	-0.1	-0.4	0.3	-0.1
Transportation and storage	1.0	2.4	0.2	0.3
Information and communication	2.3	3.8	1.4	2.2
Computer programming, consultancy, and information service activities	1.8	2.8	1.6	1.8
Professional, scientific and technical activities; administrative and support service activities	-0.8	-0.6	-1.1	-1.0
Average	**1.0**	**2.0**	**0.9**	**0.9**

Source: Europe Economics' analysis of EU KLEMS data.

In Table A2.3, we present value added TFP growth rates for Belgium calculated using the NACE I dataset.

Table 2.3: Value added TFP growth in Belgium (NACE I, %)

Comparator sectors	Business cycle 1 (1981-1992)	Business cycle 2 (1993-2006)	NACE I full period (1981-2006)
Total manufacturing	1.6	1.1	1.3
Machinery, nec	0.1	1.8	1.0
Construction	0.3	1.0	0.7
Transport and storage	3.0	-0.7	1.0
Post and telecommunications	1.9	-1.5	0.0
Average	**1.4**	**0.3**	**0.8**

Source: Europe Economics' analysis of EU KLEMS data.

In Table A2.4, we present value added TFP growth rates for the Netherlands calculated using the NACE I dataset.

Table A2.4: Value added TFP growth in the Netherlands (NACE I, %)

Comparator sectors	Business cycle 1 (1981-1992)	Business cycle 2 (1993-2007)	NACE I full period (1981-2007)
Total manufacturing	1.4	2.3	1.9
Machinery, nec	1.8	2.5	2.1
Construction	1.5	-1.3	-0.4
Transport and storage	1.0	1.5	1.3
Post and telecommunications	1.2	4.9	3.1
Average	**1.4**	**2.0**	**1.6**

Source: Europe Economics' analysis of EU KLEMS data.

9.1.2 Value added TFP growth for France and Germany

In Table A2.5, we present value added TFP growth rates for France calculated using the NACE II dataset.

Table A2.5: Value added TFP growth in France (NACE II, %)

Comparator sectors	Average (1996-2019)	Pre-crisis average (1996-2007)	Post-crisis average (2010-2019)	Sensitivity with 2020 (1996-2020)
Manufacturing	1.5	2.6	1.2	1.1
Manufacture of machinery and equipment n.e.c.	1.5	4.4	0.1	1.2
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	1.4	3.6	-0.4	1.3
Construction	-0.9	0.1	-1.2	-1.2
Transportation and storage	0.3	1.2	0.0	-0.3
Information and communication	1.7	2.7	1.4	1.6
Computer programming, consultancy, and information service activities	0.3	0.5	0.5	0.4
Professional, scientific and technical activities; administrative and support service activities	-0.8	-0.7	-0.4	-0.8
Average	**0.6**	**1.8**	**0.1**	**0.4**

Source: Europe Economics' analysis of EU KLEMS data.

In Table A2.6, we present value added TFP growth rates for Germany calculated using the NACE II dataset.

Table A2.6: Value added TFP growth in Germany (NACE II, %)

Comparator sectors	Average (1996-2019)	Pre-crisis average (1996-2007)	Post-crisis average (2010-2019)	Sensitivity with 2020 (1996-2020)
Manufacturing	1.6	2.8	2.3	1.3
Manufacture of machinery and equipment n.e.c.	0.1	1.9	1.1	-0.3
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	1.4	3.6	0.5	1.3
Construction	-0.3	-0.4	0.2	-0.2
Transportation and storage	0.8	2.5	-0.6	0.3
Information and communication	3.4	4.6	2.5	3.2
Computer programming, consultancy, and information service activities	2.5	2.8	2.9	2.4
Professional, scientific and technical activities; administrative and support service activities	-1.4	-2.3	0.6	-1.4
Average	**1.0**	**1.9**	**1.2**	**0.8**

Source: Europe Economics' analysis of EU KLEMS data.

In Table A2.7, we present value added TFP growth rates for France calculated using the NACE I dataset.

Table A2.7: Value added TFP growth in France (NACE I, %)

Comparator sectors	Business cycle 1 (1981-1992)	Business cycle 2 (1993-2007)	NACE I full period (1981-2007)
Total manufacturing	0.8	2.3	1.6
Machinery, nec	4.0	4.5	4.3
Construction	1.9	-0.8	0.4
Transport and storage	1.3	1.5	1.4
Post and telecommunications	5.9	5.6	5.7
Average	**2.8**	**2.6**	**2.7**

Source: Europe Economics' analysis of EU KLEMS data.

In Table A2.8, we present valued added TFP growth rates for Germany calculated using the NACE I dataset.

Table A2.8: Value added TFP growth in Germany (NACE I, %)

Comparator sectors	Business cycle 2 (1993-2007)	NACE I full period (1981-2007)
Total manufacturing	2.1	1.9
Machinery, nec	1.8	1.6
Construction	-0.8	-0.8
Transport and storage	3.1	2.9
Post and telecommunications	4.4	4.2
Average	**2.1**	**2.0**

Source: Europe Economics' analysis of EU KLEMS data.